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PHYSICS

10

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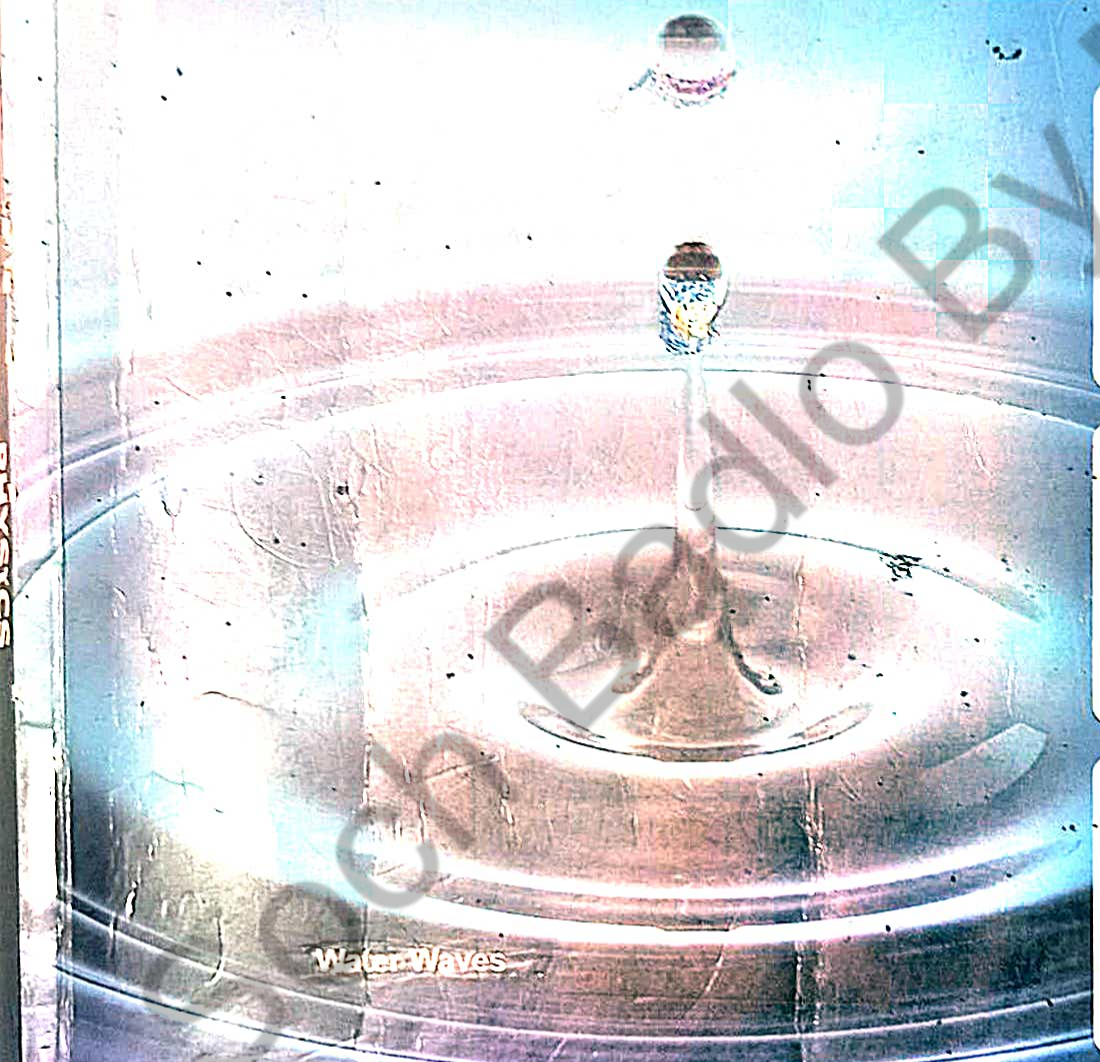

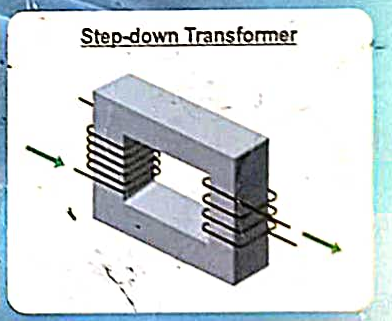

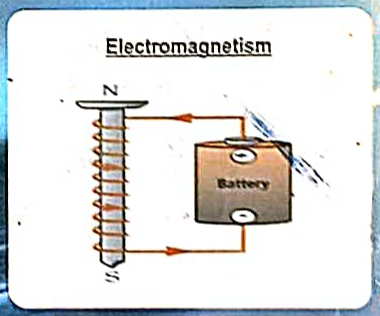

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CONTENTS

10th Physics

UNIT 10

Simple Harmonic Motion and Waves

Q.1 Define vibratory motion (oscillatory motion). 101110001

Ans. *If a body moves back and forth or to and fro about a fixed point or at an equilibrium position then this motion is said to be vibratory motion.*

Examples:

- The motion of simple pendulum.
- The motion of a swing.
- The motion of mass and spring system.

Q.2 What is meant by Simple Harmonic Motion? Prove that mass attached with a spring performs simple Harmonic Motion. (OR) (F.B. 2017) 101110002

Discuss the motion of mass attached to spring.

Ans. Simple Harmonic Motion

"The kind of vibratory motion in which acceleration of the body is directly proportional to the displacement from the mean position and is always directed towards the mean position is known as Simple Harmonic Motion".

OR

"Simple Harmonic Motion occurs when the net force is directly proportional to the displacement from the mean position and is always directed towards the mean position".

Conditions for SHM

A body executing simple Harmonic motion must fulfil the following conditions.

(i) Acceleration of body must be directly proportional to the displacement from the mean position.

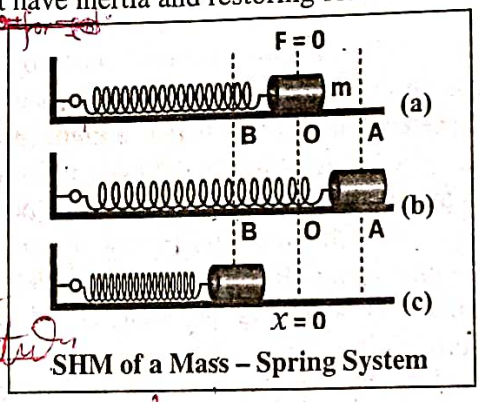
(ii) Acceleration of body should be directed towards its mean position i.e. $a \propto -x$.

(iii) The system should be frictionless and body executing SHM must have inertia and restoring force.

Motion of Mass Attached With a Spring

Consider a body of mass 'm' is attached with a spring and is placed on a horizontal surface. Other end of spring is attached with a firm support. There is no extension in the spring in this state. This means that body is at equilibrium position.

If an external force is applied on the mass, the length of spring increases by an amount 'x' and mass move from 'O' to new position 'A' which is called extreme position.



SHM of a Mass – Spring System

Hooke's Law:

According to Hooke's Law

"The external force applied on the spring is directly proportional to the increase in length" i.e.

$F_{ext} \propto x$

$F_{ext} = kx$ Where "k" is constant and is called spring constant.

Spring Constant:

The ratio of external force acting on a spring to the increase in length is called spring constant. Mathematically it can be written as:

$$k = \frac{F_{ext}}{x}$$

Unit: Its unit is Nm^{-1}.

The value of k is a measure of the stiffness of the spring. Stiff spring have a large value of k and soft spring have a small value of k.

Restoring Force:

When an external force is applied on the spring, its length will increase. After releasing the force, the spring will move towards mean position. The motion of spring towards mean position is due to a force which is called restoring force. **OR**

Restoring force always pushes or pulls the object performing oscillatory motion towards mean position.

If displacement is 'x' of mass 'm' then restoring force is:

$$F = -kx \quad \text{.....(i)}$$

Here, negative sign indicates that restoring force of spring is opposite to the direction of motion or displacement of body from mean position.

When mass 'm' is set free, it starts moving towards 'O'. According to 2nd law of motion.

$$F = ma \quad \text{.....(ii)}$$

comparing (i) and (ii)

$$ma = -kx$$

$$a = -\frac{k}{m}x$$

$$a = -\text{constant}\,(x)$$

$$a \propto -x$$

This shows that acceleration is directly proportional to displacement from the mean position and negative sign shows that it is directed towards mean position.

Vertical Forces acting on the Mass attached with a spring:

When the body is at mean position 'O' the force acting on the mass is zero. Because at this position two vertical forces i.e. the weight of the body acting downward is equal to the upward normal reaction of the horizontal surface. Hence, they cancel out each others effect so there is no motion.

Speed of mass attached with a spring between position A and B:

i. When the body is disturbed from 'O' to 'A' on ceasing the external force, body starts moving towards the mean position 'O' under the action of restoring force.

ii. When the body is about to reach at 'O' its velocity is maximum.

iii. Due to inertia, body does not stop at point 'O' but continues its motion towards point 'B' when it reaches at point 'B' its velocity reduces to zero.

Acceleration of Body between Points A and B:

i. Acceleration of the body is directly proportional to its displacement 'x' from the mean position 'O' and is always directed towards the mean position 'O'.

ii. As the mass 'm' moves towards the point 'O', its displacement 'x' goes on decreasing and velocity goes on increasing. Resultantly, the acceleration 'a' of the body also decreases.

iii. On reaching the point 'O' 'x' becomes zero and so the acceleration 'a' of the mass 'm' also reduces to zero.

iv. The acceleration of mass 'm' remains towards mean position 'O' when it moves from point 'O' to 'B'. Because the velocity of the mass 'm' starts decreasing as it passes the point 'O'.

v. The body after coming to rest at point 'B' again returns to the point 'O' under the action of the restoring force.

vi. This process continues and the body keeps on vibrating between the points 'A' and 'B'.

Conclusion:

As the acceleration of the body is directly proportional to its displacement from the mean position and is always directed towards the mean position, therefore, we can say that the motion of a mass attached to a spring is a Simple Harmonic Motion.

Time Period:

The time period of Simple Harmonic Motion of a mass attached to a spring can be found by:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Q.3 Explain the motion of ball in bowl perform Simple Harmonic Motion. 101110003

Ans. Ball and Bowl System:

The motion of a ball placed in a bowl is another example of simple harmonic motion.

Consider a ball is placed at the mean position 'O', that is, at the center of the bowl.

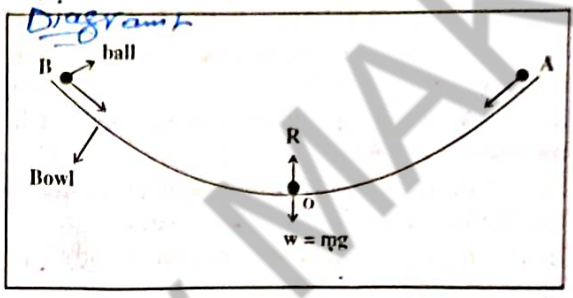
Vertical Forces acting on the ball:

When the ball is at mean position 'O', the force acting on the ball is zero because at this position two vertical forces that is the weight of the ball acting downward is equal to the upward normal force of the surface of the bowl. Hence they cancel out each others effect so there is no motion.

Motion of Ball under Restoring Force:

When an external force is applied on the ball and bring the ball to position A and then release it, the ball will start moving towards the mean position 'O' due to the restoring force caused by the weight of the ball.

Speed of ball between position A and B:



1. When the ball is disturbed from 'O' to 'A' it starts moving towards the mean position 'O' due to the restoring force caused by its weight.
2. At mean position 'O' the ball gets maximum speed and due to inertia it moves towards the extreme position B.
3. While moving towards the position 'B' the speed of the ball decreases due to the restoring force which acts towards the mean position.
4. At position 'B' the ball stops for a while, here the speed of ball becomes zero and then again ball moves towards the mean position 'O' under the action of Restoring Force.

Acceleration of ball between 'A' and 'B':

1. The speed of ball increases while moving from point 'A' to 'O' the acceleration of the ball is towards 'O'.
2. The acceleration of the ball remains towards mean position 'O', when it moves from point 'O' towards point 'B', because now speed of the ball decreases. It means acceleration of the ball always towards the mean position i.e. towards point 'O'.

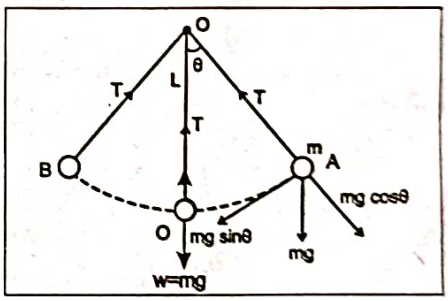
Energy changes between 'A' and 'B':

- At point 'O' the ball is at its lowest position so the potential energy of the ball is minimum and K.E of the ball is maximum.
- At point 'A' or 'B' at the highest level, the P.E is maximum and K.E of the ball is minimum i.e. zero.
- In between extreme and mean position, the energy of the ball is partially potential and partially kinetic. But the total energy remains the same.

Q.4 What is Simple Pendulum? Prove that motion of Simple Pendulum is SHM. 101101004

Ans. Simple Pendulum

"A Simple Pendulum consists of a single isolated bob suspended from frictionless support by light inextensible string." A small bob of mass 'm' is suspended by light inextensible string of length 'L'.



Vertical forces at mean position

When simple pendulum is at the mean position 'O' the net forces acting on the bob is zero and the bob is stationary. The weight of the bob is equal to the tension in the string.

Forces At Extreme Position.

When the bob is at extreme position A, the net force is not zero. There is no force acting along the string as the tension in the string cancels the component of weight mg cos θ. Hence there is no motion along this direction. The component of weight mg sinθ is directed towards mean position and act as a restoring force. Due to this force bob starts moving towards the mean position.

Velocity of Bob between 'A' and 'B':

1- In equilibrium position, the pendulum is held stationary in a vertical position at point "O".

2- When the bob is disturbed from 'O' to 'A' it starts moving towards the mean position under the action of gravitational force.

3- At 'O' the velocity of bob is maximum and due to inertia, the bob will not stop at 'O' and move to the other end 'B' and the velocity of the bob begin to decrease, and becomes zero at 'B'.

4- The bob starts its motion from 'B' to 'O' and towards 'A' the bob will continue its motion between 'A' and 'B'.

Acceleration of bob between A and B:

1. The speed of bob increases while moving from point 'A' to 'O', the acceleration of the bob is towards 'O' the direction of acceleration remains same directed towards O.
2. The direction of acceleration remain same towards 'O' during motion from point 'O' to 'B' because the speed of bob starts decreasing.

This shows that acceleration is always directed towards the mean position and is directly proportional to the displacement. So we can say that motion of simple pendulum is simple harmonic motion.

Energy changes between A and B:

1. At point 'O', the bob is at lowest position so the potential energy of the bob is minimum and K.E of bob is maximum.
2. At point 'A' or 'B', at the highest level, the potential energy is maximum and K.E of the bob is minimum i.e. zero.
3. In between extreme and mean position, the energy of the bob is partially potential and partially kinetic. But the total energy remains the same.

Note: In simple harmonic motion, a body repeats its to and fro motion in equal interval of time about its mean position.

Time Period: Time period of simple pendulum can be found by the formula.

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

Frequency $= f = \frac{1}{T} \Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$

Where 'ℓ' is length of pendulum, which is equal to the distance between the point of suspension and center of bob.

Factors on which Time Period of Simple Pendulum Depends:

The time period of simple pendulum depends on length 'ℓ' and the value of gravitational acceleration 'g', but it is independent of mass of body.

101110005

Q.5 Explain the following terms: (F.B. 2016)

(a) Vibration **(b) Time Period** **(c) Frequency**
(d) Amplitude **(e) Periodic Motion** **(f) Displacement**

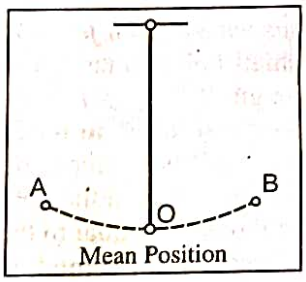
Ans.

(a) Vibration

One complete round trip of the vibrating body about its mean position is called Vibration.

(b) Time Period (T)

The time required by the vibrating body to complete one vibration is called Time Period.



(c) Frequency (f)

The number of vibrations of a vibrating body completed in one second is called Frequency.

Unit: The unit of frequency is Hertz or cycle/sec or vib/sec.

Mathematically, it can be written as:

$f = \frac{1}{T}$, this relation shows that it is the reciprocal of time period.

(d) Amplitude

The maximum displacement between mean position and extreme position of the vibrating body on either side is called Amplitude.

(e) Periodic Motion:

The type of motion in which body repeated its motion after regular interval of time is called Periodic Motion.

(f) Displacement:

The distance of vibrating body at any time from the mean position is called Displacement.

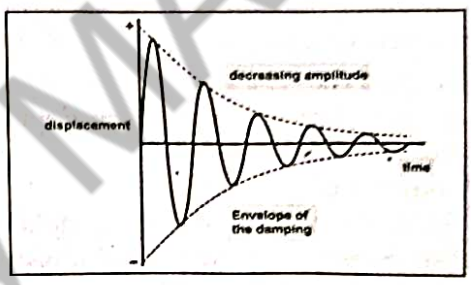
Q.6 Write the characteristic of Simple Harmonic Motion. OR
What are the important features of SHM? 101110006

Ans. Characteristics of Simple Harmonic Motion

(1) In SHM, body always vibrates about fixed point.
(2) Acceleration is always directed towards the mean position.
(3) Magnitude of acceleration is directly proportional to the displacement from the mean position and a = 0 at the mean position, 'a' is maximum at extreme position.
(4) Velocity is maximum at mean position and minimum at extreme position.

Q.7 What are damped oscillations? How damping progressively reduces the amplitude of oscillation?
OR
What do you mean by Damped Oscillation? Explain. 101110007
OR
How the strength of oscillations can reduce? Also describe its application.

Ans. Damped Motion: *"The friction reduces the mechanical energy of the system as time passes, the strength of motion reduces so that the motion is said to be damped".*

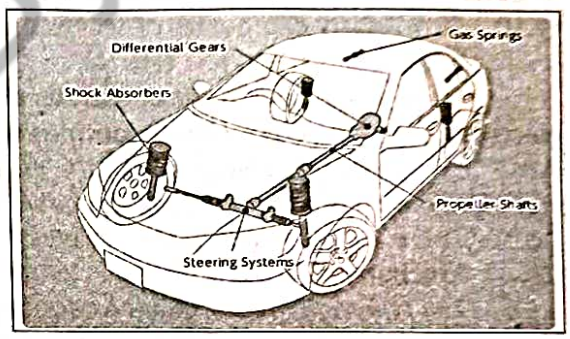


Damping progressively reduces the amplitude of the motion.

Damped Oscillations

"The oscillations of a system in the presence of some resistive force are called Damped Oscillations."

Explanation: Vibratory motion of ideal system, in the absence of any friction or resistance continues for unlimited time (Indefinitely) under the action of a restoring force. Practically in all systems the force of friction retards (reduces) the motion, so the system do not oscillate for unlimited time.



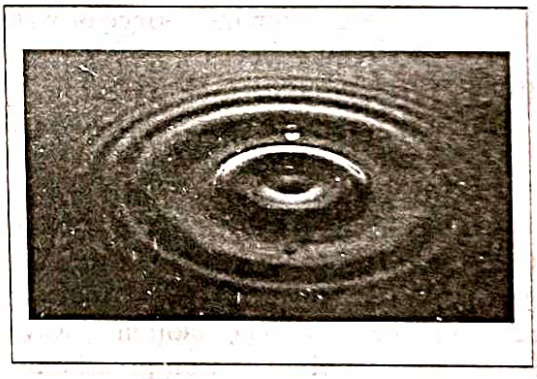
Application: Shock absorbers in automobiles are one practical application of damped motion. A shock absorber consists of a piston moving through a liquid such as oil. The upper part of the shock absorber is firmly attached to the body of the car. When the car travels over a bump on the road, the car may vibrate violently. The shock absorber damp these vibrations and convert their energy into the heat energy of the oil. Thus in the presence of some resistive force the oscillations of the system become damped oscillations.

Q.8 What is wave? Write its importance in our daily life. 101110008

Ans. *"Wave is a mechanism in which energy is transferred from one place to another place due to disturbance in the medium".*

OR

"A wave is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time."



Importance

There are some waves, which we can see while there are some, which we cannot see, but can be detected with some sensitive instruments.

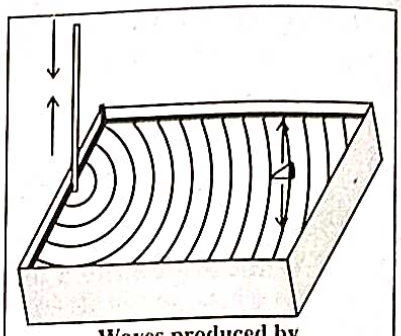
1- Sound reaches in our ears in the form of waves.
2- The sunlight and heat reaches us through waves.
3- The join broadcasting of radio and television is possible by waves.
4- The defects in human body e.g. broken bones, tumors, bullets can also be detected by waves.

Q.9 What is wave motion? Explain. 101110009
OR
What is wave motion? Demonstrate the production and propagation of waves with vibratory motion of object.

Ans. *"A wave is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time."*

Experiment 1

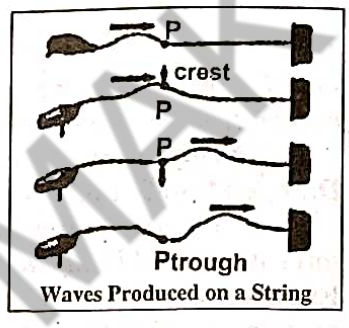
Take a tub of water and dip one end of a pencil at the edge of a tub. Move the pencil rapidly up and down vertically. The ripples emerge outward on the surface of water which moves away from the source. Place some pieces of paper or cork equally spaced in the direction of waves and observe the movement of paper, we will see that every piece of paper move up and down about its mean position. They are not displaced forward from their original position along with water waves. The pieces exhibit vibratory motion and have consecutive vertical vibratory motion. Hence this disturbance is transferred along with the wave and visible water waves are observed.



Waves produced by dipping a pencil in a water tub

Experiment 2

Take a rope and mark a point P on it. Tie one end of the rope with a hook and stretch the string by holding its other end in your hand as shown in fig. Now, flipping the rope up and down regularly will set up a wave in the rope which will travel towards the fixed end..The point P on the rope will start vibrating up and down as the wave passes across it. The motion of point P will be perpendicular to the direction of the motion of wave.



Waves Produced on a String

Conclusion

From this we can conclude that by moving the free end up and down disturbance is generated and transferred to the other end of the string and they start vibratory motion about their mean position. This disturbance travels along the string in the form of waves.

Q.10 How many categories of waves are there? Give examples of each. 101110010

OR

How can you define the term wave? Elaborate the difference between mechanical and electromagnetic waves? Give examples of each.

Ans. *"A wave is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time."*

There are two categories of waves.

(i) Mechanical Waves

The types of waves which require a medium for their production and propagation are called Mechanical Waves.

Examples:

(i) Waves on the surface of water. (ii) Waves produced in stretched string.
(iii) Sound waves

(ii) Electromagnetic Waves

The waves which do not require a medium for their propagation are called Electromagnetic waves.

Examples:

(i) Radio waves (ii) Heat and light waves
(iii) X-Rays (iv) Television Waves

Q.11 Explain the types of Mechanical Waves. Explain with examples. 101110011

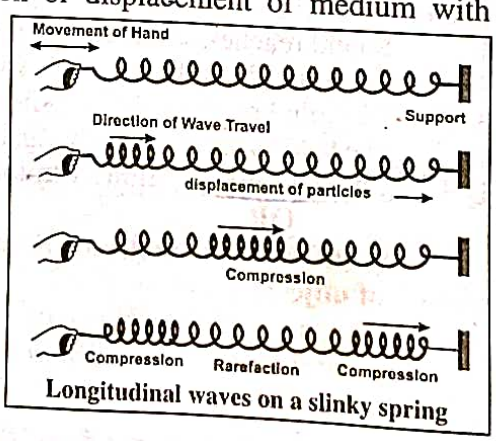
Ans. Waves are classified as following, depending upon the direction of displacement of medium with respect to the direction of motion of wave itself.

i) Longitudinal or Compressional Waves:

"In longitudinal waves the particles of the medium move back and forth, along the direction of propagation of wave". OR

"The type of mechanical waves in which the direction of vibratory motion of particles of medium is parallel to the direction of propagation of wave". e.g.,

(i) The sound waves
(ii) Waves produced in mass attached with spring.



Longitudinal waves on a slinky spring

Example:

Longitudinal waves can be produced on a spring (slinky) placed on a smooth floor or a long bench. If one end of the slinky is fixed with rigid support by holding the other end into the hand and give it a regular push or pull in the direction of its length a series of disturbance (waves) will start moving along the length of the slinky.

Regions of Longitudinal Wave

Such waves consist of two regions called compression and rarefaction.

(a) Compression

"The regions in which the loops of spring are closed together are called Compressions".

In the regions of compression, particles of medium are closed together.

(b) Rarefactions: (Expansions)

"The regions where the loops are spaced apart".

In the regions of rarefaction particles of medium are spaced apart.

ii) Transverse Waves:

"In transverse waves the motion of particles of medium is perpendicular to the motion of wave". e.g.

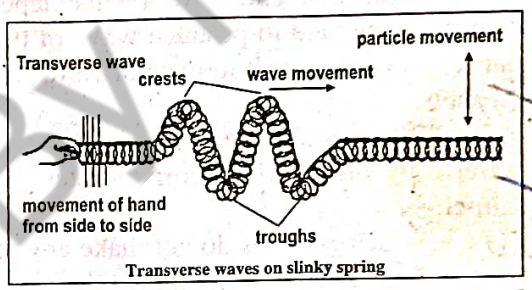
i) Waves produced in slinky by up and down motion.

ii) Waves produced on water surface.

Example 1

We can produce transverse waves with the help of a slinky. Stretch out a slinky along a smooth floor or long bench with one end fixed. Grasp the other end of slinky and move it up and down quickly.

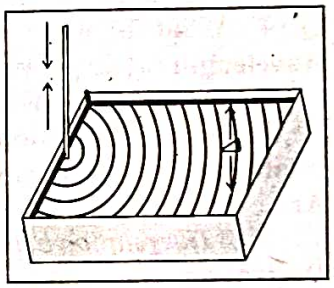
A wave in the form of alternative crests and trough will start travelling towards the fixed end. The crests are the highest points while the troughs are the lowest points of the particles of the medium from the mean position. The crests and troughs move perpendicular to the direction of the wave.



Transverse waves on slinky spring

Example 2

If one end of the pencil is dipped in water and then move up and down, waves are produced on the surface of water due to which the particles of the medium vibrate up and down, which means that direction of vibratory motion of water particles is perpendicular to the motion of waves.



Q.12 Define the following terms: 101110012

(i) Crest (ii) Trough (iii) Wavelength

Ans.

(i) Crest: (Highest Points)

The part of transverse waves where particles of medium are above the normal position are called Crest.

(ii) Trough: (Lower Points)

The part of transverse waves where the particles of medium are below the normal position are called Trough.

(iii) Wave Length (λ)

The distance between two consecutive crests or troughs is called Wavelength.

It is represented by (λ).

Note: A crest and a trough are joined to make one complete wave.

Q.13 Write a note on "waves as a carrier of energy". Also describe factors on which the amount of energy carried by the wave depends. 101110013

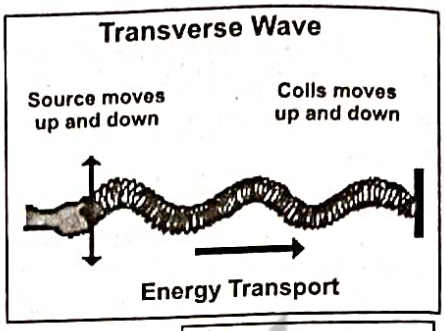
OR

Waves are the means of energy transfer without transfer of matter. Justify this statement with the help of a simple experiment.

Ans. Waves as a Carrier of Energy

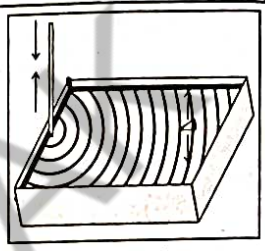
Energy can be transferred from one place to another through waves.

Example 1



When we shake the stretched string up and down we provide our muscular energy to the string. As a result a set of waves can be seen travelling along the string. The vibrating force of hand disturbs the particles of string and sets them in motion. These particles transfer their energy to the adjacent particles in the string. Energy is thus transferred from one place of the medium to the other in the form of waves.

Example 2



Take a rectangular tray and fill it with water. Start moving a vertical rod in the water up and down which produces transverse waves on the surface of water.

Place a cork on the surface of water near the other end of the tray opposite to rod.

When waves pass through cork, the cork vibrates up and down perpendicular to the water surface.

Dependence of Energy Carried by Waves

The amount of energy carried by the waves depends on the distance of stretched string from its mean position.

That is the energy of a wave depends on a wave amplitude. If we shake the string faster, we give more energy per second to produce wave of higher frequency, and the wave delivers more energy per second to the particles of string as it moves forward.

Reason

We have transferred our energy in moving the rod up and down. This energy reaches the cork through water wave due to which cork vibrates.

Conclusion

(1) Water particles do not make any forward motion along the direction of wave.

(2) They keep on vibrating at their respective places and wave passes through it.

Q.14 What is wave equation? Establish a relation between wave speed (v), frequency (f) and wavelength (λ) or prove that v = f λ. (F.B. 2015) 101110014

OR

Derive a relationship between velocity, frequency and wavelength of a wave. Write a formula relating velocity of a wave to its time period and wavelength.

Ans. Wave Equation

"The relation between the velocity, frequency and wavelength of the wave is known as Wave Equation."

Derivation

Wave is infact a disturbance in a medium which travels from one place to another and hence have a specific velocity of travelling. This is called the velocity of wave which is defined by

$$Velocity = \frac{distance}{Time}$$

$$v = \frac{d}{t}$$

If time taken by the wave in moving from one point to another is equal to the time period then the distance covered by the wave will be equal to one wavelength, hence we can write it as

$$v = \frac{\lambda}{T}$$

As the time period 'T' is reciprocal of the frequency 'f' i.e. $T = \frac{1}{f}$

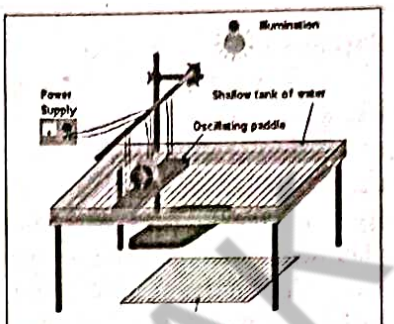
Therefore, $v = \frac{1}{T} \times \lambda, \; v = f\lambda$

This equation is called wave equation and is true for all type of waves i.e. Longitudinal, Transverse etc.

Q.15 Write a note on Ripple Tank. How can we generate straight waves and circular waves with the help of Ripple Tank? 101110015

Ans. Ripple Tank

It is an apparatus which is used to produce waves and to study their properties.



Wave patterns on a viewing screen or table.

Construction

It consists of rectangular tray with glass bottom. It is placed nearly half metre above the surface of table by means of four supporting legs. Waves are produced on the surface of water present in the tray by means of vibrator. The vibrator is an oscillating electric motor which is fixed on wooden bar. The plate is suspended by means of rubber band and its lower end just touches the surface of water.

Generation of Straight Waves

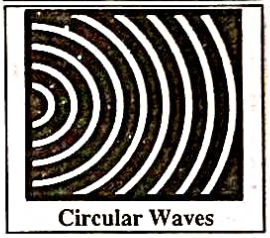
On setting vibrator on, the plates start vibrating and straight waves are generated on water surface.


Plane Waves

A lamp is hung over tray, to see image of water waves which is obtained on white paper or screen. The crest of wave appear as bright line on the paper because they function like convex lens and converge the light falling on them. The trough behaves like concave lens and diverge the light and appear as dark straight portions between bright lines.

Generation of Circular waves

To generate circular waves, the vibrating bar is raised up and a knob is attached, which is lowered in such a way that it touches the surface of water, when vibrator is set, circular waves are produced.


Circular Waves

The picture of waves has been taken by the help of a high power camera. The waves were seen continuously moving on the paper.

Q.16 Describe the following characteristics of waves: 101110016

(a) Reflection (b) Refraction (c) Diffraction

OR

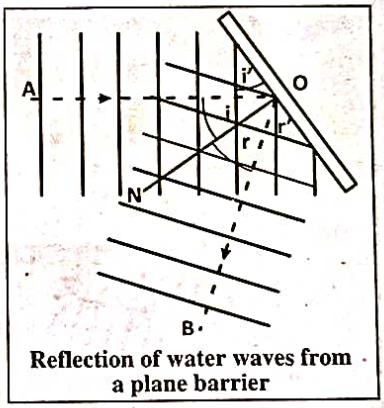
Explain the following properties of waves with reference to ripple tank experiment

(a) Reflection (b) Refraction (c) Diffraction

Ans. To study these properties we will use ripple tank.

(i) Reflection of Waves

When waves moving in one medium fall on the surface of another medium they bounce back into the first medium such that the angle of incidence is equal to the angle of reflection. The phenomena is called reflection of waves.



Reflection of water waves from a plane barrier

Explanation:

The water waves are reflected according to the laws of reflection of light waves. To observe the reflection of water waves straight waves are generated in the ripple tank. Place a plane surface obstacle in the path of waves making certain angle with the direction of propagation of waves. After striking the obstacle, the waves will be reflected in a particular direction to obey the laws of reflection.

Angle of Incidence

The angle between incident ray and normal is called angle of incidence '$\angle i$'.

Angle of Reflection

The angle between reflected ray and normal is called angle of reflection '$\angle r$'.

Angle of Incidence and angle of Reflection

The angle between the line AO and normal NO is called angle of Incidence and the angle between OB and ON is the angle of Reflection.

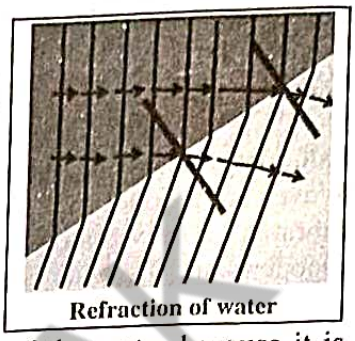
It is evident that angle of incidence is equal to angle of reflection i.e.

$\angle i = \angle r$.

(ii) Refraction

"When waves from one medium enter in the second medium at some angle their direction of travel may change. This phenomenon is called refraction of waves."

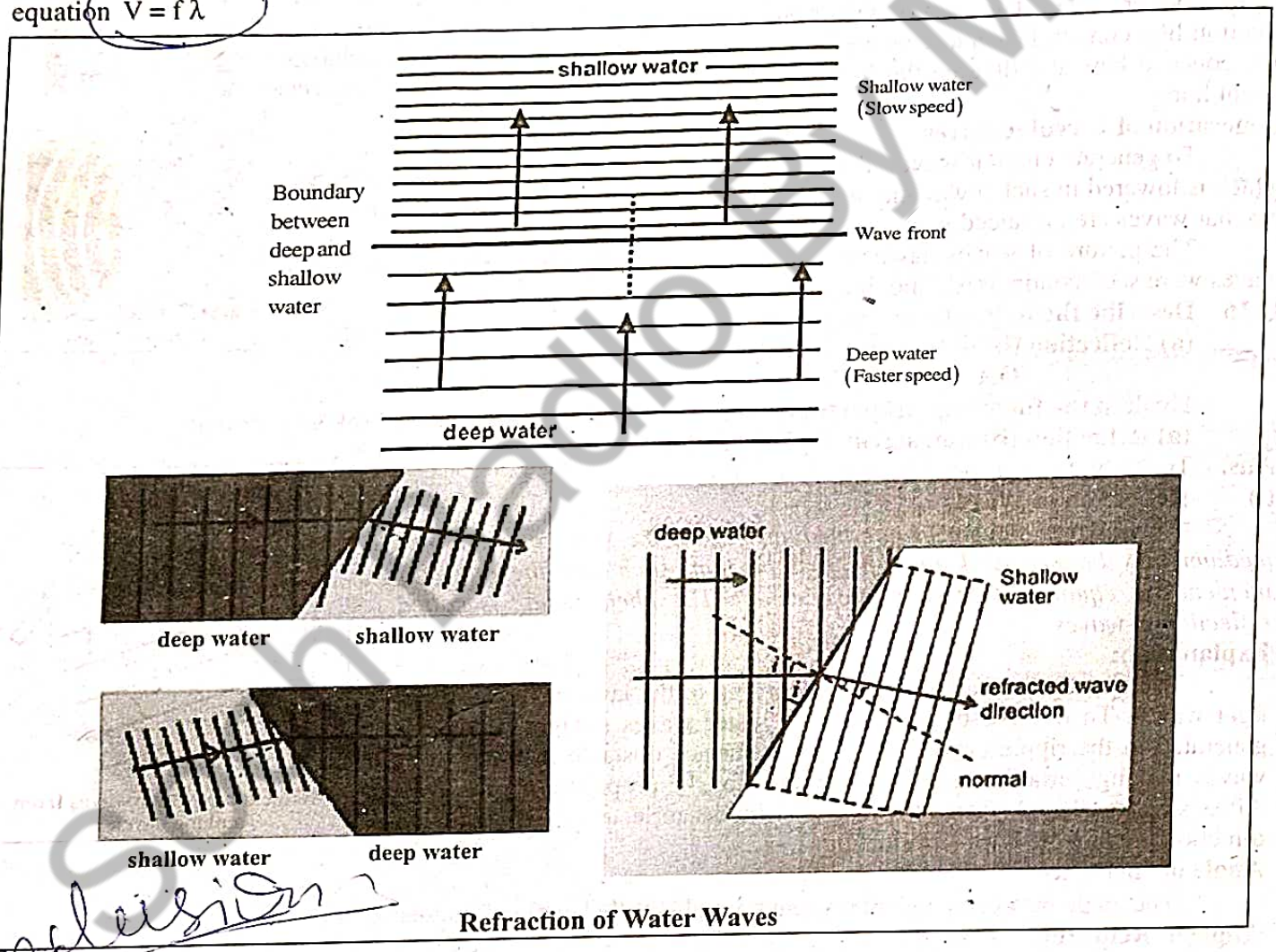
Explanation:


Refraction of water

The speed of light is more in air or vacuum than in glass or water. The speed of water waves depends upon the depth of water. Its speed is reduced when it enters into the shallow water. To observe the relation between wave speed with water depth cover the half of the bottom of the ripple tank with a thick glass plate. By doing so we get two portions of water with different depths. The edge of the plate separating the two portions should be parallel to the bar of the vibrator.

When the electric motor is switched on, straight waves are produced on the surface of water. We find that the wavelength of the waves decreases when they reach the shallow part. The frequency of the waves does not change in both parts of the water because it is equal to the frequency of vibrator.

In the shallow part, the decrease in wavelength is due to decrease in speed of wave according to the equation $V = f\lambda$



Refraction of Water Waves

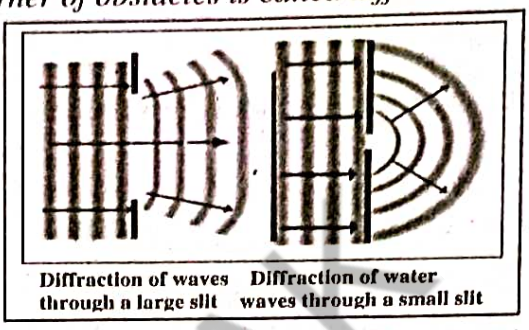
For the observation of refraction of water waves, we repeat the above experiment such that the boundary between the deep and the shallower water is at some angle to the wave front. Now we will observe that in addition to the change in wavelength, the waves change their direction of propagation as well. Note that the direction of propagation is always normal to the wave fronts. This change of path of water waves while passing from a region of deep water to that of shallower one is called refraction:

(3) Diffraction

The bending or spreading of waves around the sharp edges or corner of obstacles is called diffraction.

Explanation

To generate straight waves in a ripple tank, place two obstacles in a line in such a way that the separation between them is equal to the wavelength of water wave. After passing through the slit between two obstacles the waves can be seen spreading in every direction and changing to almost semicircular pattern.



Diffraction of waves through a large slit | Diffraction of water waves through a small slit

Condition

Diffraction of wave can be observed clearly only when size of slit or obstacle is nearly equal to the wavelength of the wave.

But if the size of the slit is larger than the wavelength of the wave, then diffraction is not significant and waves keep their initial motion even after passing through the slit, and their shape remains straight. A little diffraction effect appears near the corners of the obstacle.

Q17. What are wave fronts? Short Question 101110017

Ans. Wave fronts

A surface on the wave, where all points of waves have same phase of oscillation. Wave fronts generally form a continuous line or surface.

There are three types of wave fronts

(i) Spherical wave front.
(ii) Plane wave front.
(iii) Cylindrical wave front.

Q18. Does increasing the frequency of a wave also increase its wavelength? If not, how are these quantities related? 101110018

Ans. As we know that $v = f\lambda$ $\Rightarrow f = \frac{v}{\lambda}$

According to this relation if wave speed is constant then wavelength 'λ' will decrease as the frequency increases. The frequency and wavelength of a wave have inverse relation with each other.

Multiple Choice Questions

Choose the correct answer from the following choices:

Exercise MCQs

1. Which of the following is an example of simple harmonic motion? 101110019
(a) Motion of a simple pendulum
(b) The motion of ceiling fan
(c) The spinning of the Earth on its axis
(d) A bouncing ball on a floor

2. If the mass of the bob of a pendulum is increased by a factor of 3, the period of the pendulum's motion will: 101110020
(a) be increased by a factor of 2
(b) remain the same
(c) be decreased by a factor of 2
(d) be decreased by a factor of 4

3. Which of the following devices can be used to produce both a transverse and longitudinal waves? 101110021
(a) a string
(b) a ripple tank
(c) a helical spring (slinky)
(d) a tuning fork

4. Waves transfer (F.B. 2016,17) 101110022
(a) energy (b) frequency
(c) wavelength (d) velocity

5. Which of the following is a method of energy transfer? 101110023
(a) conduction (b) radiation
(c) wave motion (d) all of these

6. In a vacuum all electromagnetic waves have the same: (F.B. 2017) 101110024
(a) speed (b) frequency
(c) amplitude (d) wavelength

7. A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves in a distance of 50 cm. The velocity of the wave is: (F.B. 2017) 101110025
(a) 53 cms^{-1} (b) 60 cms^{-1}
(c) 750 cms^{-1} (d) 1500 cms^{-1}

8. **Which of the following characteristics of a wave is independent of the others** 101110026
(a) speed (b) frequency
(c) amplitude (d) wavelength

9. **The relation between v, f and λ of a wave is:** (F.B. 2014) 101110027
(a) $v f = \lambda$ (b) $f \lambda = v$
(c) $v \lambda = f$ (d) $v = \lambda / f$

Additional MCQs

10. **The disturbance travelling in a medium is called** 101110028
(a) Wave motion
(b) Simple Harmonic Motion
(c) Motion
(d) both a, b

11. **The waves, which are used to detect the broken bones, are called:** 101110029
(a) Light waves (b) X-rays
(c) Sound waves (d) transvers waves

12. **The force applied on the mass attached with a spring is represented by:** 101110030
(a) F_a (b) F_c
(c) F_{ext} (d) F_s

13. **If there is no extension in the spring then this position is called** 101110031
(a) Equilibrium position
(b) Unequilibrium
(c) Neutral equilibrium
(d) Stable equilibrium

14. **The unit of spring constant is.** 01110032
(a) m (b) kg
(c) Nm^2 (d) Nm^{-1}

15. **If the displacement in spring is 'x' of mass "m" attached with a spring then restoring force is:** 101110033
(a) F = ma (b) F = kx
(c) F = - kx (d) $F = \frac{m}{a}$

16. **The ratio of external force applied on the spring to displacement is called:** 101110034
(a) Hooke's Law
(b) Constant
(c) Spring constant
(d) Force

17. **The time required to complete one round trip (vibration) about mean position is called:** 101110035
(a) Time period (b) Frequency
(c) Amplitude (d) None of these

18. **The time period of mass attached with a spring can be calculated by:** 101110036
(a) $T = 2\pi\sqrt{\ell / g}$ (b) $T = 2\pi\sqrt{\frac{k}{m}}$
(c) $T = 2\pi\sqrt{g / \ell}$ (d) $T = 2\pi\sqrt{\frac{m}{k}}$

19. **The time period of simple pendulum can be calculated by:** 101110037
(a) $T = 2\pi\sqrt{\ell / g}$ (b) $T = 2\pi\sqrt{\frac{m}{k}}$
(c) $T = 2\pi\sqrt{g / \ell}$ (d) $T = 2\pi\sqrt{\frac{k}{m}}$

20. **The maximum displacement from mean position is called:** 101110038
(a) Maximum height (b) Time period
(c) Amplitude (d) Interval

21. **The displacement produced in the spring is directly proportional to force is called:** 101110039
(a) Hooke's law (b) Boyle's law
(c) Newton's law (d) Joule's law

22. **At mean position of pendulum, the potential energy of the pendulum is:** 101110040
(a) Maximum (b) Minimum
(c) Much more (d) both a and c

23. **At mean position kinetic energy of the ball is.** 101110041
(a) Minimum (b) Zero
(c) Maximum (d) 10J

24. **At extreme position potential energy of the pendulum is _____.** 101110042
(a) Maximum (b) Minimum
(c) a and b (d) Zero

25. **In Simple Harmonic Motion, the acceleration of the body is_____ proportional to the displacement.** 101110043
(a) Inversely (b) Directly
(c) Equally (d) ratio

26. **The value of acceleration in simple harmonic motion at mean position is** 101110044
(a) Maximum (b) Zero
(c) 10N (d) Both a, b

27. **The waves in which particles of the medium vibrate parallel to the direction of waves are called.** 101110045
(a) Longitudinal waves
(b) Transverse waves
(c) Electromagnetic waves
(d) both 'b' and 'c'

28. The waves in which particles of the medium vibrate perpendicular to the direction of waves are: 101110046
(a) Electromagnetic waves
(b) Sound waves
(c) Both 'a' and 'b'
(d) Transverse waves

29. The sound waves are the example of
(a) Longitudinal waves 101110047
(b) Transverse waves
(c) Electromagnetic waves
(d) x-rays

30. The energy is transferred from one place to another: 101110048
(a) Through matter (b) through waves
(c) both 'a' and 'b' (d) through vacuum

31. The waves have properties 101110049
(a) Reflection (b) Refraction
(c) Diffraction (d) all of these

32. The time period of body attached to spring depends on. 101110050
(a) mass
(b) gravitational constant
(c) length
(d) amplitude

33. The part of waves at which particles of the medium are below the normal position are called. 101110051
(a) Extreme position (b) Crest
(c) Trough (d) Compression

34. The distance between two consecutive troughs or crests is called: 101110052
(a) Wavelength (b) Frequency
(c) Time period (d) Amplitude

35. The number of waves passing through a point in one second is called: 101110053
(a) Time period (b) Cycle
(c) Frequency (d) Amplitude

36. The unit of frequency is: 101110054
(a) Hertz
(b) Vibration per second
(c) Cycle per second
(d) all a, b, c,

37. The speed of waves can be calculated by: 101110055
(a) vt (b) $d \times t$
(c) $f\lambda$ (d) Tf

38. The water waves after striking the hurdle will. 101110056
(a) Reflect (b) Refract
(c) Diffract (d) All a, b, c

39. The motion in which the friction reduces the mechanical energy of the system as times passes and the amplitude of motion reduces is called: 101110057
(a) SHM
(b) Random motion
(c) Damped motion
(d) Circulatory motion

40. The oscillations of a system in the presence of ---------- force are called damp oscillations: 101110058
(a) Resistive force
(b) Attractive force
(c) Coulomb force
(d) Both 'a' and 'b'

41. The example of shock absorber of the vehicles are: 101110059
(a) Simple harmonic motion
(b) Vibratory motion
(c) Damped motion
(d) Linear motion

42. Time period is reciprocal of: (F.B 2018) 101110060
(a) Frequency (b) Cycle
(c) Wave length (d) Amplitude

43. The water waves obey the laws of: (F.B 2013) 101110061
(a) Reflection (b) Refraction
(c) Diffraction (d) all of these

44. The product of frequency and time period is equal to: 101110062
(a) v (b) 1
(c) 0 (d) λ

45. If the mass of bob of a simple pendulum is doubled, its time period: 101110063
(a) is doubled
(b) becomes four times
(c) remains same
(d) becomes half

46. If the length of a simple pendulum is halved, its time period 'T' will become: 101110064
(a) $\frac{T}{2}$ (b) $\frac{T}{\sqrt{2}}$
(c) $\sqrt{2}\,T$ (d) 2T

47. Diffraction of wave can be observed clearly only when the size of slit or obstacle is nearly _____ to the wavelength of the wave: 101110065
(a) Two times (b) Equal
(c) Four times (d) Half

48. **In simple pendulum motion restoring force is provided by** 101110066
(a) Air resistance
(b) Tension in the string
(c) Inertia
(d) Weight of the body

49. **Ripple tank is an instrument which is used to study the characteristics of:** 101110067
(a) Mechanical Waves
(b) Light Waves
(c) Radio Waves
(d) Electro-Magnet Waves

50. **Radio waves are:** 101110068
a) Longitudinal waves
b) Transverse waves
c) Electromagnetic waves
d) All of these

51. **The product of frequency and wavelength is equal to:** 101110069
(a) time period (b) amplitude
(c) wave speed (d) wave energy

52. **When a body moves to and fro about a point, its motion is called:** 101110070
(a) random motion (b) vibratory motion
(c) linear motion (d) rotatory motion

53. **If time period is given the frequency is calculated as:** 101110071
(a) $f = \frac{1}{T}$ (b) $f = \frac{2}{T}$
(c) $f = \frac{3}{T}$ (d) $f = \frac{4}{T}$

54. **The distance between two consecutive waves compressions or rarefaction is called:** 101110072
(a) focal length (b) wave length
(c) frequency (d) time period

55. **The spring constant is:** 101110073
(a) $k = \frac{-F}{x}$ (b) $F = ma$
(c) $w = mg$ (d) $k = \frac{-x}{m}$

56. **Frequency is equal to:** 101110074
(a) $f = \frac{1}{T}$ (b) $f = \frac{l}{g}$
(c) $f = 2\pi\sqrt{\frac{l}{g}}$ (d) $f = kx$

57. **If F = 0.08N and x = 4cm, then value of 'k' is:** (F.B. 2016) 101110075
(a) 4 Nm^{-1} (b) 0.2 Nm^{-1}
(c) 0.4 Nm^{-1} (d) 2 Nm^{-1}

58. **When a ball is gently displaced from the centre of a bowl, it starts oscillating about the centre due to:** (F.B.2016) 101110076
(a) force of friction (b) force of gravity
(c) elastic force (d) magnetic force

59. **The pendulum clock was invented by:** 101110077
(a) Newton (b) Galileo
(c) Hygens (d) Faraday

60. **A body has mass 0.5kg. If the spring constant is 8Nm^{-1}. What will be the period of the body?** 101110078
(a) 12.4 sec (b) 1.57 sec
(c) 15.7 sec (d) 0.157 sec

61. **What is the frequency of second pendulum?** (F.B 2018) 101110079
(a) 1.5 Hz (b) 2 Hz
(c) 1 Hz (d) 0.5 Hz

62. **If the mass of bob of a pendulum is increased by a factor '2' then period of pendulum motion will:** (F.B 2018) 101110080
(a) increase a factor of '2'
(b) increase a factor of '4'
(c) remains' same
(d) increase a factor of $\sqrt{2}$

Answer Key

1.	a	2.	b	3.	c	4.	a	5.	d	6.	a	7.	b
8.	c	9.	b	10.	a	11.	b	12.	c	13.	a	14.	d
15.	c	16.	c	17.	a	18.	d	19.	a	20.	c	21.	a
22.	b	23.	c	24.	a	25.	b	26.	b	27.	a	28.	d
29.	a	30.	c	31.	d	32.	a	33.	c	34.	a	35.	c
36.	d	37.	c	38.	a	39.	c	40.	a	41.	c	42.	a
43.	d	44.	b	45.	c	46.	b	47.	b	48.	d	49.	a
50.	c	51.	c	52.	b	53.	a	54.	b	55.	a	56.	a
57.	d	58.	b	59.	c	60.	b	61.	d	62.	c		

Review Questions

Q.10.1 What is simple harmonic motion? What are the necessary conditions for a body to execute simple harmonic motion?

OR

Define simple harmonic motion. Write down its three properties. 101110081

Ans. The acceleration of the body executing S.H.M is directly proportional to the displacement from the mean position and always directed towards the mean position.

(i) A body always vibrate about its mean position.
(ii) Acceleration is always directed towards mean position.
(iii) Acceleration is directly proportional to the displacement and a = 0 at mean position and 'a' is maximum at extreme position.
(iv) The velocity 'v' is maximum at mean position and zero at extreme position.

Q.10.2 Think of several examples in everyday life of motion that are simple harmonic? 101110082

Ans.

(i) Up and down motion of a leaf in water pond.
(ii) Motion of plucked string fixed at the both ends.
(iii) Motion of swing
(iv) Motion of vibrating prongs of tuning fork

Q.10.3 What are damped oscillations. How damping progressively reduces the amptitude of oscillation? 101110083

Ans. See Q#7 on Page# 5

Q.10.4 How can you define the term wave? Elaborate the difference between mechanical and electromagnetic waves? 101110084

Ans. Wave: A wave is a mechanism in which energy is transferred from one place to another due to disturbance in the medium.

Mechanical waves	Electromagnetic waves
The type of wave which requires a medium for its production and propagation is called mechanical waves e.g. sound wave	The type of wave which does not require a medium for its propagation is called electromagnetic wave. e.g. light waves

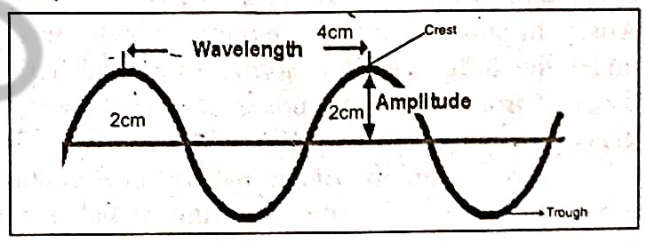
Q.10.5 Distinguish between longitudinal and transverse waves with suitable examples. 101110085

Ans.

Longitudinal Waves	Transverse Waves
1. In longitudinal waves the particles of the medium move back and forth, along the direction of propagation of wave.	1. In transverse waves the particles of the medium vibrate perpendicular to the direction of propagation of wave.
2. Longitudinal waves propagate in the form of compression and rarefactions	2. Transverse waves propagate in the form of crests and troughs.
3. Example: Sound waves, waves produced in mass attached with spring	3. Example: Water waves, waves produced in slinky by up and down motion.

Q.10.6 Draw a Transverse wave with an amplitude of 2 cm and a wavelength 4 cm. Label a crest and trough on the wave. (F.B.2017) 101110086

Ans.



Q.10.7 Derive the relationship between velocity, frequency and wavelength of a wave. Write a formula relating velocity a wave to its time period and wavelength. 101110087

Ans. See Q#14 on Page# 8

Q.10.8 Waves are the means of energy transfer without transfer of matter. Justify this statement with the help of simple experiment. 101110088

Ans. See Q#13 on Page# 7

Q.10.9 Explain the following properties of waves with reference to ripple tank experiment (a) Reflection (b) Refraction (c) Diffraction 101110089

Ans. See Q#16 on Page# 9

Q.10.10 Does increasing the frequency of a wave also increase its wavelength? 101110090

If not, how are these quantities related?

Ans. See Q#18 on Page#11

Conceptual Questions

Q.10.1 If the length of simple pendulum is doubled. What will be change in time period? (F.B. 2014,16) 101110091

Ans. If the length of simple pendulum is doubled its time period will be $\sqrt{2}\,T$.

As we know

Time period of simple pendulum

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

When $\ell = 2\ell$

Then

$$T' = 2\pi\sqrt{\frac{2\ell}{g}}$$

$$T' = \sqrt{2}\left(2\pi\sqrt{\frac{\ell}{g}}\right)$$

$$T' = \sqrt{2}\,T$$

Q.10.2 A ball is dropped from a certain height onto the floor and keeps bouncing. Is the motion of the ball simple harmonic? Explain. 101110092

Ans. In simple harmonic motion, a body moves under the influence of restoring force and a ball dropped from the height moves under the force of gravity.

No, the motion of the ball is not executing SHM. Because during the bouncing of ball mean position is not specified and it does not fulfill the conditions of simple harmonic motion. Bouncing ball moves with linear motion while SHM is the vibratory motion.

Q.10.3 A student performed two experiments with a simple pendulum. He / She used two bobs of different masses by keeping other parameters constant. To his/her astonishment the time period of the pendulum did not change! Why? 101110093

Ans. Time period of the simple pendulum is independent of mass. Time period of the simple pendulum does not change, with the change of mass, because it does not depend upon mass of the body as

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

Q.10.4 What types of waves do not require any material medium for their propagation? 101110094

Ans. Electromagnetic waves do not require any material medium to propagate.

Q.10.5 Plane waves in the ripple tank undergo refraction when they move from deep to shallow water. What change occurs in the speed of the waves? (F.B. 2017) 101110095

Ans. The water waves enter into the region of shallow water, their wavelength decreases as given by the formula: $v = f\lambda$

As wavelength decreases, the speed of wave also decreases.

Additional Short Questions

Q.1 Define Vibratory motion. Give conditions of vibratory motion. 101110096

Ans. To and fro motion of a body about its mean position in equal interval of time is called Vibratory motion, and the particle of the medium does not change their place.

These are some conditions of vibratory motion.

i. The motion is under the action of some restoring force.

ii. Vibratory motion repeats itself after regular intervals of time.

iii. It satisfies law of conservation of energy.

iv. Body moves to and fro about its mean position.

v. The body must have inertia.

Q.2 What is meant by Time Period? 101110097

Ans. Time required to complete one round trip (vibration) is called Time Period.

Q.3 What are Mechanical waves?

OR

Define mechanical waves and given an example. 101110098

Ans. The waves which require some medium for their propagation are called Mechanical waves. For example sound waves, water waves, string waves.

Q.4 Define Transverse waves. 101110099

Ans. The waves in which particle of the medium vibrates perpendicular to the direction of propagation of waves. For example water waves.

Q.5 Define crest and trough of a wave. 101110100

Ans. Crest: The part of transverse waves at which particles of the medium are above the normal position is called crest.

Trough: The part of transverse wave at which particles of the medium are below the normal position is called trough.

Q.6 What is frequency? Write its unit. 101110101

Ans. The number of waves passing through a point in one second is called frequency. Its unit is cycle per sec, Hertz (Hz) or vib/sec.

Q.7 State Hooke's Law. 101110102

Ans. The force applied on the spring is directly proportional to the increase in length is called Hooke's law i.e. $F_{ext} \propto x$.

Q.8 What is meant by Amplitude? 101110103

Ans. The maximum displacement from mean position to extreme position during vibratory motion is called Amplitude.

Q.9 Define Compressional waves. / Longitudinal Waves. 101110104

Ans. The waves in which particles of the medium vibrate parallel to direction of propagation of waves are called compression al waves.

Q.10 Define the following terms Reflection, Refraction and Diffraction. 101110105

Ans. Reflection

The bouncing back of water waves after striking the hurdle is called reflection of waves, and it also obeys the laws of reflection of light.

Refraction:

When a ray of light enters from one transparent medium to another transparent medium, it bends away from its path the bending of waves from their incident path is called refraction.

Diffraction

The bending or spreading of waves around the sharp edges or corner of obstacle is called diffraction.

Q.11 Give an example, which explain that energy is transferred through waves. 101110106

Ans. Take a rectangular tray and fill it with water start moving vertical road up and down which produce the wave on the surface of water. Place the cork on the surface of water near the other end of tray opposite to road.

When wave pass through the cork, the cork vibrate up and down. Which shows that energy transfer through the waves.

Q.12 Define damped oscillations. 101110107

Ans. "The oscillations of a system in the presence of some resistive force are damped oscillations".

Q.13 What is the advantage of having shock absorbers in a car? (F.B. 2014) 101110108

Ans. Shock absorbers in automobiles are one practical application of damped motion. A shock absorber consists of a piston moving through a liquid such as oil. The upper part of the shock absorber is firmly attached to the body of the car. When the car travels over a bump on the road, the car may vibrate violently. The shock absorber damp these vibrations and convert their energy into the heat energy of the oil. Thus in the presence of some resistive force, the oscillations of the system become damped oscillation.

Q.14 Write down any three common properties of longitudinal and transverse waves. (F.B. 2018) 101110109

Ans. Three common properties of longitudinal and transverse waves are given below:

(i) Longitudinal and transverse waves are mechanical waves.

(ii) Both waves need a material medium for it propagation.

(iii) Both waves transfer energy from one place to another place.

(iv) In both types of waves, particles of the medium vibrate about their mean position.

Q.15 If the length of sample is 4 times, What will be change in its time period. (F.B. 2018) 101110110

Ans. As we know that, time period of simple pendulum is:

$$T = 2\pi\sqrt{\frac{\ell}{g}} \quad \text{----- (i)}$$

If length is four times then

$$\ell' = 4\ell$$

$$T' = 2\pi\sqrt{\frac{\ell'}{g}}$$

Put the value of "ℓ'"

$$T' = 2\pi\sqrt{\frac{4l}{g}}$$

$$T' = \sqrt{4}\left(2\pi\sqrt{\frac{\ell}{g}}\right)$$

From Eq.(i), $2\pi\sqrt{\frac{\ell}{g}} = T$

$$T' = \sqrt{4}\,T$$

$$T' = 2T$$

It means that if the length of simple pendulum is 4-times then the change in time period will be 2-times the original time period of simple pendulum.

Side Information

Q.16 How does a spider detect its prey? 101110111

Ans. A spider detects its prey due to the vibrations produced in the web.

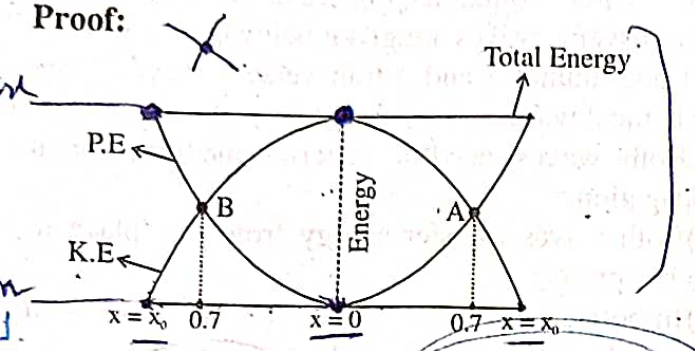
Q.17 Under which restoring force a ball oscillates in a bowl when displaced from the centre of bowl? 101110112

Ans. When a ball is gently displaced from the centre of a bowl, it starts oscillating about the centre due to the force of gravity which acts as a restoring force.

Q.18 What will be the displacement of an object in SHM when the kinetic and potential energies are equal? 101110113

Ans. Following graph shows energy conservation in S.H.M.

Proof:



Instantaneous Kinetic Energy $= \frac{1}{2}Kx_0^2 - \frac{1}{2}Kx^2$

Instantaneous Potential Energy $= \frac{1}{2}Kx^2$

According to the statement

Inst. Potential Energy = Inst. Kinetic Energy

$$\frac{1}{2}Kx^2 = \frac{1}{2}Kx_0^2 - \frac{1}{2}Kx^2$$

$$\frac{1}{2}Kx^2 + \frac{1}{2}Kx^2 = \frac{1}{2}Kx_0^2$$

$$Kx^2 = \frac{1}{2}Kx_0^2$$

$$x^2 = \frac{1}{2}x_0^2$$

By taking square root on both sides

$$\sqrt{x^2} = \frac{\sqrt{x_0^2}}{\sqrt{2}}$$

$$x = \frac{x_0}{\sqrt{2}}$$

$$x = 0.7 \times x_0 \qquad \left(\because \frac{1}{\sqrt{2}} = 0.7\right)$$

As 0.7 = 70%

At intersecting points A and B, both the kinetic and potential energies are equal. The instantaneous displacement at A and B is 0.7 which is 70% of amplitude.

Hence, we can say that when the Potential and Kinetic energies in SHM are equal then the instantaneous displacement of an oscillator will be 70% of the amplitude.

Q.19 Tell whether or not below mentioned motions are SHM. 101110114

Ans.

(a) Up and down motion of a leaf in water pond. (SHM)

(b) Motion of a ceiling fan. (Not SHM)

(c) Motion of hands of clock. (Not SHM)

(d) Motion of plucked string fixed at the both ends. (SHM)

e) Movement of honey bee. (Not SHM)

Q.20 Who invented the pendulum clock and when? 101110115

Ans. Christian Huygens invented the pendulum clock in 1656. Huygens developed the first clock that could accurately measure time.

Q.21 Relate the speed of longitudinal and transverse waves through solid, liquid or gas. 101110116

Ans. Longitudinal waves move faster through solids than through gases or liquids. Transverse waves move through solids at a speed less than half of the speed of longitudinal waves. It is because the restoring force exerted during up and down motion of the particles of medium is less than the restoring force exerted by a back and forth motion of the particles of the medium in case of longitudinal waves.

Q.22 How much energy is required to generate the high frequency wave as compared to the low frequency wave? 101110117

Ans. To generate a high frequency wave requires more energy per second than to generate a low frequency waves. Thus, a high frequency wave carries more energy than low frequency wave of the same amplitude.

Q.23 What are Seismic Waves? Explain. 101110118

Ans. Earthquake produces waves through the body of the Earth in the form of seismic waves. By studying such waves, the geophysicists learn about the internal structure of the Earth and information about the occurrence of future Earth activity.

Q.24 What happens to the angle of refraction when water waves pass from deep to shallow part of the water? 101110119

Ans. While entering from the part of greater depth to shallower depth wave changes its direction in addition to decrease in wavelength. It is clear that when water enters the shallow part, water waves bend towards the normal on line separating the two parts. Hence, the angle of refraction becomes less than the angle of incidence.

Q.25 Do the magnitude of angle of incidence and angle of refraction equal? 101110120

Ans. As the wave bend towards or away from the normal on refracting hence angle of refraction becomes less than angle of incidence.

Q.26 How many times human drum ear oscillate in one second? 101110121

Ans. Human eardrum can oscillate back and forth up to 20,000 times in one second.

Q.27 Do mechanical waves pass through vacuum, that is, empty space? 101110122

Ans. No mechanical waves cannot pass through vacuum because they require a material medium for the propagation.

Q.28 What do the dark and bright fringes on the screen of the ripple tank represent? 101110123

Ans. Bright fringes represent crests whereas darks fringes represent troughs of the waves on the screen of the ripple tank.

Because the Crest of wave behaves like a convex lens and converge the rays of light on screen. While trough behaves like a concave lens that diverge rays of light and dark fringe is appeared on the screen.

Q.29 If the time for 20 vibrations is 100 second then find: 101110123(a)

a) Time period b) Frequency

Ans. Number of vibrations = n = 20

time taken = t = 100 sec

Frequency = f = ?

Time period = t = ?

(a) $\text{Freequency} = \frac{\text{Number of vibrations}}{\text{Time taken}}$

$f = \frac{n}{t} = \frac{20}{100}$

$f = 0.2\,Hz$

(b) $\text{Time period} = \frac{1}{\text{frequency}}$

$T = \frac{1}{f}$

$T = \frac{1}{0.2}$

$T = 5\,sec$

Result:

The time period will be 5sec and frequency of wave will be 0.2Hz.

Solved Examples

10.1 Find the time period and frequency of a simple pendulum 1.0m long at a location where g = 10.0 ms^{-2}: 101110124

Given Data:

Length of pendulum = $\ell = 1.0m$

Acceleration due to gravity = g = 10.0 ms^{-2}

To Find:

Time period = T = ?

Frequency = f = ?

Calculation:

As we know that

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$= 2\times3.14\sqrt{\frac{1.0}{10.0}}$$

$$= 2\times3.14\times0.31$$

$$\boxed{T = 1.99\,sec.}$$

Frequency of pendulum is given by

$$f = \frac{1}{T}$$

$$f = \frac{1}{1.99} = 0.50Hz$$

$$f = 0.50Hz$$

Result: Time period of simple pendulum is 1.99 sec and frequency is 0.50Hz

10.2 A wave moves on a slinky with frequency of 4Hz and wavelength of 0.4m. What is the speed of the wave? 101110125

Given data:

Frequency = f = 4 Hz

Wavelength = λ = 0.4m

To Find:

Speed of wave = v = ?

Calculation:

We know that

$$V = f\lambda$$
$$= 4 \times 0.4$$
$$V = 1.6 ms^{-1}$$

Result:

Hence, the speed of wave is $1.6 ms^{-1}$.

10.3 A student performs an experiment with waves in water. The student measures the wavelength of wave to be 10cm. By using stop watch and observing the oscillations of a floating ball. The student measures the frequency of 2 Hz. If the student starts a wave in one part of a tank of water, how long will it take the wave to reach the opposite side of the tank 2m away?

Given data: 101110126

Frequency = f = 2Hz

Wavelength = λ = 10cm = 0.1m

Distance = d = 2m

To Find:

Speed = v = ?

Time taken = t = ?

Calculation:

According to the wave equation

$$V = f\lambda$$
$$= (2) \times (0.1)$$
$$V = 0.2 ms^{-1}$$

As we know that

$$d = v \times t$$
$$\frac{d}{v} = t$$
$$\frac{2}{0.2} = t$$
$$10s = t$$

Hence

$$t = 10\,sec$$

Result:

The wave with speed $0.2 ms^{-1}$ will reach the opposite side of the tank in 10s.

Numerical Problems

10.1 The time period of a simple pendulum is 2s. What will be its length on Earth? What will be its length on the moon if $g_m = \frac{g_e}{6}$?

Where $g_e = 10 ms^{-2}$. 101110127

Given Data:

The given data is

Time period = T = 2s

Length on earth = ℓ_e = ?

Length on moon = ℓ_m = ?

g_e = $10 ms^{-2}$

$$g_m = \frac{g_e}{6} = \frac{10}{6} = 1.67\ ms^{-2}$$

Formula:

$$T = 2\pi\sqrt{\frac{\ell_e}{g_e}}$$

Calculation:

$$T^2 = 4\pi^2 \frac{\ell_e}{g_e}$$

$$\frac{T^2 g_e}{4\pi^2} = \ell_e$$

Putting values, we get

$$\frac{(2)^2 \times 10}{4 \times (3.14)^2} = \ell_e$$

$$\frac{4 \times 10}{4 \times (3.14)^2} = \ell_e$$

$$\frac{10}{(3.14)^2} = \ell_e$$

$$1.02\text{m} = \ell_e$$

Similarly, for moon, we use formula.

$$\ell_m = \frac{T^2 g_m}{4\pi^2}$$

$$= \frac{(2)^2 \times 1.67}{4 \times (3.14)^2}$$

$$= \frac{4 \times 1.67}{4 \times (3.14)^2}$$

$$\ell_m = \boxed{0.17\ \text{m}}$$

Result:

The length of simple pendulum on earth will be 1.02m and on moon will be 0.17m.

10.2 A pendulum of length of 0.99m is taken to the moon by an astronaut. The time period of the pendulum is 4.9s. What is the value of 'g' on the surface of the moon? 101110128

Given Data:

Length of Pendulum = ℓ = 0.99m

Time period of Pendulum on Moon = T_m = 4.9 sec.

To Find:

Acceleration due to gravity = g_m = ?

Calculation:

As we know that

$$T_m = 2\pi\sqrt{\frac{\ell}{g_m}}$$

Taking square on both sides

$$(T_m)^2 = \left(2\pi\sqrt{\frac{\ell}{g_m}}\right)^2$$

$$T_m^2 = 4\pi^2\frac{\ell}{g_m}$$

Hence

$$g_m = \frac{4\pi^2 \times \ell}{T_m^2}$$

$$= \frac{4\times(3.14)^2\times 0.99}{(4.9)^2}$$

$$= \frac{4\times 9.86\times 0.99}{24.01}$$

$$= \frac{39.04}{24.01} = 1.63 ms^{-2}$$

$$\boxed{g_m = 1.63 ms^{-2}}$$

Result:

The value of 'g' on the surface of the moon will be $1.63 ms^{-2}$.

10.3 Find the time periods of a simple pendulum of 1 meter length, placed on Earth and on moon. The value of g on the surface of moon is 1/6th of its value on Earth. Where g_e is $10 ms^{-2}$. 101110129

Given data:

Length of simple pendulum = ℓ = 1m

Acceleration due to gravity = $g_e = 10 ms^{-2}$ on the surface of Earth

Acceleration due to gravity = $g_m = \frac{10}{6}$

$$= \frac{10}{6} ms^{-2} \Rightarrow 1.66 ms^{-2}$$

on the surface of Moon

To Find

Time period on Earth = T_e = ?

Time period on Moon = T_m = ?

Calculation:

As we know that

$$T_e = 2\pi\sqrt{\frac{\ell}{g}}$$

Putting values, we get

$$T_e = 2\times 3.14\sqrt{\frac{1}{10}}$$

$$= 2\times 3.14\sqrt{0.1}$$

$$= 2\times 3.14\times 0.3162$$

$$= 1.98 \text{ sec}$$

Or

$$\boxed{T_e = 2 \text{ sec}}$$

Similarly, the time period on Moon is

$$T_m = 2\pi\sqrt{\frac{\ell}{g_m}}$$

$$= 2\pi\sqrt{\frac{\ell}{g/6}}$$

$$= 2\pi\sqrt{\frac{6\ell}{g}}$$

$$T_m = 2\pi\sqrt{\frac{6\ell}{g}}$$

$$T_m = 2\times 3.14\sqrt{\frac{6}{10}}$$

$$T_m = 2\times 3.14\times\sqrt{0.60}$$

$$T_m = 2\times 3.14\times 0.7745$$

$$= 4.86 \text{ Sec}$$

or 4.9 Sec

$$T_m = \boxed{4.9 \text{Sec}}$$

Result:

Time period of simple pendulum on the Earth surface is 2s and on the moon surface is 4.9 sec.

10.4 A simple pendulum completes one vibration in two seconds. Calculate its length when g = 10.0 ms^{-2} 101110130

Given data:

Time period of simple pendulum = T = 2s

Acceleration due to gravity = g = $10.0 ms^{-2}$

To Find:

Length of simple pendulum = ℓ = ?

Calculation:

As we know that

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

By taking square on both sides

$$(T)^2 = \left(2\pi\sqrt{\frac{\ell}{g}}\right)^2$$

$$T^2 = 4\pi^2\times\frac{\ell}{g}$$

$$\frac{T^2\times g}{4\pi^2} = \ell$$

Hence $\ell = \frac{T^2 \times g}{4\pi^2}$

By putting the values we get

$$\ell = \frac{(2)^2 \times (10.0)}{4 \times (3.14)^2}$$

$$= \frac{4 \times 10}{4 \times 9.86}$$

$$= \frac{40}{39.44}$$

$$\ell = 1.02 \text{ m}$$

Result:
The length of simple pendulum is 1.02m.

10.5 If 100 waves pass through a point of a medium in 20 seconds, what is the frequency and time period of the wave? If wavelength is 6cm, calculate the wave speed. 101110131

Given data:

Number of waves passed = n = 100
Time taken = t = 20 sec
Wavelength = λ = 6cm = 0.06m

To Find

Frequency = f = ?
Time Period = T = ?
Speed of Wave = V = ?

Calculation:

i) As we know that, the frequency of wave is, the number of waves passing through a point of medium in one second. Hence

$$\text{Frequency} = f = \frac{no.of\ waves\ passed}{time\ taken} = \frac{n}{t}$$

$$f = \frac{100}{20}$$

$$\boxed{f = 5Hz}$$

ii) As the time period 'T' is reciprocal of the frequency 'f' hence,

$$T = \frac{1}{f}$$

$$T = \frac{1}{5} = 0.2\,sec$$

$$\Rightarrow \boxed{T = 0.2\,sec}$$

iii) According to the wave equation

$$v = f\lambda$$

$$v = 5 \times 0.06$$

$$\boxed{v = 0.3\,ms^{-1}}$$

Result:

(i) Frequency of wave is 5Hz.
(ii) Time period of wave is 0.2s.
(iii) Wave speed is $0.3ms^{-1}$.

10.6 A wooden bar vibrating into the water surface in a ripple tank has a frequency of 12 Hz. The resulting wave has a wavelength of 3cm. What is the speed of the wave? 101110132

Given data:

Frequency of wave = f = 12 Hz
Wavelength = λ = 3cm = 0.03m

To Find:

Speed of wave = v = ?

Calculation:

According to the wave equation

$$v = f\lambda$$

$$v = 12 \times 0.03$$

$$\boxed{v = 0.36ms^{-1}}$$

Result:

Thus, the speed of wave is $0.36ms^{-1}$.

10.7 A transverse wave produced on a spring has a frequency of 190 Hz and travels along the length of the spring of 90m, in 0.5s. 101110133

a. What is the time period of wave?
b. What is the speed of wave?
c. What is the wavelength of wave?

Given data:

Frequency of wave = f= 190 Hz
Distance travelled = d = 90m
Time taken = t = 0.5 sec

To Find:

i. Time period of wave = T = ?
ii. Speed of wave = v = ?
iii. Wavelength of wave = λ = ?

Calculation:

i) As we know that, the time period of wave is reciprocal of the frequency

Hence, $T = \frac{1}{f}$

$$= \frac{1}{190}$$

$$= 0.005\,sec$$

$$\boxed{T = 0.01\,sec}$$

Result:

Time period of wave is 0.01s.

ii) As we know that

$$Speed = \frac{distance\ travelled}{Time\ taken}$$

$V = f\lambda$, $V = d/t$

$$v = \frac{d}{t}$$

$$v = \frac{90}{0.5}$$

$$v = 180 ms^{-1}$$

$$\Rightarrow \boxed{v = 180 ms^{-1}}$$

Result:
Wave speed is $180 ms^{-1}$.

iii) According to the wave equation

$$v = f\lambda$$

$$180 = 190 \times \lambda$$

$$\frac{180}{190} = \lambda$$

Hence, $\boxed{\lambda = 0.95m}$

Result:
Wavelength of wave is 0.95m.

10.8 Water waves in a shallow dish are 6.0 cm long. At one point, the water waves move up and down at a rate of 4.8 oscillations per second. 101110134

(a) What is the speed of water waves?
(b) What is the time period of water waves? (F.B. 2016)

Given data:

Wavelength = λ = 6.0cm = 0.06m
Frequency = f = 4.8 Hz

To Find

a) Speed of water wave = v = ?
b) Time period of water wave = T = ?

Calculation:

a) According to the wave equation

$$v = f\lambda$$

$$v = 4.8 \times 0.06$$

$$\boxed{v = 0.29 ms^{-1}}$$

b) As the time period of wave is reciprocal to frequency of wave

Hence $T = \frac{1}{f} = \frac{1}{4.8}$

$$\boxed{T = 0.21 sec}$$

Result:
Hence, the wave speed is 0.29 ms^{-1} and time period of wave is 0.21s.

10.9 At one end of a ripple tank 80cm across, a 5 Hz vibrator produces waves whose wavelength is 40mm. Find the time the wave need to cross the tank. 101110135

Given data:

Distance = d = 80cm = 0.8m
Frequency = f = 5Hz

Wavelength = λ = 40mm = $\frac{40}{1000}$ = 0.04m

To Find: Time to cross the tank = t = ?

Calculation:

According to the wave equation

$$v = f\lambda$$

$$= 5 \times 0.04$$

$$\boxed{v = 0.2 ms^{-1}}$$

As we know that

$$d = v \times t$$

Hence, $t = \frac{d}{v} = \frac{0.8}{0.2} = 4 sec$

$$\boxed{t = 4 sec}$$

Result:
Time taken by the wave to cross the ripple tank is 4s.

10.10 What is the wavelength of the radio waves transmitted by an FM station at 90 MHz? Where 1MHz = 10^6Hz, and speed of radio wave is $3 \times 10^8 ms^{-1}$. (F.B. 2017) 101110136

Given data:

Frequency = f = 90 MHz = 90×10^6 Hz
Speed = v = 3×10^8 ms^{-1}

To Find: Wavelength = λ = ?

Calculation: According to the wave equation

$$v = f\lambda$$

$$\frac{v}{f} = \lambda$$

$$\lambda = \frac{3 \times 10^{8-6}}{90}$$

$$\frac{3 \times 10^2}{90} = \lambda$$

$$\frac{300}{90} = \lambda, \quad 3.33m = \lambda$$

Hence, $\boxed{\lambda = 3.33m}$

Result:
Wavelength of the radio waves is 3.33m.

UNIT 11

Sound

101111001

Q.1 What is Acoustics?

Ans. The study of sound is called acoustics. 101111002

Q.2 How is sound produced? Give example.

Ans. *Sound is produced due to vibration of a body.* It needs a material medium for its propagation. It travels in the form of compression and rarefaction.

For example,

(i) In guitar, sound is produced due to the vibration of strings.

(ii) Our voice is due to the vibration of vocal cords.

(iii) Human heart beats and vibration of other organs like lungs produce sound.

Q.3 Give an experiment which shows that sound is produced due to vibration of a body. 101111003

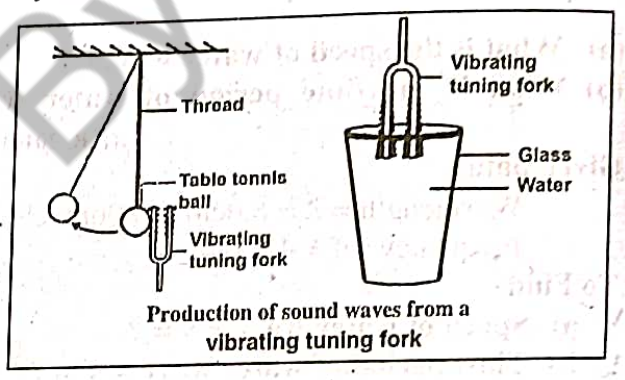
Ans. Sound is a form of energy produced due to vibration of a body.

Experiment 1:

In school laboratories sound is produced by a device called tuning fork. If we strike the tuning fork on rubber pad its prongs will began to vibrate. Its sound can be heard by bringing the tuning fork near the ear. Its vibration can be felt by touching it and its vibration can be seen by dipping its prongs in a glass of water. We will see that water splashes due to vibration in prongs. So we can say that sound is produced due to vibration of a body, and this vibration can be felt and seen.

Experiment 2:

We can also feel the vibration by slightly touching one of the prongs of the vibrating tuning fork with a plastic ball suspended from a thread as shown in the fig. Touch the ball gently with the prong of a vibrating tuning fork. The tuning fork will push the ball because of its vibration.



Production of sound waves from a vibrating tuning fork

Conclusion

From the above experiment we conclude that sound is produced by the vibration of the body.

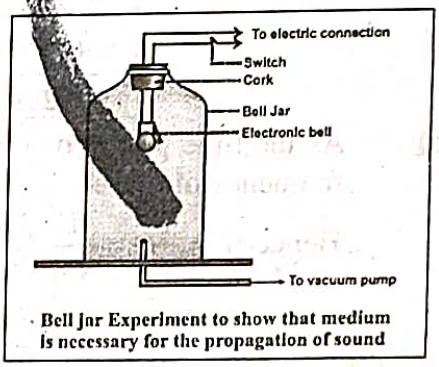
Q.4 Show by experiment that sound requires a material medium for its propagation. 101111004

OR

How can you prove the mechanical nature of sound by a simple experiment?

Ans. Sound waves always require a medium for its propagation which is shown by the following experiment.

An electric bell which is suspended in the glass jar with the help of wires connected to a power supply, on connecting the wires with the battery, the bell will begin to ring and we can hear its sound. But when we start pumping out air from the jar with the help of vacuum pump the sound of bell becomes feeble and eventually dies out, and we cannot hear the sound, although the bell is ringing, when we put air back into the jar. We can hear the sound again which shows that sound waves required a medium for their propagation.



Bell jar Experiment to show that medium is necessary for the propagation of sound

Q.5 What do you understand by the longitudinal wave? Describe the longitudinal nature of sound waves. 101111005

OR

What is the nature of sound? Explain.

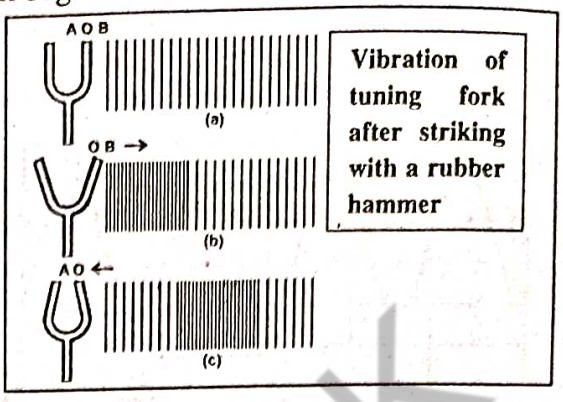
Ans. Longitudinal waves:

"In longitudinal or compressional waves the particles of the medium vibrate parallel to the direction of propagation of wave." e.g. Sound waves

Nature of Sound:

Sound waves are Compressional in nature which can be explained by following experiment.

When we strike the tuning fork on rubber pad its prongs will begin to move between positions AOB. When prongs move from O to B, they exert pressure on the adjacent layer of air and compression is produced. The compressed layer of air compress, as the layer of air next to it and so on. When prongs move from B to A, the pressure on layer of air is decreased and rarefaction is produced. This rarefaction is transferred to the air layer next to it and so on. So when the tuning fork moves back and forth rapidly, a series of compression and rarefaction is produced due to which sound waves propagate through air. As the direction of sound wave is along the direction of oscillating air molecules, it shows that sound waves are compressional in nature.



Vibration of tuning fork after striking with a rubber hammer

Wavelength.

Distance between two consecutive compressions or rarefactions is the wavelength of sound waves. It is denoted by λ.

Q.6 Explain the characteristics of sound. 101111006

Ans.

(1) LOUDNESS OF SOUND:

The characteristic of sound through which a loud and a faint sound can be distinguished is called loudness.

The loudness of sound depends upon.

(a) The amplitude of the vibrating body.

(b) Area of vibrating body

(b) Distance from vibrating body.

(a) Amplitude of the vibrating body:

If the amplitude of the vibrating body is large, the sound produced will be louder. The sound will be faint if the amplitude is small.

Example:

i) The sound produced by sitar is loud if its wires are plucked violently.

ii) When we beat drum forcefully, its membrane vibrates with large amplitude and loud sound is produced.

(b) Area of vibrating body:

Larger the area of vibrating body, louder sound is produced.

Examples:

(i) Strike a tuning fork on rubber pad. It begins to vibrate and a feeble sound is heard. If it is placed on table vertically, the sound becomes louder, because the tabletop also begin to vibrate along with tuning fork. Hence, the total vibrating area increases.

(ii) Similarly the sound produced by a large drum is louder than that by a small one because of the large vibrating area of big drum.

(c) Distance from vibrating body:

Greater is the distance of the listener from vibrating body, fainter is the sound.

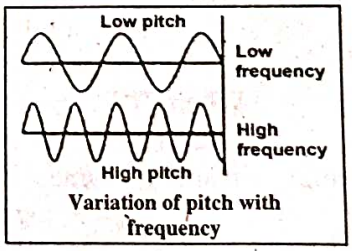
Loudness of sound is more if the distance between the listener and vibrating body is less.

Other factors:

❖ Loudness of a sound also depends upon the physical condition of ear of listener. A sound appears to be louder to a person with sensitive ear than to man with defective ear.

(2) PITCH OF SOUND: **(Board 2014)**

The characteristic of sound by which a shrill sound can be distinguished from a grave sound is called pitch.



Variation of pitch with frequency

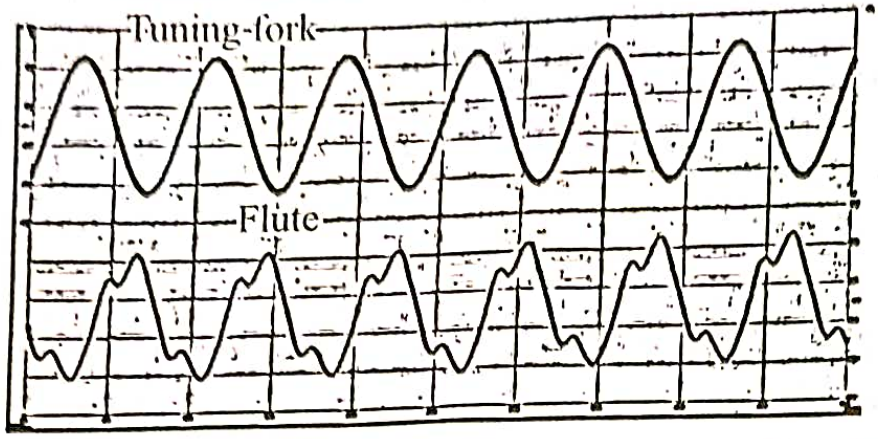
Factors:

Pitch of sound depends upon frequency. Greater is frequency of sound higher is the pitch, smaller is the frequency of sound smaller is the pitch.

The frequency of the voice of ladies and babies is greater than that of men. Hence, their voice is shrill and of high pitch.

(3) QUALITY OF SOUND

The characteristic of sound by which two sounds of same loudness and pitch are distinguished from each other is called quality of sound.



Sound wave forms produced by (a) tuning fork. (b) flute, both at approximately the same frequency. Pressure is plotted vertically time horizontally

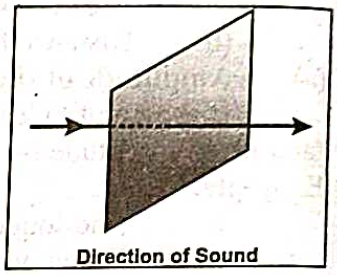
Example

If in a room a note of given loudness and pitch is sounded on a flute and also on a piano, we can distinguish between them by standing even outside the room, because quality of these notes is different.

Above waveform of the sound produced by tuning fork and that produced by a flute. Their pitch and loudness is same but their waveform is different, hence their quality is different.

(4) INTENSITY OF SOUND

Sound energy flowing per second through a unit area held perpendicular to the direction of sound wave is called intensity of sound.



Unit: Its unit is watt per square meter Wm^{-2}. It is a physical quantity and can be measured accurately.

Intensity of faintest sound and loudest sound:

(1) The intensity of faintest sound is 10^{-12} Wm^{-2}.

(2) The intensity of loudest sound which is loud enough to cause pain is 1 Wm^{-2}.

Intensity and loudness of sound:

Intensity of sound is physical quantity and it does not depend upon the condition or sensitiveness of ear. Intensity of sound depends on the amplitude of sound.

Sound intensity level:

The human ear responds to the intensities ranging from 10^{-12} Wm^{-2} to more than 1 Wm^{-2} (Which is loud enough to be painful). Because the range is so wide, intensities are scaled by factors of ten. The barely audible and the faintest intensity of sound i.e., 10^{-12} Wm^{-2} is taken as reference intensity, called zero bel (a unit named after Alexander Graham Bell).

Q.7 Calculate sound level (intensity level). **101111007**

OR

What do you mean by the term intensity level? Name and define unit of intensity level of sound.

Ans. For human ear, loudness of sound is not directly proportional to its intensity, but it is directly proportional to the logarithm of intensity of sound.

Mathematically:

$$L \propto \log I$$

$$L = K \log I \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where 'K' is constant of proportionality.

If L_o represents the loudness of the faintest audible sound of intensity I_o and L is loudness of an unknown sound of intensity I, then above equation can be written as.

$$L_o = K \log I_o \quad \ldots\ldots\ldots\ldots (2)$$

Subtracting (1) and (2)

$$L - L_o = K \log I - k \log I_o$$

$$L - L_o = K (\log I - \log I_o)$$

$$L - L_o = K \log \frac{I}{I_o}$$

Sound level or intensity level:

The difference $(L - L_o)$ *between the loudness 'L' of an unknown sound and loudness '* L_o*' is called* ***intensity level or sound level.***

$$\text{Intensity level} = L - L_o = K \log \frac{I}{I_o} \quad \ldots\ldots\ldots (3)$$

Value of K

The value of K depends upon the unit of I and I_o and on the unit of intensity level. If the intensity I of any unknown sound is 10 times greater than the intensity I_o of the faintest audible sound.

i.e. $I = 10I_o$, and

Intensity level of this sound is taken as unit, called Bel. Then value of K is 1.

Put $K = 1$ in eq. (3)

$$\text{Sound level} = \log \frac{I}{I_o} \text{ (bel)} \quad \ldots\ldots\ldots (4)$$

Unit of Sound Level:

Bel is a very large unit of the intensity level of sound.

Smaller unit is decibel

1 bel = 10 dB.

$$\text{Sound level} = 10 \log \frac{I}{I_o} (\text{dB})$$

We can construct a scale for measuring the intensity level of sound. Such scale is known as **"decibel scale".**

Source of sound	Intensity (Wm^{-2})	Intensity level (dB)
Nearby jet airplane	10^{3}	150
Jackhammer	10^{1}	130
Fast train Siren	10^{0}	120
Lawn mover	10^{-2}	100
Vacuum Cleaner	10^{-5}	70
Mosquito buzzing	10^{-8}	40
Whisper	10^{-9}	30
Rustling of leaves	10^{-11}	10
Faintest audible sound i.e., Threshold	10^{-12}	0

Q.8 Explain reflection (Echo) of sound. 101111008

OR

Explain is there any difference between echo and reflection of sound? What is condition for Echo?

Ans. *When sound is incident on the surface of a medium, it bounces back into the first medium. This phenomenon is called echo or reflection of sound.*

Example:

When we clap or shout near a reflecting surface such as tall building or a mountain, we hear the same sound again a little later. This sound which we hear is called an echo and is a result of reflection of sound from the surface.

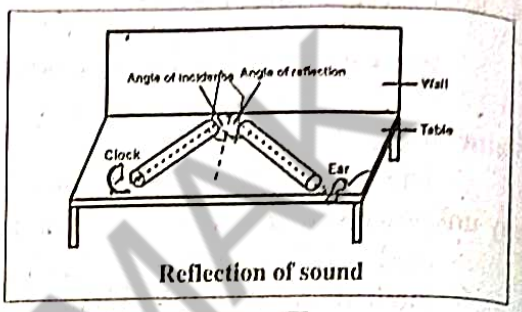
Explanation:

The sensation of sound persists in our brain for about 0.1s. To hear a clear echo the time interval between our sound and the reflected sound must be at least 0.1s. If we consider speed of sound to be 340 ms^{-1} at a normal temperature in air, we will hear the echo after 0.1s. The total distance covered by the sound from the point of generation to the reflecting surface and back should be at least ($340ms^{-1}$) x 0.1 s = 34.0m. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, that is, 17m. Echoes may be heard more than once due to successive or multiple reflections.

Q9. Show that sound waves reflect at the same angle at which angle they strike. 101111009

Ans. Experiment:

Take two identical plastic pipes of suitable length and arrange the pipes on a table near a wall. Now place a clock near the open end of one of the pipes and try to hear the sound of the clock through the other pipe. Adjust the position of the pipes so that you can hear the sound of the clock clearly. Now, measure the angles of incidence and reflection. We will see that they are same. If we lift the pipe on the right vertically to a small height we will observe that sound is not heard clearly.



Reflection of sound

Speed of sound in various media	
Medium	**Speed (ms^{-1})**
Gases	
Air(0^0C)	**331**
Air (25^0C)	**346**
Air (100^0C)	**386**
Hydrogen (0^0C)	**1290**
Oxygen (0^0C)	**317**
Helium (0^0C)	**972**
Liquids at 25^0C	
Distilled water	**1498**
Sea water	**1531**
Solids 25^0C	
Wood	**2000**
Aluminum	**6420**
Brass	**4700**
Nickel	**6040**
Iron	**5950**
Steel	**5960**
Flint Glass	**3980**

Q.10 How speed of sound varies in different material? 101111010

Ans. Speed of sound depends upon density of medium. So different medium having different density.

Speed of Sound in Liquids and Gases:

The speed of sound in liquids is five times than in gases and the speed of sound in solid is about fifteen times than in gases.

The speed of sound in Air:

The speed of sound in air is affected by changes in some physical conditions such as pressure temperature and humidity etc.

The speed of sound in air is $343ms^{-1}$ at one atmosphere of pressure and room temperature (21°C). The speed varies with temperature and humidity. The speed of sound in solids and liquids is faster than in air. Following relation can be used to find the speed of sound.

$$v = f\lambda$$

Where v is the speed, f is the frequency and λ is the wavelength of sound wave.

Q.11 How can we measure speed of sound by Echo method? 101111011

Ans. Apparatus: Measuring tape, Stopwatch, Flat wall that can produce a good echo.

Procedure:

1. Measure a distance of 50 meters from the wall with the help of measuring tape.
2. Now clap your hands in front of the wall at a distance of 50 m and check if you can clearly hear an echo from the wall. Make sure the echo is not coming from any other wall in the area. The time taken by the sound to travel 100 meters is the time difference between the clap and the echo.
3. Now restart the clapping and start the stopwatch at the first clap. Count the number of claps, and stop the clapping and the stopwatch when you hear the echo of the 10th clap. Now find the average time for 10th claps.
4. After calculating the time interval t between claps and using the formula S = vt we can calculate the speed of the sound.

Q.12 Define music and noise. 101111012

Ans. Music: *Such sounds which has pleasant effect on our ears are called musical sounds. e.g sound produced by musical instruments such as flute, harmonium violin, drum etc.*

Noise: *Sound which has jarring and unpleasant effect on our ears is called noise.* Noise corresponds to irregular and sudden vibrations produced by some sounds. e.g sounds of machinery traffic, slamming of a door. etc.

Q.13 Explain Noise Pollution and what is the safe level of noise? 101111013

OR

Explain that noise is a nuisance.

Ans. Noise Pollution:

Noise pollution has become a major issue of concern in big cities. Noise is an undesirable sound that is harmful for health of human and other species.

Sources of noise pollution:

Transportation equipment and heavy machinery are the main sources of noise pollution. For example, noise of machinery in industrial areas, loud vehicle horns, hooters and alarms.

Negative effects of sound:

Noise has negative effects on human health as it can cause conditions such as hearing loss, sleep disturbances, aggression, hypertension, high stress levels. Noise can also cause accidents by interfering with communication and warning signals.

Safe Level of Noise

A safe level of noise depends on two factors:

i. the level (volume) of the noise; and
ii. the period of exposure to the noise.

The level of noise recommended in most countries is usually 85-90 dB over an eight-hour workday.

Ways to reduce noise

Pollution can be reduced to acceptable level by replacing the noisy machinery with environment friendly machinery and equipments, putting sound-reducing barriers, or using hearing protection devices.

Q.14 What is the importance of acoustic protection? 101111014

OR

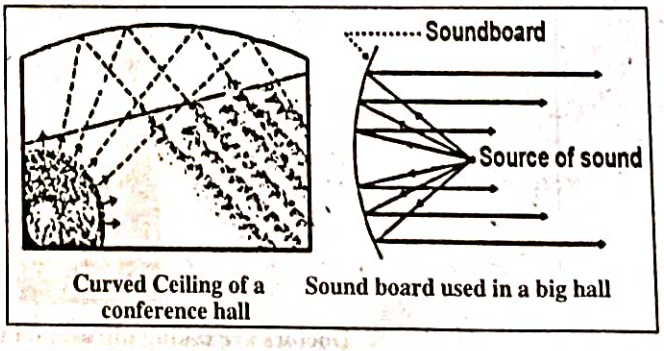
Describe the importance of acoustic protection.

Ans. *"The technique or method used to absorb undesirable sounds by soft and porous surfaces is called acoustic protection".*

Explanation

Soft, porous materials, such as draperies and rugs absorb large amount of sound energy and thus quiet echoes and soften noises. Thus, by using such material in noisy places we can reduce the level of noise pollution. However,

(1) If the surface of class rooms or public halls are too absorbent, the sound level may be low for the audience.



Curved Ceiling of a conference hall — Sound board used in a big hall

(2) Sometimes, when sound reflects from the wall, ceiling, and floor of a room, the reflecting surfaces are too reflective and the sound becomes garbled. This is due to multiple reflections called reverberations.

(3) In the design of lecture halls, auditorium, or theater halls, a balance must be achieved between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience.

(4) Generally the ceilings of lecture halls, conference halls and theatre halls are curved so that sound after reflection may reach all the corners of the hall. Sometimes curved soundboards are placed behind the stage so that sound after reflection is distributed evenly across the hall.

Q.15 Describe Audible Frequency Range. OR What is the range of audible frequency of sound. 101111015

OR

What is the audible frequency range for human ear? Does this range vary with the age of people? Explain.

Ans. Audible Frequency Range:

"A human ear can hear a sound only if its frequency lies between 20 Hz to 20,000 Hz. In other words a human ear neither can hear a sound of frequency less than 20 Hz and nor a sound of frequency beyond 20,000 Hz".

Sounds of frequency beyond 20,000 Hz are inaudible because the eardrum cannot vibrate so rapidly. The audible frequency range differs a little for different persons. The above mentioned audible frequency range is only an average. It also decreases with age.

Q.16 What are audible frequency range for young children and old people? 101111016

Ans. Young children can hear sounds of 20,000 Hz frequency.

Old people cannot hear sounds even above 15,000 Hz frequency.

Q.17 Define Ultrasonic and write their uses. 101111017

OR

What is the use of ultrasound in medical field?

Ans. UltraSound

Sound of frequency higher than 20,000 Hz which are inaudible to normal human ear can be produced and utilized in many useful ways. Such sounds are called ultrasonic or ultrasound.

Characteristics

It has been seen that ultrasonic waves carry more energy than audible sound waves. Moreover, according to the relation $v = f \lambda$ the wavelength of ultrasonic waves is very small. Due to these characteristics ultrasonic are usefully utilized in medical and technical fields.

(i) Use in medical field:

1. For Diagnosis and Treatment:

In medical field ultrasonic waves are being used to diagnose and treat different ailments.

2. Internal View of Organs:

For diagnosis of different diseases ultrasonic waves are made to enter the human body. These waves are reflected differently by different organs, tissues, tumors. The reflected ultrasonic waves are then amplified and fed to a monitor, which forms an image of the internal organs of the body on its screen. Such an image helps in detecting the defects of these organs.

3. To Remove Blood Clot:

Powerful ultrasonic are now being used to remove blood clots formed in the arteries.

Doctors are taking ultrasound test of a patient with an ultrasound machine

4. **For Thyroid Glands**
Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.

5. **To Kill Germs**
Germs and bacteria in liquids can be destroyed by using high intensity ultrasonic waves.

6. **Physical abnormalities before birth:**
Now a days ultrasonic waves are used not only to find the sex of a body but also to find its physical abnormalities before birth in the womb of mother.

7. **Removal of kidney Stones:**
The kidney stones can be crushed and removed out through urine with the help of ultrasonic waves without any surgery.

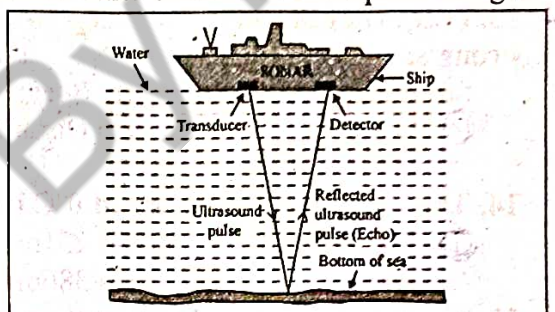
8. **Scaling of Teeth:**
Ultrasonic waves are used for the scaling of teeth, as their vibrations are so intense that they remove easily the dirt and plaque sticking to the teeth.

(ii) Use in Technical field

Due to excessive use, cracks appear in the interior of the moving parts of high speed heavy machines such as turbines engines of ships and aeroplanes. These cracks are not visible from outside but they can be very dangerous. Such cracks can be detected by ultrasonic. A powerful beam of ultrasonic is made to pass through these defective parts. While passing, these waves are reflected by the surface of these cracks and flaws. The comparison of the ultrasonic waves reflected from the cracks and from the other surface of these parts can give a clue of the existence of the cracks.

(iii) Use to find depth of Sea:

Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called SONAR, (sound navigation and ranging). The sound waves are sent from a transmitter, and a receiver collects the reflected sound as shown in Fig. The time-lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated. SONAR ranging is also used to see the shape and the size of the object.



Ultrasound are used to measure the depth of water by echo method

Multiple Choice Questions

Choose the correct answer from the following choices.

Exercise MCQs

1. Which is an example of a longitudinal wave? 101111018
(a) Sound wave (b) Light wave
(c) Radio wave (d) Water wave

2. How does sound travel from its source to your ear? 101111019
(a) By changes in air pressure
(b) By vibration in wires or strings
(c) By electromagnetic waves
(d) by infrared waves

3. Which form of energy is sound? 101111020
(a) Electrical (b) Mechanical
(c) Thermal (d) Chemical

4. Astronauts in space need to communicate with each other by radio links because: (F. B. 2016) 101111021
(a) Sound waves travel very slowly in space.
(b) Sound waves travel very fast in space.
(c) Sound waves cannot travel in space.
(d) Sound waves have low frequency in space

5. The loudness of a sound is most closely related to its: (F. B. 2017) 101111022
(a) Frequency (b) Period
(c) Wavelengt h (d) Amplitude

6. For a normal person audible frequency range for sound wave lies between (F. B. 2017) 101111023
(a) 10Hz and 10kHz
(b) 20Hz and 20kHz
(c) 25Hz and 25kHz
(d) 30Hz and 30kHz

7. When frequency of sound wave is increased, which of the following decreases? 101111024
(i) Wavelength
(ii) Period
(iii)Amplitude
(a) (i) only (b) (iii) only
(c) (i) and (ii) only (d) (i) and (iii) only

Additional MCQs

8. The speed of sound was accurately measured in: 101111025
(a) 1736 (b) 1737
(c) 1738 (d) 1739

9. The speed of sound in air at 21°C is: 101111026
(a) 336ms^{-1} (b) 343ms^{-1}
(c) 430ms^{-1} (d) 470ms^{-1}

10. Bats can hear sound of frequency up to: 101111027
(a) 100,000Hz (b) 25000Hz
(c) 120,000Hz (d) 1000Hz

11. The SI unit of intensity of sound: (F. B. 2015) 101111028
(a) Wm^{-1} (b) Wm
(c) Wm^{-2} (d) Wm^{2}

12. The intensity of lawn mover is: 101111029
(a) 10^{-1}Wm^{-2} (b) 10^{-2}Wm^{-2}
(c) 10^{-3}Wm^{-2} (d) 10^{-4}Wm^{-2}

13. Frequency of tuning fork depends upon the prong's: 101111030
(a) Weight (b) Speed
(c) Mass (d) Distance

14. The speed of sound in air at 0°C is: 101111031
(a) 331ms^{-1} (b) 231ms^{-1}
(c) 376ms^{-1} (d) 386ms^{-1}

15. The speed of sound in sea water at 25°C is: 101111032
(a) 1530ms^{-1} (b) 1531ms^{-1}
(c) 1560ms^{-1} (d) 1570ms^{-1}

16. The speed of sound in iron at 25°C is 101111033
(a) 5950m/sec (b) 5900 m/sec
(c) 6950m/sec (d) 6940 m/sec

17. The frequency of silent whistle is 101111034
(a) 20,000 Hz – 25000Hz
(b) 2000 Hz – 25000Hz
(c) 200 KHz – 2000 Hz
(d) 25000 KHz

18. The sound level of rustling of leave is:
(a) 1dB (b) 20dB 101111035
(c) 30dB (d) 10dB

19. To hear echoes, the minimum distance of the obstacle from source of sound should be: 101111036
(a) 10m (b) 15m
(c) 17m (d) 20m

20. Old people cannot hear sound above than: 101111037
(a) 1000 Hz (b) 15000 Hz
(c) 20000 Hz (d) 10000 Hz

21. Intensity level of the sound produced by mosquito buzzing is: 101111038
(a) 70dB (b) 40dB
(c) 10dB (d) 120dB

22. The speed of sound in air at 100°C is: 101111039
(a) 380ms^{-1} (b) 382ms^{-1}
(c) 386ms^{-1} (d) 300ms^{-1}

23. The intensity level of whispering is:
(a) 20dB (b) 30dB 101111040
(c) 40dB (d) 50dB

24. The intensity of rustling of leaves is: 101111041
(a) 10^{-11} Wm^{-2} (b) 10^{-10} Wm^{-2}
(c) 10^{-9} Wm^{-2} (d) 10 Wm^{-2}

25. Which frequency is used by elephants to communicate with each other? 101111042
(a) zero frequency (b) low frequency
(c) medium frequency (d) high frequency

26. The intensity level of train siren is: 101111043
(a) 150dB (b) 130dB
(c) 100dB (d) 120dB

27. The pitch of a sound is most closely related to its: 101111044
(a) frequency (b) period
(c) wavelength (d) amplitude

28. The quality of sound is most closely related to its: 101111045
(a) wave form (b) period
(c) amplitude (d) frequency

29. Safe level of nosie depends on factors: 101111046
(a) one (b) two
(c) three (d) four

30. The technique or method used to absorb undesirable sounds by soft and porous surface is called: 101111047
(a) ultrasonics
(b) acoustic protection
(c) infrasonics
(d) echo

31. Mice can hear frequencies upto: 101111048
(a) 100,000 Hz (b) 25,000 Hz
(c) 120,000 Hz (d) 1,000 Hz

32. Sound waves having frequency lower than 20Hz are called: 101111049
(a) ultrasonic (b) infrasonic
(c) audible (d) echo

33. Sound wave having frequency higher than 20,000 Hz are called: 101111050
(a) ultrasonic (b) infrasonic
(c) audible (d) echo

34. 1 bel = (F. B. 2015) 101111051
(a) 0.1 dB (b) 10 dB
(c) 100 dB (d) 0.01 dB

35. Ultrasound waves carry ___ energy. 101111052
(a) less (b) more
(c) equal (d) none of these

36. Level of noise recommended in eight-hour work day: 101111053
(a) 80-90 dB (b) 80-85 dB
(c) 85-90 dB (d) 90-95 dB

37. The sensation of sound persists in our brain for: 101111054
(a) 0.1sec (b) 0.01 sec
(c) 1 sec (d) 10 sec

38. The speed of sound in a liquid is ____ than that in gases: 101111055
(a) ten times (b) fifteen times
(c) five times (d) two times

39. We can distinguish between the notes of a piano and flute due to __ of sound. 101111056
(a) loudness (b) pitch
(c) quality (d) intensity

40. The characteristics of sound by which we can distinguish between two sounds of same loudness and pitch is called: 101111057
(a) intensity (b) quality
(c) loudness (d) pitch

41. Example of Mechanical waves is. 101111058
(a) radio waves (b) x-rays
(c) light waves (d) sound waves

42. Bel is the unit of_____: 101111059
(a) Intensity level of a sound
(b) Pitch of Sound
(c) Loudness of Sound
(d) Quality of Sound

43. How many times speed of sound is greater in water than air? (F.B 2016) 101111060
(a) 2 times (b) 3 times
(c) 4 times (d) 5 times

44. Which type of wave is slower? (F. B. 2014) 101111061
(a) Light (b) Sound
(c) Radio waves (d) infra-red

45. The intensity level of faintest audible sound in decibel is: (F. B. 2016) 101111062
(a) 10 dB (b) 0 dB
(c) 100db (d) 10^{-12}dB

46. The intensity level for vaccum cleaner is: 101111063
(a) 10dB (b) 70dB
(c) 100dB (d) 170dB

47. The sound energy passing per unit area per second is called: (F.B 2018) 101111064
(a) loudness (b) intensity of sound
(c) pitch of sound (d) frequency

48. The intensity level of mosquito buzzing is: (F.B 2018) 101111065
(a) 40 db (b) 30dB
(c) 20dB (d) 10dB

Answer Key

1.	a	2.	a	3.	b	4.	c	5.	d	6.	b	7.	c
8.	c	9.	b	10.	c	11.	c	12.	b	13.	c	14.	a
15.	b	16.	a	17.	a	18.	d	19.	c	20.	b	21.	b
22.	c	23.	b	24.	a	25.	b	26.	d	27.	a	28.	a
29.	b	30.	b	31.	a	32.	b	33.	a	34.	b	35.	b
36.	c	37.	a	38.	c	39.	c	40.	b	41.	d	42.	a
43.	d	44.	b	45.	b	46.	b	47.	b	48.	a		

Review Questions

Q.11.1 What is the necessary condition for the production of sound? 101111066

Ans. The sensation of sound produce on our ear only when an object vibrate about its mean position. So, the necessary condition for the production of sound is vibration of a body.

Q11.2 What is the effect of the medium on the speed of sound? In which medium sound travels more faster: air, solid or liquid? Justify your answer. 101111067

Ans. Effect of medium on Sound:

Sound waves are mechanical waves which require a material medium for its propagation. Sound cannot pass through vacuum. Sound waves can be transmitted only by any medium containing particles that can vibrate. Nature of medium will affect the speed of sound. Denser medium transmits energy more quickly as compared to rare medium. So, speed of sound is more in solids as compared to liquid and gases. In general, speed of sound in liquid is five times than in gases. The speed of sound in solids is about fifteen times than in gases.

Q11.3 How can you prove the mechanical nature of sound by a simple experiment? 101111068

Ans. See Q#4 on Page# 24

Q11.4 What do you understand by the longitudinal wave? Describe the longitudinal nature of sound waves. 101111069

Ans. See Q#5 on Page# 24

Q11.5 Sound is a form of wave. List at least three reasons to support the idea that sound is a wave? (F. B. 2016) 101111070

Ans.

1. Sound is a form of energy which obeys all the laws of reflection.
2. Sound is a form of energy which obeys all the laws of refraction.
3. Sound is a form of energy which obeys all the laws of diffraction.

Q11.6 We know that waves manifest Phenomenon of reflection, refraction and diffraction. Does sound also manifest these characteristics? 101111071

Ans. All the waves manifest Phenomenon of Reflection, refraction, interference and diffraction. Sound is a form of energy and it propagates in the form of waves. When another medium (or) obstacle is placed in the path of sound wave it obeys the reflection, refraction and diffraction. Sound manifests all these characteristics.

Q11.7 What is the difference between the loudness and intensity of sound? Derive the relationship between the two. 101111072

Ans.

Loudness of Sound

(i) Loudness is the characteristics of sound by which we can distinguish between a loud and faint sound

(ii) Loudness of sound depends on the intensity of sound and also on the physical condition of the ear

(iii) Loudness of sound mainly depends on

i. Area of vibrating body
ii. Amplitude of vibrating body
iii. Distance from vibrating body

Intensity of Sound

(i) Sound energy passing per second through a unit area held perpendicular to the direction of propagation of sound waves is called intensity of sound.

(ii) Intensity of sound is a physical quantity and it depends on the amplitude of sound wave. It does not depend on physical condition of ear.

(iii) Unit of intensity of sound is Wm^{-2}. The human ear responds to the intensities ranging from 10^{-12} Wm^{-2} to $1 Wm^{-2}$.

Relation between Loudness and Intensity

The loudness (L) of sound is directly proportional to the logarithm of intensity (I) of sound. i.e.

$$L \propto \log I$$

$$L = K \log I$$

K is constant of proportionality

Q11.8 On what factors does the loudness of sound depends? (F. B. 2016) 101111073

Ans. Loudness of sound depends upon the following factors

(i) The amplitude of the vibrating body
(ii) Area of vibrating body
(iii) Distance from vibrating body
(iv) Physical condition of Ear of listener
(v) Direction of wind.

Q11.9 What do you mean by the term intensity level of the sound? Name and define the unit of intensity level of sound. 101111074

Ans. See Q#7 on Page# 26,27

Q11.10 What are the units of loudness? Why do we use logarithmic scale to describe range of the sound intensities we hear? 101111075

Ans. Unit of Loudness

Loudness is always measured, in terms of intensity level or sound level.

Unit of sound level is Bel and smaller unit of sound level is (dB).

1 bel = 10 dB

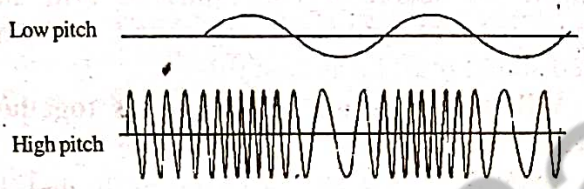
Since the range of intensities is so wide and is difficult to calculate their sound level hence we use the scale by factor of ten. In this way sound level is easily calculated by logarithm scale.

Human ear can hear wide range of intensities. Sound level or sound intensity level on a linear scale is not convenient for us. So instead of linear scale, logarithmic scale is used for this purpose.

Intensities are scaled by factor of ten. By using this scale, sound level can easily be calculated.

Q11.11 What is the difference between frequency and pitch? Describe their relationship graphically. 101111076

Ans. Pitch is characteristics of sound due to which we can distinguish between shrill and grave sound. While frequency is the number of waves passing through a point in one second.



Q11.12 Describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound. 101111077

Ans. Effect of amplitude on loudness

Loudness of sound changes directly with the amplitude of vibrating body. A body vibrating with large amptitude produces loud sound.

Example:

(i) When we beat a drum forcefully, the amplitude of its membrane increases and we hear a loud sound.

(ii) The sound produced by a sitar will be loud if we pluck its wires more violently.

Effect of frequency on Pitch:

A sound with high pitch has higher frequency and vice versa.

Pitch of sound depends on the frequency of sound waves.

The frequency and pitch of voice of ladies and children is higher than that of men.

Q 11.13 If the pitch of sound is increased, what are the changes in the following? 101111078

(a) The frequency (b) The wavelength

(c) The wave velocity

(d) The amplitude of the wave

Ans.

(a) If the pitch of sound is increased frequency will also increase.

(b) With the increase of pitch, wavelength of the waves decreases according to the relation

$$\lambda = \frac{v}{f}$$

(c) If the pitch increases then velocity of wave remains same because speed of sound depends on the temperature humidity and density of medium.

(d) Pitch is independent of amplitude of the sound waves so amplitude of the wave does not change with the change of pitch.

Q11.14 If we clap or speak in front of a building while standing at a particular distance. We rehear our sound after sometime. Can you explain how does this happen? 101111079

Ans. When we clap or shout near a tall building or a mountain, we hear the same sound again after a moment. This sound we hear later is an echo and is a result of reflection of sound. When sound is incident on the surface of a medium, it bounces back into the first medium. This phenomenon is called echo or Reflection of sound.

Condition for Echo:

To hear a clear echo, the minimum distance of obstacle and source of sound must be 17m, and the time interval between our sound and the reflected sound must be at least 0.1s.

Q11.15 What is the audible frequency range for human ear? Does this range vary with age of people? Explain. 101111080

Ans. See Q#13 on Page# 30

Q11.16 Explain that noise is a nuisance. 101111081

Ans. See Q#13 on Page# 29

Q11.17 Describe the importance of acoustic protection. 101111082

Ans. See Q#14 on Page# 29

Q11.18. What are the uses of ultrasound in medicine? 101111083

Ans. See Q#17 on Page# 30

Conceptual Questions

Q.1 Why two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air? 101111084

Ans. String stretched between two tin cans could be better way to communicate than merely shouting through the air because sound waves propagate much better and faster in solid material than air. Sound expands in air in all directions and communication between persons become difficult. In two tin cans and wire system, sound travel in a specific direction with greater speed than in air.

So it is better way for communication.

Q.2 We can recognize persons speaking with the same loudness from their voice. How is this possible? 101111085

Ans. We can recognize person speaking with same loudness from their voice because sound waves have different waveforms, so their quality is different and we can distinguished them from each other.

Q.3 You can listen to your friend around a corner, but you cannot watch him/ her. Why? 101111086

Ans. Voice can be listened around the corner because sound waves travel around obstacles, due to its very large wavelength it is diffracted around the corner of obstacle. We cannot watch a person around the corner because light wave cannot bend around normal sized objects due to its very small wavelength. So we can listen a friend a corner but we cannot watch him.

Q.4 Why must the volume of a stereo in a room with wall-to-wall carpet be tuned higher than in a room with a wooden floor? 101111087

Ans. The volume of the stereo in a room with wall to wall carpet turned higher than in a room with wooden floor because the carpet absorbs sound waves. Reflection of sound is higher in wooden floor so loud sound give the sensation of sound easily.

Q.5 A student says the two terms speed and frequency of the wave refer to the same thing. What is your response? 101111088

Ans. No, wave frequency is the number of waves that you get in a second, and the wave speed is the measure of how long it takes to travel in a given distance, so speed and frequency are two different quantities having time as common factor.

Q.6 Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen. 101111089

Ans. They disagree on loudness because loudness depends upon the sensitivity of the ear of the listener.

Q.7 Is there any difference between echo and reflection of sound? Explain. (F. B. 2017) 101111090

Ans. The phenomena of repetition of a sound caused by reflection of sound from a surface is called echo. For example, you shout from a valley, you hear an echo. While the reflection is the change in direction of a wave such as light or sound wave, away from a boundary.

Condition for Echo:

To hear a clear echo, the minimum distance of obstacle and source of sound must be 17m, and the time interval between our sound and the reflected sound must be at least 0.1s.

Q.8 Will two separate 50dB sounds together constitute a 100dB sound? Explain. 101111091

Ans. Since dB is the unit of sound level, and its value depends upon the log of intensities, therefore 50dB sound from two bodies does not constitute 100dB sound.

Q.9 Why ultra-sound is useful in medical field? 101111092

Ans. Ultra-sound is useful in medical field because it carries more energy and higher frequency, ($v = f\lambda$) with very small wavelengths than audible sound waves. Ultrasound due to its characteristics has vast applications in medical and in technical field.

Additional Short Questions

Q.10 Is any medium required for propagation of sound? 101111093

Ans. Yes, material medium is required for propagation of sound, i. e. solid, liquid and gas.

Q.11 Write the name of characteristics of sound. 101111094

Ans. There are five characteristics of sound.

i. Loudness of sound
ii. Intensity of sound
iii. Pitch of sound
iv. Quality of sound
v. Music and noise

Q.12 Define Loudness. 101111095

OR

What is meant by loudness of sound?

Ans. Loudness is the characteristic of sound by which loud and faint sounds can be distinguished.

Q.13 What do you mean by intensity of sound? Also write its unit. 101111096

Ans. Sound energy flowing per second through a unit area held perpendicular to the direction of sound waves is called intensity of sound. Its SI unit is Wm^{-2}.

Q.14 Distinguish between noise and musical sound. 101111097

(OR)

What is the difference between noise and music?

Ans. The sound which has pleasant effect on ears is called musical sound. The sound which has jarring effect on ears is called noise. The frequency and amplitude of musical sound change in a regular manner and in noise frequency and amplitude does not change in regular manners.

Q.15 How can you explain that greater the surface area the greater is sound? 101111098

Ans. Greater the surface area of vibrating body greater is the sound produced. For example, the bell of school has greater area, so its sound is louder while the bell used in home has less area so faint sound is produced.

Q.16 How many times is the speed of sound in water faster than in air? 101111099

Ans. Sound waves travel five times faster in water than in air.

Q.17 Describe the compression and rarefactions produced in the sound wave?

Ans. 101111100

Compression:

Compression is places where air pressure is slightly higher than the surrounding air pressure due to high density of air particles.

Rarefactions:

Rarefactions are the regions correspondence to low air pressure due to low density of air particles.

Q.18 Define pitch and quality? 101111101

OR What is the difference between pitch and quality of sound?

Ans. Pitch:

The characteristics of sound by which a shrill sound can be distinguished from a grave sound is called pitch. It depends on frequency of sounds.

Quality:

The characteristics of sound by which two sounds of same loudness and pitch are distinguished from each other is called quality of sound. It depends upon the wave shape of sound.

Q.19 Describe the factors on which a safe level of noise depends. 101111102

Ans. A safe level of noise depends on two factors:

i) The level of noise.

ii) The period of exposure to the noise.

The level of noise recommended in most countries is usually 85-90 dB over an eight-hour workday.

Q.20 What is meant by pitch of sound? On what factors does it depend? 101111103

Ans. Pitch:

The characteristics of sound by which a shrill sound can be distinguished from a grave sound is called pitch.

Factors:

It depends upon frequency. A higher pitch means a higher frequency and vice versa.

Q.21 Is speed of sound more in solids or liquids? And why? 101111104

Ans. Speed of sound in solids is more than in liquids because the molecules of solids are closely packed whereas molecules of liquids are far apart.

Q.22 Define acoustic protections? 101111105

Ans. "The technique or method used to absorb undesirable sounds by soft and porous surfaces is called acoustic protection".

Q.23 What is the reflection of sound? OR Define "Echo". 101111106

Ans. When sound is incident on the surface of a medium, it bounces back into the first medium. This phenomenon is called echo or reflection of sound.

Q.24 How depth of sea can be measured by ultrasonics? 101111107

Ans. To find depth of Sea:

Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called SONAR, (sound navigation and ranging). The sound waves are sent from a transmitter, and a receiver collects the reflected sound. The time-lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated. SONAR ranging is also used to see the shape and the size of the object.

Q.25 What is meant by ultrasound? 101111108

Ans: Sound of frequency higher than 20,000 Hz

which are inaudible to normal human ear can be produced and utilized in many useful ways. Such sounds are called Ultrasonic.

Q.26 What do you mean by noise pollution? 101111109

Ans: Sounds which has jarring and unpleasant effect on our ear is called noise. Noise is undesirable sound that is harmful for health of human and other species. When noise effect environment such situation is called noise pollution.

Q.27 What is meant by SONAR? 101111110

Ans: The technique to locate underwater depths or is used for locating object lying deep on the ocean floor with the help of ultra sound is called SONAR. Its full form is sound navigation and ranging.

Q.28 Why sound waves are called mechanical waves? 101111111

Ans. Sound waves require a medium for their propagation and they cannot travel in vacuum. That is why sound waves are called mechanical waves.

Q.29 Define the followings. 101111112

(a) Reverberation (F.B. 2018)

(b) Acoustics

Ans. (a) Reverberation

When sound reflects from the wall, ceiling and floor of a room, the reflecting surfaces are too reflective and sound becomes garbled. This is due to multiple reflections called reverberations.

(b) **Acoustics** The study of sound is called acoustics.

Q.30 Give three uses of ultrasound. (F.B. 2017) 101111113

Ans. Three uses of ultrasound are given below.

(i) The powerful ultrasonic waves are now being used to remove blood clots formed in the arteries.

(ii) Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.

(iii) The kidney stones can be crushed and removed out through urine with the help of ultrasonic waves without any surgery.

Side Information

Q.31 How sound is produced? 101111114

Ans. All sounds are produced by the vibrations of objects. Sound is a form of energy that travels in the form of compressional waves from one place to another.

Q.32 How can we hear the sound through stethoscopes? Or What is stethoscope? 101111115

Ans. Stethoscopes operate on the transmission of sound from the chest-piece, via air-filled hollow tubes, to the listener's ears. The chest-piece usually consists of a plastic disk called Diaphragm. If Diaphragm is placed on the patient's body sound vibrates the diaphragm creating acoustic pressure waves which after multiple reflection travels up the tubing to the doctor's ears.

Q.33 What is silent whistle? OR What is meant by soundless whistle? 101111116

Ans. Some people use silent whistle to call dogs whose frequency lies between 20,000 Hz to 25,000 Hz. It is silent for human but not for dogs because their audible frequency range is much more than human's audible frequency range.

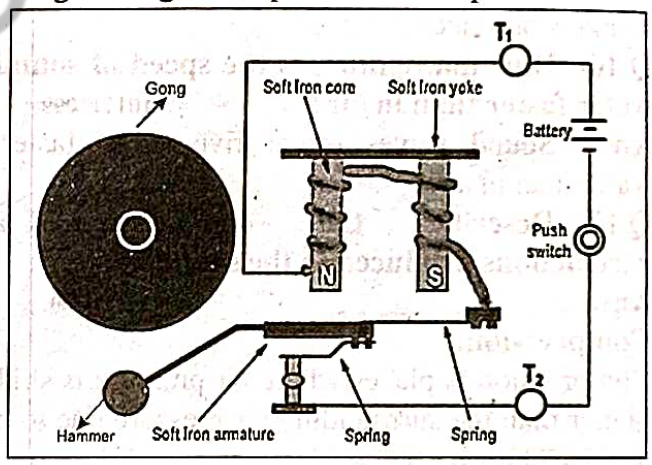
Q.34 Identify which part of these instruments vibrate to produce sound? 101111117

(a) Electric Bell (b) Loud Speaker
(c) Piano (d) Violin
(d) Flute

Ans.

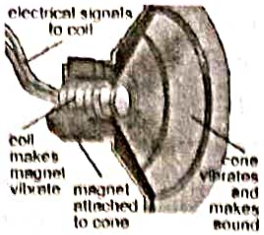
(a) Electric Bell:

When the switch is pressed, the circuit is closed and the current begins to flow through the solenoid. The core gets magnetized and attract the armature. Due to the movement of the armature, the hammer moves and strikes the gong and the bell rings. As a result, the hammer vibrates and the bell continues to ring as long as the push-button is pressed.



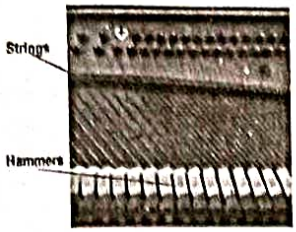
(b) Loud Speaker

The most basic sound a loudspeaker can produce in a form of sine wave. It vibrates the speaker's diaphragm in and out at a single frequency. The speaker cone moves very fast in and out which causes vibrations in the air. Those vibrations are picked up by our ears. The speaker cone movement is caused by the electric current in the speaker wires. The current makes a magnetic field which repels or attracts the permanent magnet attached to the speaker.



(c) Piano

A piano has strings which are struck by small "hammers" when you press the keys. The strings vibrate and create the sound, which is amplified by the sound board.

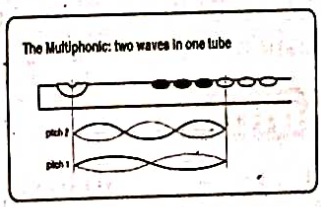


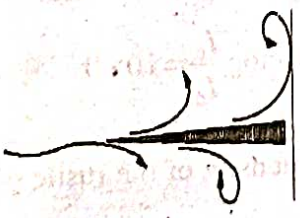
(d) Violin

Producing sound on violin is pretty simple. When we touch the strings of violin. The strings that we have touched create vibrations, affecting all of the molecules in the area around those strings. These vibrations then create the sound. The way in which violin produces sound very similar to the way anything else - like our voice - produces sound energy.

(e) Flute

Flute is a hollow pipe. When air is blown over its mouth, the air inside the pipe is set into vibration. As a result, a pleasant sound is produced.





Q.35 Can sound waves travel on moon? 101111118

Ans. There is no air on the Moon, and the vacuum has no molecules to carry vibration. Moon does have a very tenuous atmosphere. The density on Moon is about a billion times less than the Earth's, so in terms of conducting sound waves, it is pretty poor.

Q.36 How can the singers shatter the glass by sound waves? 101111119

Ans. Thin-walled glass goblets can vibrate. This is due to a phenomenon of sound known as Resonance. Some singers can produce a loud note of particular frequency such that it vibrates the glass so much that it shatters.

Q.37 Why is the voice of women more shrill than that of men? 101111120

Ans. Greater the frequency, higher is the pitch, smaller frequency, smaller is the pitch. As the frequency of women and babies is greater than that of men, hence their voice is shrill and of high pitch.

Q.38 Which property of sound wave determines its: 101111121

(a) loudness (b) pitch

Ans. The absolute loudness is determined by the wave's amplitude. Pitch is determined by the frequency of the wave.

Q.39 On which factor frequency of tuning fork depends upon? 101111122

Ans. Frequency of tuning fork depends on the mass of its prongs. The greater the mass, the lower the frequency of vibration which means the lower of the pitch.

Q.40 Which sound is the loudest animal sound ever recorded? 101111123

Ans. A blue whale's 180 dB rumble is the loudest animal sound ever recorded. Whale's sound also appears to be part of a highly evolved communication system. Some Whales are thought to communicate over hundreds and may be thousands of kilometers.

Q.41 Elephants can communicate effectively with one and another, even they are separate by many kilometers. Why? 101111124

Ans. Elephants use low frequency sound waves to communicate with one another. Their large ears enable them to detect these low frequency sound waves, which have relatively long wavelength. Elephants can effectively communicate in this way, even when they are separated by many kilometers.

Q.42 Can we see sound wave on screen? How? 101111125

Ans. Yes, we can see the sound wave by using oscilloscope.

Q.43 What is higher frequency range of the following? 101111126

(a) Bats (b) Mice
(c) Dogs (d) Cats

Ans.

a) **Bats:** Bats can hear frequencies up to 120,000 Hz.
b) **Mice:** Mice can hear frequencies up to 100,000 Hz.
c) **Dogs:** Dog can hear frequencies up to 35,000 Hz.
d) **Cats:** Cat can hear frequencies up to 25,000 Hz.

Q.44 When was the speed of sound in air first accurately measured? Explain. 101111127

Ans. The speed of sound in air was first accurately measured in 1738 by members of the French Academy. Cannons were set up on two hills approximately 29 km apart. By measuring the time interval between the flash of a Cannon and the "boom" the speed of sound was calculated. Two cannons were fired alternatively to minimize errors due to the wind and to delayed reactions in the observers. From their observations, they deduced that sound travels at about $336 ms^{-1}$ at 0°C.

Q.45 Which property displays by the sound when it interacts with materials and boundaries? 101111128

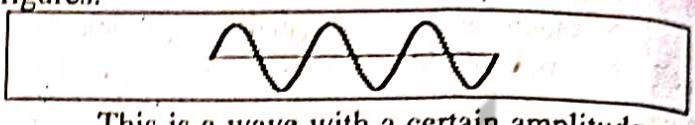
Ans. Sound displays all the properties of waves when it interacts with materials and boundaries. e.g. Reflection, refraction, diffraction and absorption.

Q.46 Can bats and dolphins travel without vision? Explain how. 101111129

Ans. The phrase "Blind as a bat" is a false statement. Bats have some vision using light, but when placed in pitch-black rooms crisscrossed with fine wires, they can easily fly around and unerringly locate tiny flying insects for food. We usually assume that vision requires light but both bats and dolphins have the ability to "see" using sound waves. Research in science and technology has developed "eyes" that enable humans also to see using sound waves.

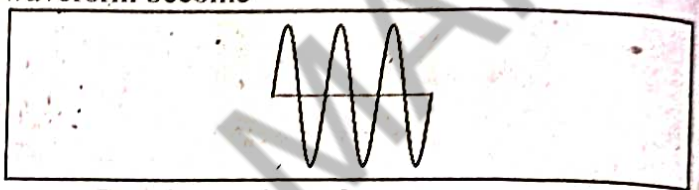
Q.47 What would happen to the loudness of sound with increase in it's frequency? 101111130

Ans. To understand this consider following figures.



This is a wave with a certain amplitude and frequency.

Now if we increase the frequency the waveform become



By increasing frequency, amplitude of sound increase. Loudness depends upon amplitude hence if the frequency increases, amplitude increases due to which loudness increases.

Q.48 How speed of sound vary with temperature? 101111131

Ans. Variation of speed of sound with temperature is as follows:

i. In low (cooler) temperature sound travel slower.
ii. In high (warmer) temperature sound travel faster.

Q.49 What is the relationship between decibel scale and amplitude of sound waves. 101111132

Ans. The decibel scale is a logarithmic measure of the amplitude of sound waves. In a logarithmic scale, equal intervals correspond to multiplying by 10 instead of adding equal amounts.

Q.50 Suppose you and your friend are on the moon. Will you be able to hear any sound produced by your friend? 101111133

Ans. We cannot hear any sound on the moon because there is no medium and sound waves cannot travel in vacuum.

Solved Examples

11.1 Calculate the intensity levels of the (a) faintest audible sound (b) rustling of leaves. 101111134

Solution:

(a) Intensity level of faintest audible sound can be calculated by substituting $I = I_o = 10^{-12}\ Wm^{-2}$.

Therefore,

Intensity level of faintest audible sound

$$L - L_o = 10 \log \frac{I}{I_0} \quad \because \boxed{I = I_0}$$

$$= 10 \log \frac{I_0}{I_0} = 10 \times 0$$

$$L - L_o = 0dB$$

(b) As the intensity of the rustle of leaves is I =

10^{-11} Wm^{-2}

Therefore,

Intensity level due to rustling of leaves

$= 10 \log 10^{-11}/10^{-12}$

$= 10 \log 10 = 10$dB

Result:

The intensity level of faintest audible sound is zero decible and rustle of leaves is 10 decible.

11.2 Calculate the frequency of a sound wave of speed 340ms^{-1} and wavelength 0.5 m. 101111135

Given data;

Speed of waves $v = 340 ms^{-1}$

Wave length $\lambda = 0.5m$

To Find:

Wave speed $v = ?$

Solution:

Using the formula

$$v = f\lambda \Rightarrow f = \frac{V}{\lambda}$$

$f = 340/0.5 = 680$ Hz

Result:

The frequency of sound wave is 680Hz.

11.3 Flash of lightning is seen 1.5 seconds earlier than the thunder. How far away is the cloud in which the flash has occurred? (speed of sound = 332ms^{-1}) 101111136

Solution:

Given data

Time = $t = 1.5s$

speed of sound = $v = 332 ms^{-1}$

To Find:

Distance of cloud = $S = ?$

Solution:

distance of the clouds = vt

$= 1.5 \times 332$

$= 498$m.

Result:

Thus the distance of cloud is 498m.

Numerical Problems

11.1 A normal conversation involves sound intensities of about 3.0×10^{-6} Wm^{-2}. What is the decibel level for this intensity? What is the intensity of the sound for 100 dB? 101111137

Given data:

Intensities of sound = $I = 3 \times 10^{-6}$ Wm^{-2}

Threshold intensity $I_o = 10^{-12}$ Wm^{-2}

To Find

Decibel level = $L - L_o = ?$

Calculation: $L - L_o = 10 \log \frac{I}{I_o}$ dB.

$= 10 \log \left(\frac{3 \times 10^{-6}}{10^{-12}} \right)$ dB.

$= 10 \log (3 \times 10^{-6} \times 10^{12})$ dB.

$= 10 \log (3 \times 10^{6})$ dB.

$= 10 (\log 3 + \log 10^{6})$ dB.

$= 10 (0.477 + 6 \log 10)$ dB

$= 10 (0.477 + 6)$ dB.

$= 10 \times 6.477$

$= 64.77$ dB.

$L - L_o = 64.8$ dB.

Result:

The decible level for the sound is 64.8 decible.

Now $L - L_o = 100$ dB

Intensity of sound = $I = ?$

$L - L_o = 10 \log \frac{I}{I_o}$ dB.

$100 = 10 \log \frac{I}{10^{-12}}$

$100 = 10 \log (I \times 10^{+12})$

$100 = 10 (\log I + \log 10^{+12})$

$\frac{100}{10} = (\log I + 12 \log 10)$

$10 = (\log I + 12)$

$10 - 12 = \log I$

$-2 = \log I$

Taking antilog of both sides

antilog. (Log I) = antilog (–2)

$I = 0.01$

$I = 10^{-2}$ Wm^{-2}

Results:

The intensity of the sound for 100 dB is 1×10^{-2} Wm^{-2}.

11.2 If at Anarkali bazaar Lahore, the sound level is 80dB, what will be the intensity of sound there? (F.B. 2015, 18) 101111138

Given data

Sound level = $L - L_o = 80$dB.

Intensity for faintest sound = $I_o = 10^{-12}$ Wm^{-2}.

To Find

Intensity of sound = $I = ?$

Calculation: $L - L_o = 10\log\frac{I}{I_o}$ dB.

$$80 = 10\log\frac{I}{10^{-12}}$$
$$80 = 10\log(I\times10^{+12})$$
$$80 = 10(\log I + \log 10^{12})$$
$$\frac{80}{10} = \log I + 12\times\log 10$$
$$8 = \log I + 12\times1$$
$$8 - 12 = \log I$$
$$-4 = \log I$$

Taking anti log on both side.

$$I = 10^{-4}\,Wm^{-2}$$

Result:

The intensity of sound is $10^{-4}Wm^{-2}$

11.3 At a particular temperature, the speed of sound in air is 330ms^{-1}. If the wavelength of a note is 5cm, calculate the frequency of the sound wave. Is this frequency lies in the audible range of the human ear? 101111139

Given data:

Speed of sound = v = 330ms^{-1}.

Wavelength = λ = 5cm = 0.05m

To Find

Frequency = f = ?

Calculation: $v = f\lambda$

$$330 = f\times0.05$$
$$\frac{330}{0.05} = f.$$
$$6600Hz = f$$
$$6.6\times10^{3}Hz = f$$
$$f = 6.6\times10^{3}\ Hz$$

Result:

Yes, this range lies between the audible frequency range.

11.4 A doctor counts 72 heartbeats in 1 min. Calculate the frequency and period of the heartbeats. 101111140

Given data

Number of heart beats = n = 72

Time = t = 1min = 60 sec

To Find

Frequency = f = ?

Time Period = T = ?

Calculation:

We know that

$$f = \frac{\text{number of heart beats}}{\text{time in seconds}} = \frac{n}{t}$$
$$f = \frac{72}{60} = 1.2Hz$$
$$T = ?$$
$$T = \frac{1}{f} = \frac{1}{1.2}$$
$$T = 0.833\,sec$$

Result:

The frequency and time period of heartbeats is 1.2Hz and 0.833 seconds.

11.5 A marine survey ship sends a sound wave straight to the sea bed. It receives an echo 1.5s later. The speed of sound in sea water is 1500 ms^{-1}. Find the depth of the sea at this position. 101111141

Given data

Time to hear echo = 1.5s

Time taken by waves to reach the sea bed = $t = \frac{1.5}{2} = 0.75$sec

Speed of sound = V = 1500ms^{-1}.

To Find

Depth of sea = S = ?

Calculation: We know

$$S = v\times t$$
$$= 1500\times0.75$$
$$S = 1125m.$$

Result:

Thus the depth of the sea at this position is 1125m.

11.6 A student clapped his hands near a cliff and heard the echo after 5 s. What is the distance of the cliff from the student if the speed of the sound, v is taken as 346ms^{-1}? 101111142

Given data:

Time to hear echo = 5s

Time taken by the sound to reach the cliff = $t = \frac{5}{2} = 2.5$sec

Speed = v = 346 ms^{-1}.

To Find:

Distance of cliff from the student = S = ?

Calculation:

We know that

$$S = v\times t$$
$$S = 346\times2.5 = 865m$$

Result:

Thus the distance of the cliff from the student is 865m.

11.7 A ship sends out ultrasound that returns from the seabed and is detected after 3.42s. If the speed of ultrasound through seawater is 1531 ms^{-1}, what is the distance of the seabed from the ship? 101111143

Given data:

Time of detection of sound = $t' = 3.42$

Time of sending sound = $t = \frac{t'}{2} = \frac{3.42}{2}$

$= 1.71s$

Speed of sound = $V = 1531\ ms^{-1}$.

To Find

Distance of sea bad from ship = $S = ?$

Calculation:

We have

$S = v \times t$

$= 1531 \times 1.71$

$S = 2618m$

Result:

Thus the distance of seabed from the ship is 2618m.

11.8 The highest frequency sound humans can hear is about 20,000 Hz. What is the wavelength of sound in air at this frequency at a temperature of 20°C? What is the wavelength of the lowest sounds we can hear of about 20 Hz? Assume the speed of sound in air at 20°C is $343ms^{-1}$. 101111144

Given data

Highest frequency level of sound = $f_1 = 20{,}000Hz$

Lowest frequency level of sound = $f_2 = 20\ Hz$

Speed of sound = $v = 343\ ms^{-1}$

To Find

Wavelength of highest sound = $\lambda_1 = ?$

Wavelength of lowest sound = $\lambda_2 = ?$

Calculation:

$v = f_1 \lambda_1$

$\lambda_1 = \frac{v}{f_1}$

Putting the values

$\lambda_1 = \frac{343}{20000}$

$\lambda_1 = 0.01715m$

$\lambda_1 = 1.7 \times 10^{-2}m$

Similarly

$v = f_2 \lambda_2$

$\lambda_2 = \frac{v}{f_2}$

Putting the values

$\lambda_2 = \frac{343}{20}$

$\lambda_2 = 17.15m$

Result:

The wavelength of sound at highest frequency is $1.7 \times 10^{-2}m$ and wavelength of lowest sound is 17.15m.

11.9 A sound wave has a frequency of 2kHz and wavelength 35 cm. How long will it take to travel 1.5 km? (F.B 2016) 101111145

Given data:

Frequency = $f = 2kHz$

$= 2 \times 1000\ Hz$

$= 2000\ Hz$

Wave length = $\lambda = 35\ cm$

$= \lambda = \frac{35}{100}m$

$= \lambda = 0.35\ m$

Distance = $S = 1.5km$

$= S = 1.5 \times 1000$

$= S = 1500m$

To Find:

Time = $t = ?$

Calculation: $v = f\lambda$

$= 2000 \times 0.35$

Wave Speed $= 20 \times 35 = 700\ ms^{-1}$

We know that $S = v \times t$

$1500 = 700 \times t$

$t = \frac{1500}{700}$

$t = 2.1\ sec$

Result:

Time taken by the wave to travel this distance is 2.1 second.

UNIT 12

Geometrical Optics

Q1. Define Optics and Geometrical Optics. 101112001

Ans. Optics: "The study of light behavior is called optics".

Geometrical Optics:

"The branch of optics that focuses on the creation of images is called geometrical optics".

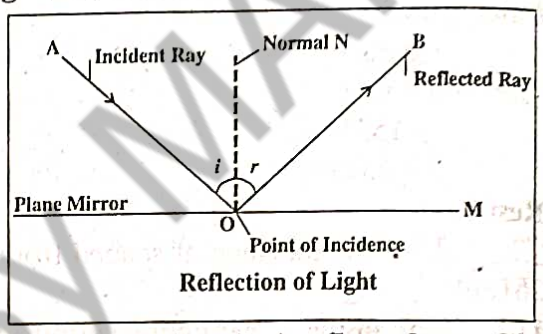
i. It is based on the relationship between angles and lines that describe light rays.

ii. Optics also includes the study of the eye itself because the human eye forms an image with a lens.

Q.2 Define the reflection of light. Also describe the laws and types of reflections. 101112002

OR

What do you understand by reflection of light: Draw a ray diagram to illustrate reflection at a plane surface?



Reflection of Light

Ans. Reflection of Light:

"When light travelling in a certain medium, falls on the surface of another medium, a part of it turns back in the same medium. This is called reflection of light."

Explanation:

Reflection of light is illustrated in following figure. When a ray of light from air along path AO falls on a plane mirror M, it is reflected along the path OB. This ray AO is called **incident ray**, while ray OB is called **reflected ray**. The angle between incident ray AO and normal N, i.e. ∠AON is called **angle of incidence** represented by **'i'**. The angle between the normal and reflected ray OB i.e. ∠NOB is called **angle of reflection** represented by **'r'**.

Laws of Reflection:

i. The incident ray, the normal and the reflected ray at the point of incidence all lie in the same plane.

ii. The angle of incidence is equal to the angle of reflection i.e. $\angle i = \angle r$

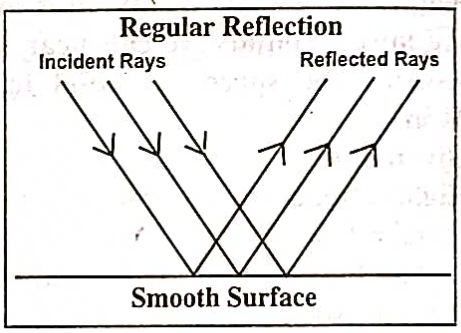
Types of Reflection:

Nature of reflection depends on smoothness of the surface.

There are two types of reflection.

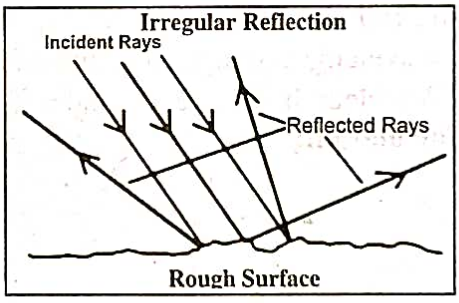
i) Regular Reflection:

A smooth surface of silver, reflects rays of light in one direction only. The reflection by these smooth surfaces is called regular reflection.



ii) Irregular Reflection:

Most of the objects in every-day world are not smooth on the microscopic level. The rough surfaces of these objects reflect the rays of light in many directions. Such type of reflection is called irregular reflections.



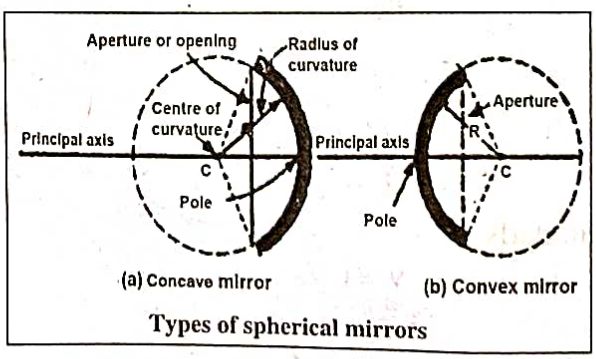
Q.3 What are spherical mirrors? Also describe the types of spherical mirrors. 101112003

Ans. Spherical Mirrors:

A mirror whose polished, reflecting surface is a part of a hollow sphere of glass or plastic is called spherical mirror.

Formation:

In a spherical mirror, one of the two curved surfaces is coated with a thin layer of silver followed by a coating of red lead oxide paint. Thus one side of the spherical mirror is opaque and the other side is highly polished reflecting surface depending upon the nature of reflecting surface, there are two types of spherical mirrors.



Types of spherical mirrors

Types of Spherical Mirrors:

1. Concave Mirror:

"A spherical mirror whose inner curved surface is reflecting is called concave mirror."

In concave mirror the size of the image depends on the position of the object. Both virtual and real image can be formed by concave mirror.

2. Convex Mirror:

"A spherical mirror whose outer curved surface is reflecting is called convex mirror".

In convex mirror the size of the image is always smaller than the object. Only virtual and erect image is formed by convex mirror.

Q.4 Define the following terms used in spherical mirrors. 101112004

Ans.

i) Pole / Vertex:

It is the mid-point of curved surface of spherical mirror. It is also called vertex and it is denoted by 'P'.

ii) Centre of Curvature (c):

A spherical mirror is a part of sphere. The centre of this sphere is called centre of curvature. It is denoted by 'c'.

iii) Radius of Curvature (R):

It is the radius of sphere of which spherical mirror is a part. It is denoted by 'R'.

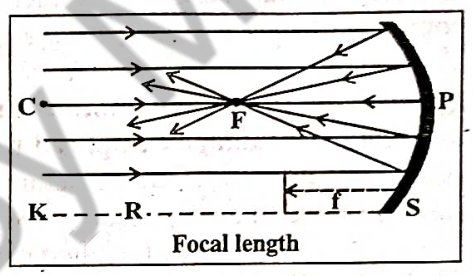
iv) Principal Axis:

It is the line joining centre of curvature and pole of spherical mirror.

v) Principal Focus (F) of Spherical Mirrors:

(a) In case of concave mirror:

After reflection from concave mirror, rays of light parallel to the principal axis converge to a point 'F'. This point is called "Principal focus" of the mirror. Hence concave mirrors are also called converging mirrors.

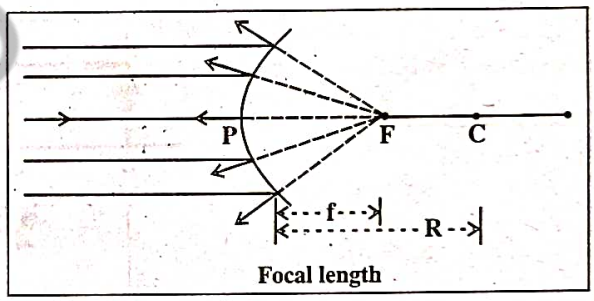


Real Focus:

Since in case of concave mirror rays of light actually pass through the principal focus, therefore, it is called real focus.

(b) In Case of Convex Mirror:

After reflection from convex mirror, rays of light parallel to the principal axis, appear to come from a point 'F' situated behind the mirror. In other words rays of light appear to diverge from F. This point is called the principal focus of convex mirror. Convex mirrors are also called diverging mirrors.

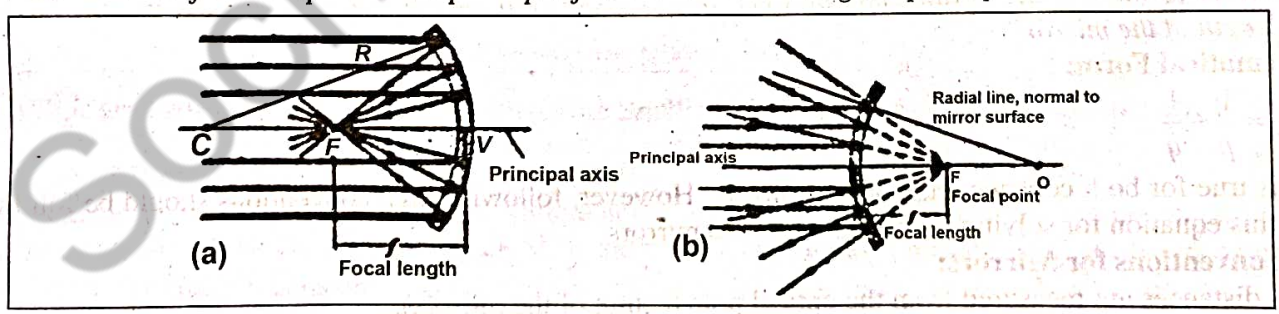


Virtual Focus:

The principal focus of convex mirror is a virtual focus because the reflected rays do not actually pass through it but appear to do so.

vi) Focal Length (F):

It is the distance from the pole to the principal focus measured along the principal axis.



vii) Aperture:

The front section of spherical mirror is circular one and its diameter is known as the aperture.

Relation between the Focal Length & Radius of Curvature:

The focal length is related to the radius of curvature of $f = \frac{R}{2} \Rightarrow R = 2f$ i.e. the focal length is half of the

radius of curvature of spherical mirror or radius of curve is twice of its focal length. For convex mirror $f = -R/2$ because we take the focal length of convex mirror as negative.

Q.5 Describe the characteristics of focus of a concave and convex mirror. 101112005

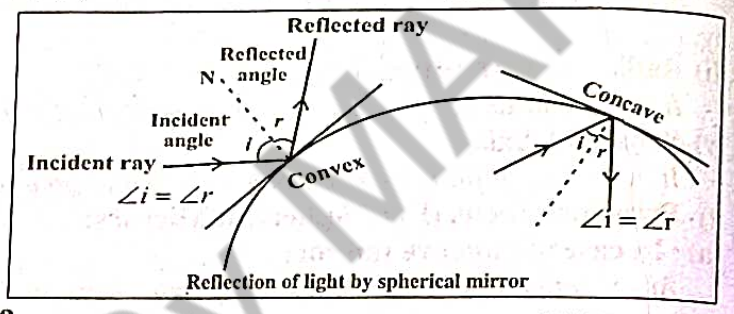
Ans. Characteristics of Focus of a Concave and Convex Mirror:

Concave Mirror	Convex Mirror
i) The focus is in front of the mirror.	i) The focus lies behind the mirror.
ii) The focus is real as the rays of light after reflection converge at the focus.	ii) The focus is virtual as the rays of light after reflection appear to come from the focus.

Q.6 Describe the reflection of light by spherical mirrors. 101112006

Ans. Reflection of Light by Spherical Mirrors:

Like plane surfaces spherical surfaces also reflect light following the two laws of reflection as stated for plane surfaces. Following figure shows how light is reflected by the spherical surfaces of concave and convex mirrors according to the laws of reflection.



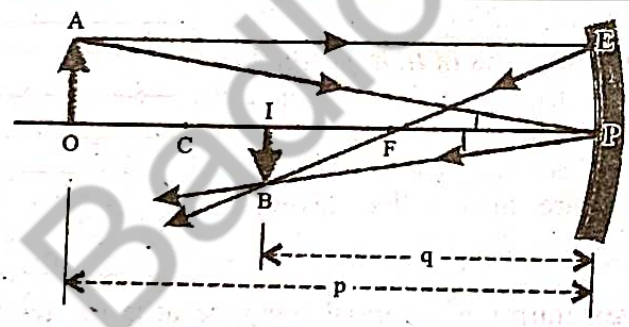
Reflection of light by spherical mirror

Q.7 How can we tell about the nature of image and the size of image compared with the size of object? 101112007

Ans. We can tell about the nature of image (whether image is real or imaginary, inverted or erect) and size of image formed in a mirror compared with the size of object, by two methods.

i) Graphical method or ray diagram ii) Mirror formula

i) By Graphical method or Ray Diagram:



Concave Mirror formula

By Mirror Formula:

"Mirror formula is the relationship between object distance p, image distance 'q' from the mirror and the focal length of the mirror".

Mathematical Form:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

It is true for both concave and convex mirrors. However, following sign conventions should be followed to apply this equation for solving problems related to mirrors.

Sign Conventions for Mirrors:

i) All distances are measured from the optical pole (centre of the mirrors).
ii) The distance of real object and real image from the mirror is taken as positive.
iii) The distance of virtual object and virtual image is taken as negative.
iv) The focal length of concave mirror is taken as positive whereas focal length of convex mirror is taken as negative.

Sign Conventions

Quantity	When Positive (+)	When Negative (–)
i) Object distance p	Real object	Virtual object
ii) Image distance q	Real image	Virtual image
iii) Focal length f	Concave mirror	Convex mirror

Q.8 Define Refraction of light. Describe the passage of light through parallel-sided transparent material. 101112008

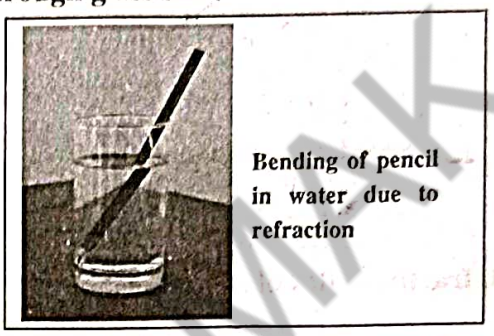
OR

What is meant by Refraction? Describe the refraction of light through glass slab.

Ans. Refraction:

"The bending of light as it passes from one transparent medium into another is called refraction". **OR**

"The process of bending of light as it passes from air into glass and vice versa is called refraction of light".



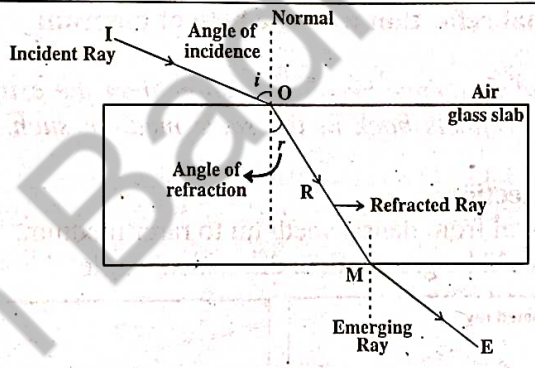
Bending of pencil in water due to refraction

Experiment:

If we dip one end of a pencil or some other object into water at an angle to the surface, the submerged part looks bent. Its image is displaced because the light coming from underwater portion of the object changes direction as it leaves the water. This bending of light or changing path of light as it passes from one transparent medium into another is called refraction.

Refraction of Light:

A ray of light travelling from air falls on the surface of a glass slab. At the air-glass interface, the ray of light IO changes its direction and bends towards the normal and travels along the path OR inside the glass slab. The ray IO and OR are called the incident ray and refracted ray respectively. The angle i made by the incident ray with the normal is called angle of incidence. The angle 'r' made by the refracted ray with the normal is called angle of refraction. When refracted ray leaves the glass it bends away from the normal and travels along the path ME. This process of ending of light as it passes from air into glass and vice versa is called refraction of light.



Refraction of light by a glass block

Q.9 What are Laws of Refraction? Also describe Snell's Law and cause of refraction of light. (F.B. 2013) 101112009

Ans. Laws of Refraction:

(i) The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.

(ii) The ratio of sine of the angle of incidence 'i' to the sine of the angle of refraction 'r' is always equal to a constant i.e $\sin\angle i / \sin\angle r = \text{constant}$

Snell's Law:

"According to the Snell's law the ratio $\sin\angle i / \sin\angle r$ is known as the refractive index of second medium with respect to the first medium". So we have

$$\frac{\sin\angle i}{\sin\angle r} = n = \frac{n_2}{n_1}$$

Cause of Refraction of light:

Refraction of light is caused by the different speed of light in different medium. However, when light travels through a medium, such as water, glass, its speed decreases. To describe the change in speed of light in a medium, we use the term **index of refraction** or **refractive index.** For example the speed of light in air is approximately 3.0×10^{8} ms^{-1} and the speed of light in water and glass approximately $2.3\times10^{8}ms^{-1}$ and 2.0×10^{8} ms^{-1} respectively.

Refractive index:

The refractive index 'n' of a medium is the ratio of the speed 'c' of light in vacuum to the speed 'v' of light in the medium:

$$n = \frac{\text{speed of light in air}}{\text{speed of light in glass}}$$

$$n = \frac{c}{v}$$

Speed of light in air is $3x10^{8}$ ms^{-1} while speed of light in glass is $2\times10^{8}ms^{-1}$.

$$n = \frac{3\times10^{8}\,ms^{-1}}{2\times10^{8}\,ms^{-1}} = 1.5$$

Refractive index of some substances

Substance	Index of Refraction (n)
Diamond	2.42
Cubic Zirconia	2.21
Glass (flint)	1.66
Glass (crown)	1.52
Ethyl Alcohol	1.36
Ice	1.31
Water	1.33
Air	1.00

Q.10 What is meant by total internal reflection? Write its conditions. 101112010

OR Explain total internal reflection with the help of diagram.

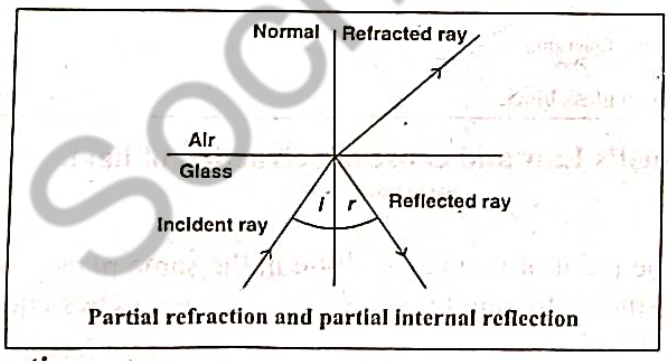
Ans: Total internal Reflection

"When the value of angle of incidence becomes greater than the critical angle, then the ray does not enter into the second medium, but reflects back in the same medium such reflection of light is called total internal reflection."

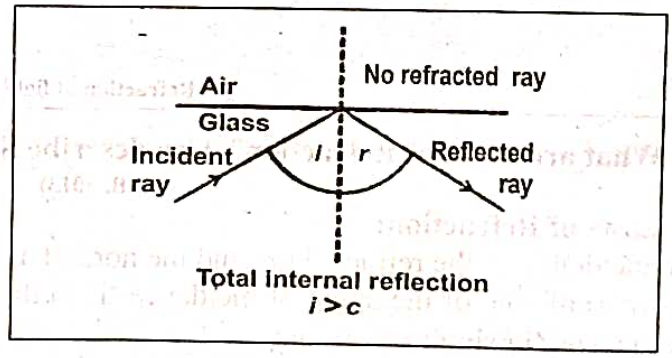
Conditions for Total Internal Reflection:

(1) The ray of light should travel from denser medium to rarer medium.

(2) The angle of incidence should be greater than the critical angle.



Partial refraction and partial internal reflection



Explanation:

When a ray of light passes from denser medium to rare medium, the refracted ray bends away from normal and the angle of refraction is greater than angle of incidence. If we increase the angle of incidence ($\hat{i}$) the angle of refraction ($\hat{r}$) also increases, till at a particular value of angle of incidence, the corresponding angle of refraction becomes 90^{o} and refracted ray becomes parallel to the surface. The angle of incidence that causes the refracted ray in the rare medium to bend through 90^{o} is called critical angle.

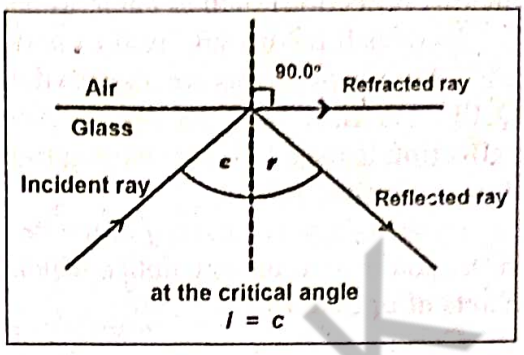
Q.11. What is critical angle? Derive the relationship between critical angle and the refractive index of a substance. OR Define Critical Angle: 101112011

Ans. Critical Angle

"The angle of incidence in the denser medium for which corresponding angle of refraction is 90°, in the rare medium is called the critical angle. It is denoted by 'C'."

OR

"The angle of incidence that causes the refracted ray in the rare medium to bend through 90^0 is called critical angle"



Relation between Critical angle and Refractive index: **(F.B. 2017)**

If refractive index of air with respect to glass is n, then refractive index of ray from glass to air is $\frac{1}{n}$.

According to Snell's Law

$$\frac{1}{n} = \frac{\sin\angle i}{\sin\angle r} \qquad [\because \quad \angle i = \angle C]$$

$$\frac{1}{n} = \frac{\sin\angle C}{\sin 90^\circ} \qquad [\because \quad \angle r = 90^\circ]$$

$$\frac{1}{n} = \frac{\sin\angle C}{1} \Rightarrow n\sin\angle C = 1$$

$$n = \frac{1}{\sin\angle C}$$

Q.12 Define total internal reflection. Also explain totally reflecting prism and their uses.

Ans. 101112012

Total Internal Reflection:

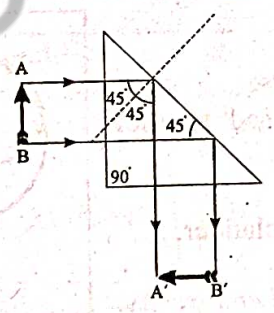
"When the value of angle of incidence becomes greater than the critical angle then the ray does not enter into the 2nd medium, but reflects back in the same medium such reflection of light is called total internal reflection".

Totally reflecting prism:

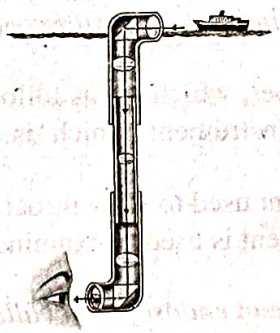
A totally reflecting prism has one of its angles equal to 90° and each of remaining two angles are equal to 45°. Hence the phenomenon of total internal reflection is used.

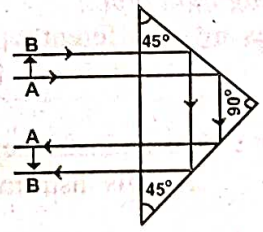
Working:

When a ray of light strikes a face of prism perpendicularly, it enters the prism without deviation and strikes the hypotenuse at an angle of 45° Since the angle of incidence 45° is greater than critical angle of glass which is 42°, the light totally reflected by the prism through an angle of 90°.



Total internal reflection through right angled prism





Prism periscope

Uses:

1. Many optical instruments use right angled prisms to reflect a beam of light through 90^o or 180^o (by total internal reflection) such as cameras and telescope.
2. Two such prisms are used in periscope, in which the light is totally reflected by the prism by an angle of 180^o. Two such prisms are also used in binoculars.

Q.13 Write a note on optical fibre. OR What are optical fibres? Describe how total internal reflection is used in light propagation through the optical fibre. (F.B. 2016) 101112013

Ans. Optical Fiber

Optical fiber consists of hair size threads of glass or plastic through which light can travel. Total internal reflection is used in fibre optics which has number of advantages in Telecommunication field.

Parts of optical fibre:

(i) Core:

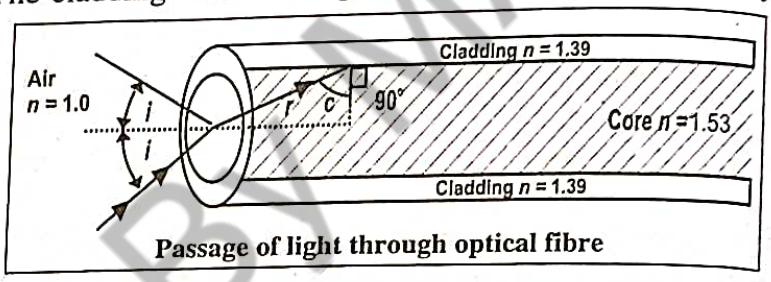
The inner part of fiber optics that carries the light is called core. The core is made from glass or plastic of relatively high index of refraction.

(ii) Cladding:

An outer concentric shell is called cladding. The cladding is made of glass or plastic but of relatively low refractive index.

Working:

Light enters from one end of the core and strikes the core/cladding at an angle of incidence greater than critical angle and is reflected back into the core. In this way light travels many kilometers with small loss of energy.



Passage of light through optical fibre

Uses:

- In developed countries, optical fibre is used in telecommunication and other modern communication systems.
- Through optical fibre we have thousands of telephone calls at the same time without interfering each other.

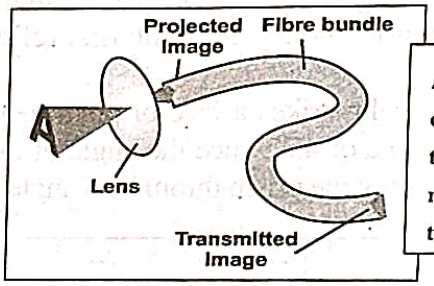
Q.14 What is light Pipe? Write down its uses? OR Write medical use of light pipe. 101112014

Light Pipe:

If several thousand fine strands of optical fiber are bundled together then a flexible light pipe is obtained.

Uses:

i. It is used by doctors and engineers to illuminate those inaccessible places which otherwise are not possible to examine.
ii. They can also be used to transmit images from one place to another.



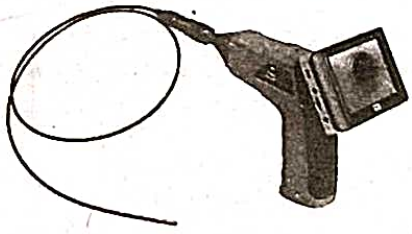
A lens and light pipe can be used together to produce a magnified transmitted image of

Q.15 Define Endoscope. Also write its types. 101112015

Ans. *Endoscope is an instrument, which is used for viewing and photographing of the internal structure of human body by using light pipes.*

Types: Endoscopes are of different types, which are as follows:

- **Gastroscope** : It is an instrument which is used to view stomach.
- **Bronchoscope** : It is an instrument used to view throat.
- **Cystoscope** : This instrument is used to examine bladder.


Endoscope

Endoscopy:

A *medical procedure using any type of endoscope is called endoscopy.*

The light shines on the organ of patient to be examined by entering through one of the fibre tubes of the endoscope. Then light is transmitted back to the physician's viewing lens through the other fibre tube by total internal reflection. Flexible endoscopes have a tiny camera attached to the end. Doctor can see the view recorded by the camera on a computer screen.

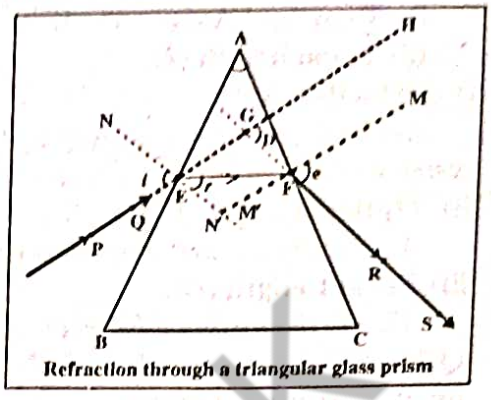
Q.16 Explain the refraction through prism. 101112016

OR

Describe the passage of light through a glass prism and measure angle of deviation.

Ans. Prism:

"Prism is a transparent body (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted."



Refraction through a triangular glass prism

Explanation of Refraction through Prism:

In case of triangular prism, the emergent rays are not parallel to the incident ray. It is deviated by the prism from its original path.

The incident ray PE makes an angle of incidence 'i' at a point E and is refracted towards the normal 'N' as EF. According to the laws of refraction $n = \frac{\sin \angle i}{\sin \angle r}$. The refracted ray EF makes an angle 'r' inside the prism and travel to the other end of the prism. This ray emerges out from prism at point 'F' and makes an angle of emergent 'e'. Hence the emerging ray FS is not parallel to the incident ray 'DE' but is deviated by an angle 'D', which is called angle of deviation.

Angle of Deviation:

The light rays after refraction through the prism deviated through an angle is called angle of deviation.

Q.17 Define lens. Also describe its uses and types. 101112017

Ans. Lens:

"A lens is any transparent material having two surfaces, of which at least one is curved. Lens refracts light in such a way that an image of the object is formed."

Uses:

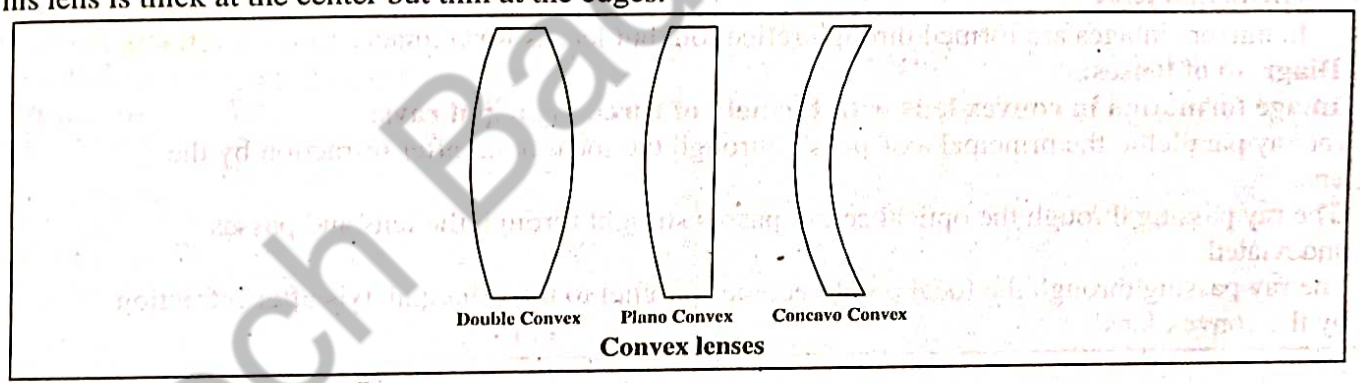
Lenses of many different types are used in optical devices such as cameras, eyeglasses, microscopes, telescopes and projectors. They also enable millions of people to see clearly and read comfortably.

Types of Lenses:

There are different types of lenses which are given below.

i) Convex or Converging Lens:

This lens is thick at the center but thin at the edges.

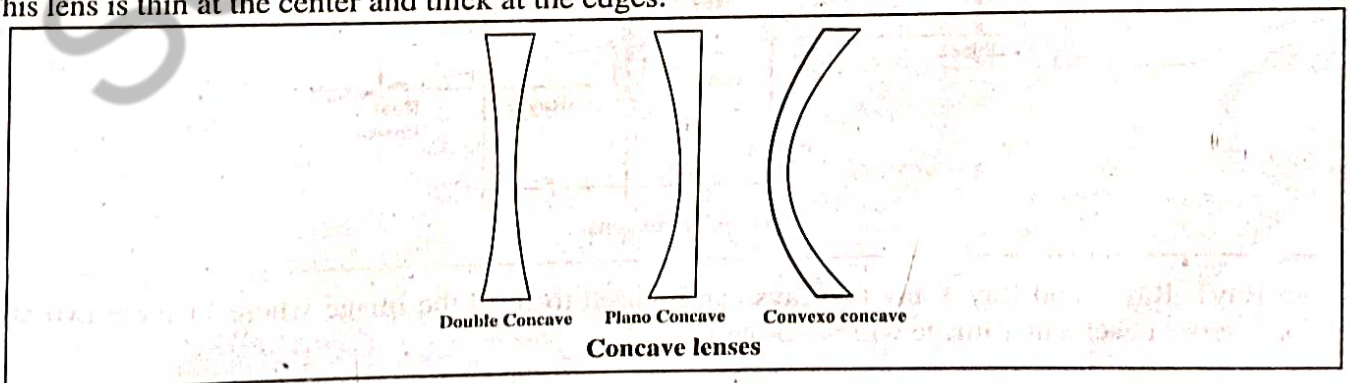


Convex lenses

ii) Concave lens or Diverging Lens:

"A lens causes the parallel rays of light to diverge from a point is called concave or diverging lens".

This lens is thin at the center and thick at the edges.



Concave lenses

Q.18 In lens terminology define the following:
i) Principal Axis ii) Optical center (C)
iii) Focal length (f)

i) Principal Axis:
Each of the two surfaces of a spherical lens is a section of a sphere. The line passing through the two centers of curvature of the lens is called principal axis.

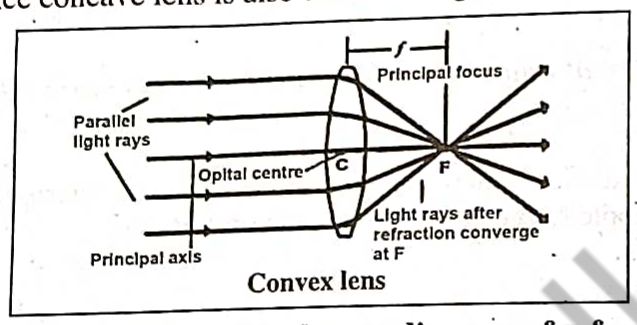
ii) Optical Center (C):
A point on the principal axis at the center of lens is called as optical center.

iii) Focal Length (f):
This is the distance between the optical centre and the principal focus.

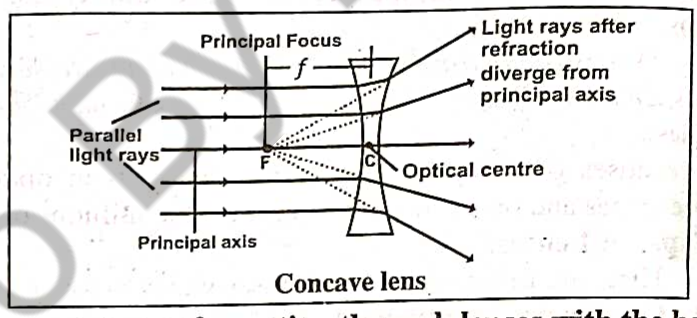
Q.19 What is meant by the Principal Focus of a (a) Convex lens (b) Concave lens? Illustrate your answer with ray diagrams. (F.B. 2017) 101112019

(a) For Convex Lens:
The light rays travelling parallel to the principal axis of convex lens after refraction meet a point on the principal axis called principal focus F. Hence convex lens is also called converging lens.

(b) For Concave Lens:
For concave lens the parallel rays appear to come from a point behind the lens called principal focus F. Hence concave lens is also called diverging lens.



Convex lens



Concave lens

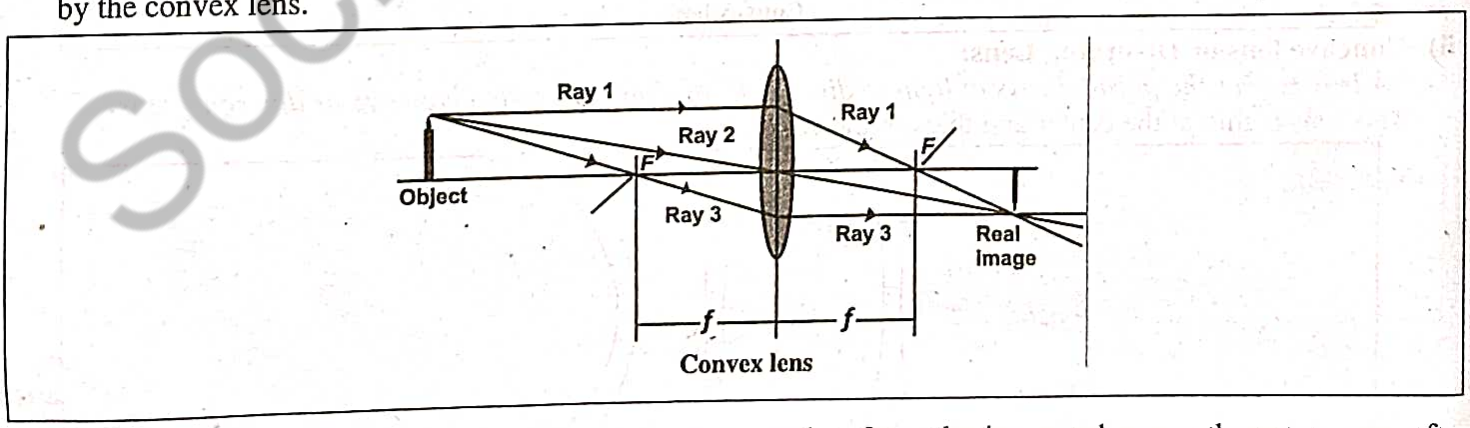
Q.20 Draw and explain the ray diagram of refraction and image formation through lenses with the help of three principal rays. 101112020

Ans. In mirrors images are formed through reflection, but lenses form images through refraction.

Ray Diagram of lenses:

(a) Image formation in convex lens with the help of three principal rays:

1. The ray parallel to the principal axis passes through the focal point after refraction by the lens.
2. The ray passing through the optical centre passes straight through the lens and passes undeviated.
3. The ray passing through the focal point becomes parallel to the principal axis after refraction by the convex lens.

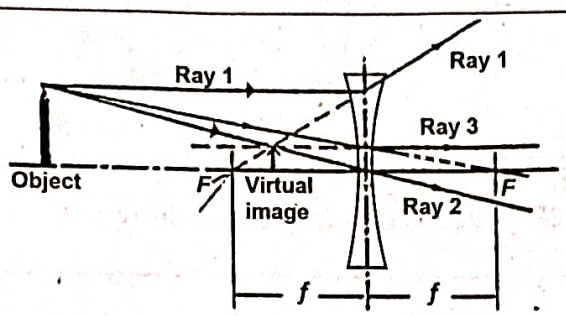


Convex lens

From Ray1, Ray 2 and Ray 3 any two rays can be used to form the image wherever these two rays after refraction intersect each other image will be formed.

(b) Image formation in concave lens with the help of three principal rays:

1. The ray parallel to the principal axis after refraction diverge outside by the lens.
2. The ray passing through the optical centre passes straight through the concave lens and passes undeviated.
3. When a ray of light strikes the concave lens at certain angle, it also diverges after refraction from the concave lens.



Concave lens

Q.21 Define power of the lens. Also define unit of power of lens. 101112021

Ans. Power of Lens:

"Power of lens is defined as the reciprocal of its focal length in meters".

Thus power of lens = P = 1/focal length in meters.

Units:

The S.I unit of power of a lens is "Dioptre" denoted by a symbol D. If f is expressed in meters so that $1D=1m^{-1}$.

Dioptre:

"1 Dioptre is the power of lens whose focal length is 1 meter".

The focal length of a convex lens is positive; therefore its power is positive. Whereas the power of a concave lens is negative, for it has negative focal length.

Q.22 Explain the image formation and characteristics of image, with ray diagrams, for object placed at different positions from a convex lens. (F.B. 2014) 101112022

Ans. Image formation in convex lens:

Ray diagrams for objects placed at different positions from a convex lens is given below:-

(a) Object beyond 2F

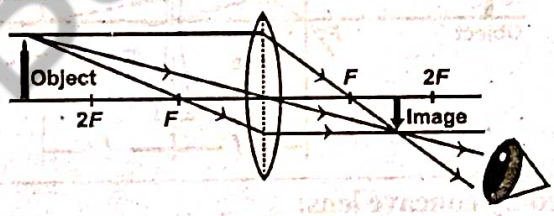


Image formation and its nature:

The image formed between F and 2F, real, inverted, smaller than the object.

(b) Object at 2F:

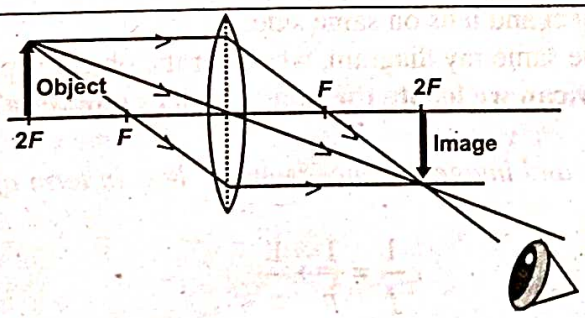


Image formation and its nature:

The image is at 2F, real, inverted, the same size as the object.

(c) Object between F and 2F

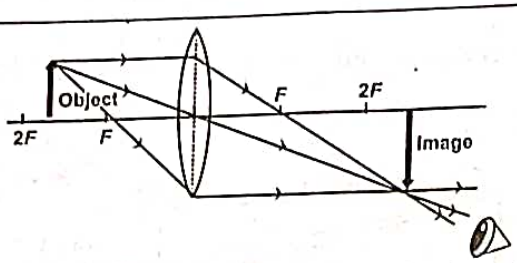


Image formation and its nature:

The image is formed beyond 2F, real, inverted, larger than the object.

(d) Object at F

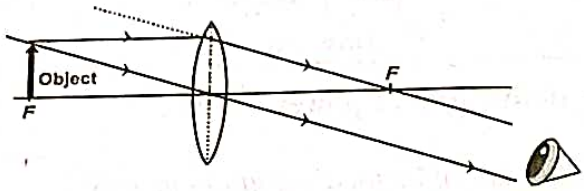
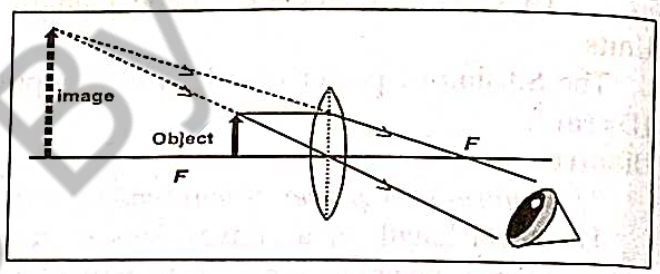


Image formation and its nature:

No image is formed because the refracted rays are parallel and never meet.



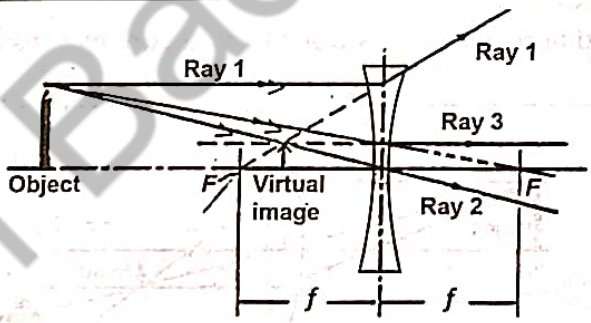
(e) Object between Lens and F

Image formation and its nature:

The image is behind the object, virtual, erect, larger than the object.

Q.23 Explain the characteristics of image formed by the concave lens, with ray diagram. 101112023

Ans. Ray diagram for object placed in front of concave lens and its image formation is given below.



Characteristics of image formed by concave lens:

Image formed by the concave lens is:

(i) Small (Diminished)
(ii) Upright (Erect)
(iii) Virtual (can not be taken on screen)
(iv) Always formed between object and lens on same side.

Note: A concave lens always has the same ray diagram, wherever the object is placed.

Q.24 What is lens equation? How can we locate the image by lens equation? 101112024

Ans. Lens Equation:

"The relation between the object and image distance from the lens in term of the focal length of the lens is called lens formula and is given by.

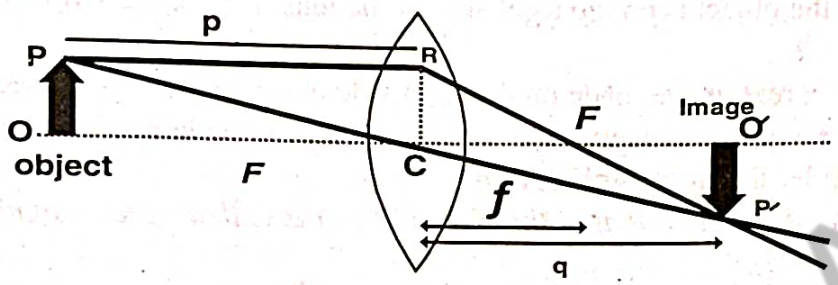
$$\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$$

Convex Lens Formula

Description:

Let an object OP is placed in front of a convex lens at a distance p. A ray PR parallel to the principal ax after refraction passes through focus F. Another ray PC meets the first ray at point P after passing through t optical centre C. If this process is repeated for the other points of the object, a real and inverted image O′P′ formed at a distance q from the lens.

Derivation:



Consider triangle ΔOPC and $\Delta O'P'C$ are similar because $\angle PCO$ and $\angle P'CO'$ are equa Also one angle is 90°. Hence

$$\frac{OP}{O'P'} = \frac{OC}{O'C} \text{-----(1)}$$

Now consider

$$m = \frac{O'P'}{OP} = \frac{O'C}{OC} = \frac{q}{p} \text{--------- (2)}$$

ΔRFC and $\Delta P'FO'$ are similar Hence,

Hence,

$$\frac{RC}{O'P'} = \frac{CF}{O'F} \text{------(3)}$$

$O'F = q - f$

$OC = p$

As, $Cf = f$

$O'C = q$

Then eq . (3) becomes.

$$\frac{p}{q} = \frac{f}{q-f}$$

$p(q-f) = qf$

$pq - pf = qf$

Dividing by pqf on both sides.

$$\frac{pq}{pqf} - \frac{pf}{pqf} = \frac{qf}{pqf}$$

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Note:

This is called lens formula and this equation is valid for both for concave and convex lenses.

However, following sign conventions should be followed while using this equation to solve problems related to lenses.

Q.25 Write sign convention for lenses.

Ans. Sign Conventions for Lenses:

i. Focal Length (f):

- f is positive for a convex (converging) lens.
- f is negative for a concave (diverging) lens.

ii. Object distance(p):

- p is positive, if the object is towards the left side of the lens. It is called a real object.
- p is negative, if the object is on the right side of the lens. It is called virtual object.

iii. Image distance(q):

- q is positive, for a real image made on the right side of the lens by real object.
- q is negative, for a virtual image made on the left side on the lens by real object.

101112026

Q.26 What do you mean by linear magnification?

Ans. *The ratio of the size of image to that of the size of object is called linear magnification.* It is denoted by 'm'.

Formula:

$$m = \frac{image\ height}{object\ height} = \frac{h_i}{h_o}$$

$$m = \frac{O'P'}{OP} = \frac{O'C}{OC} = \frac{q}{p}$$

Unit: It has no unit because it is a ratio between two same quantities.

Q.27 Describe the applications of lenses in following optical devices, with ray diagram.

101112027

i. Camera ii. Slide Projector. iii. Photograph Enlarger

Ans.

(i) Camera

Definition:

"A device for recording visual images in the form of photographs, movie film or video signals".

Construction and Working:

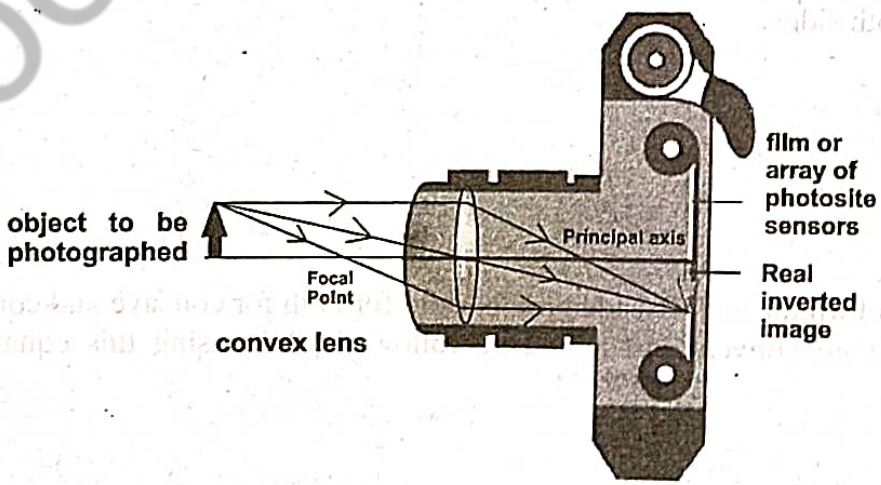
A simple camera consists of a light proof box with a converging (convex) lens in front and a light sensitive plate or film at the back. The lens focuses images to be photographed onto the film.

Object Position:

In camera, object is placed beyond 2F. In simple lens camera, the distance between lens and film is fixed which is equal to the focal length of the lens.

Nature of Image:

A real, inverted and diminished image is formed.



Schematic diagram of camera

(ii) Slide Projector:

Definition:

"An optical instrument that projects an enlarged image of individual slides onto a screen or wall".

Construction and Working:

The light source is placed at the centre of curvature of a converging or concave mirror. The concave mirror is used to reflect light back in fairly parallel rays. The condenser is made up of 2 converging lens that refract the light, so all parts of the slide are illuminated with parallel rays.

Object Position:

The slide (object) must be placed between F and 2F of projection lens so as to produce real, large and inverted image

Nature of Image:

In slide projector, the projection lens or converging lens provides a real, large and inverted image.

Note: As the projection lens provides inverted image so to get an upright (erect) image on screen the slide must be placed upside down and laterally inverted so we can see image properly.

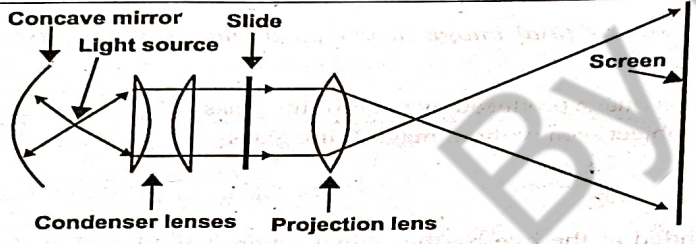


Diagram of slide projector

(iii)Photograph Enlarger:

"An optical instrument for making enlarged photographic prints in which a negative is brightly illuminated and its enlarged image is focused onto a sheet of sensitized paper"

Working Principle:

The working principle of photograph enlarger is basically the same as that of a slide projector.

Object Position:

The object slide must be placed between F and 2F of projection lens so as to produce a real, large and inverted image.

Nature of Image

It produces real, magnified and inverted image of the film (object) on the photographic paper.

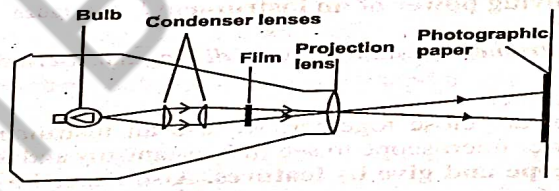


Diagram of photograph enlarger

Q.28 Wit the help of a ray diagram, how can you show the use of thin converging lens as a magnifying glass. (F.B. 2017) 101112028

OR

Define simple microscope. Also derive the formula of magnifying power.

Ans. Simple Microscope:

"A magnifying glass is a convex lens which is used to produce magnified images of small objects. Hence it is also called simple microscope".

Object position:

The object is placed nearer to the lens than the principal focus such that an upright, virtual and magnified image is seen clearly at 25cm from the normal eye.

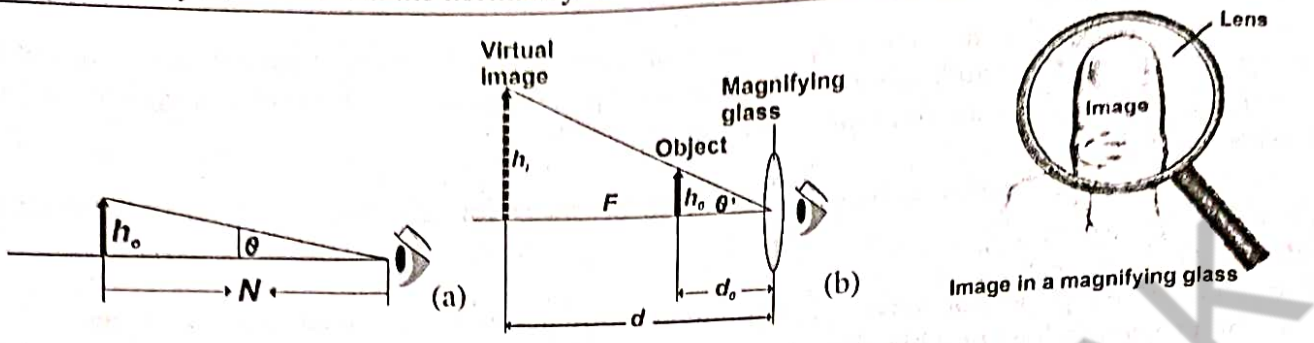


Image formation in magnifying glass

Magnifying Power;

"It is the ratio of angular size of final image produced by magnifying glass to the angular size of object seen without magnifying glass"

Formula:

$$M = \frac{\text{Angular size of final image produced by magnifying glass}}{\text{Angular size of object seen without magnifying glass}}$$

$$M = \frac{\theta'}{\theta}$$

Explanation

Let θ is the angle subtended at the eye by the object when it is placed at the near distance from eye. Let θ' is the angle subtended by the final image at the eye when the object is placed close to the eye at a distance less than f. The angular magnification (or magnifying power) M is the angular size θ' of the final image produced by the magnified glass divided by an angular size θ of the object seen without the magnifying glass.

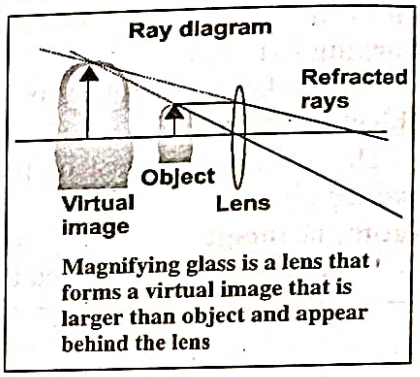
Nature:

It produces virtual image which is enlarged and upright with respect to the object.

Note:

If 'd' is the near distance of the object from eye which is usually 25cm, then magnifying power becomes

$$M \approx \left(\frac{d}{f}\right) + 1$$



Q.29 What do you mean by resolving power of an instrument? 101112029

Ans. Resolving Power

"The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources"

Instruments of High Resolving Power:

In order to see the objects that are close together, we use an instrument of high resolving power. For example, we use high resolving power microscope to see tiny organisms and telescope to view distant stars.

Q.30 Define compound microscope and give its features. Also describe the magnification of compound microscope with ray diagram. 101112030

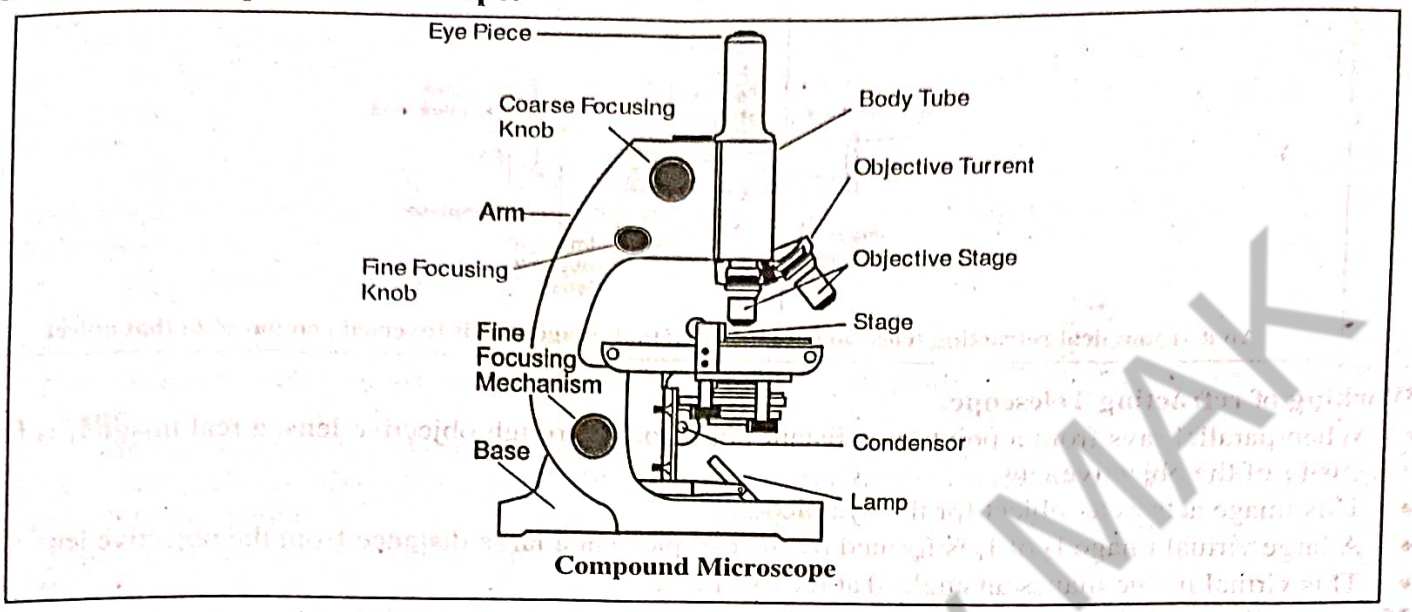
Ans. Compound Microscope:

"Compound microscope is used to investigate the structure of small objects by two converging sets of lenses, the objective and the eyepiece".

Features of compound microscope:

- It gives greater magnification than a single lens.
- The objective lens has a short focal length, $f_o < 1cm$.
- The eyepiece has a focal length f_e of a few cm.

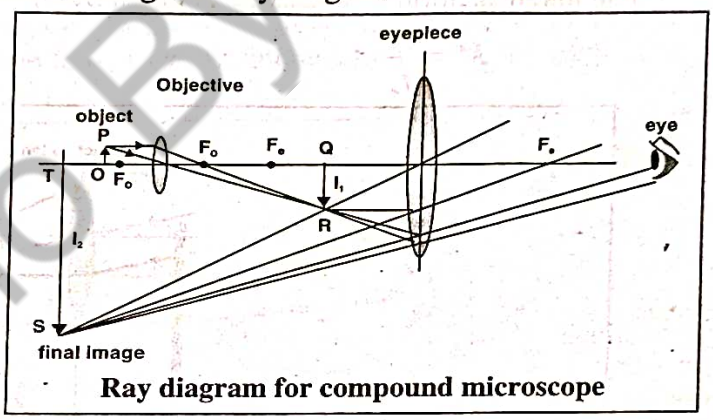
Magnification of compound microscope:



Compound Microscope

Magnification of compound microscope can be determined through the ray diagram.

- Objective forms a small image I_1 inside the focal point of eye piece.
- The image formed by the objective acts as an object for the eyepiece.
- The final larger image I_2 formed by the eyepiece lies outside the focal point of the objective.



Ray diagram for compound microscope

Formula:

The magnification of compound microscope is given by

$$M = \frac{L}{f_o}\left(1+\frac{d}{f_e}\right)$$

- Where 'L' is the length of compound microscope which is equal to the distance between objective and eye piece.
- 'd' is the near distance of object from eye.
- f_o and f_e are the focal length of objective and eye piece respectively.

Uses:

A compound microscope is used to study bacteria and other micro objects. It is also used for research in several fields of science like, Microbiology, Botany, Geology and Genetics.

Q.31 Define telescope and refracting telescope. Also describe the working and magnification of telescope with ray diagram. **(F.B. 2017) 101112031**

Ans. Telescope:

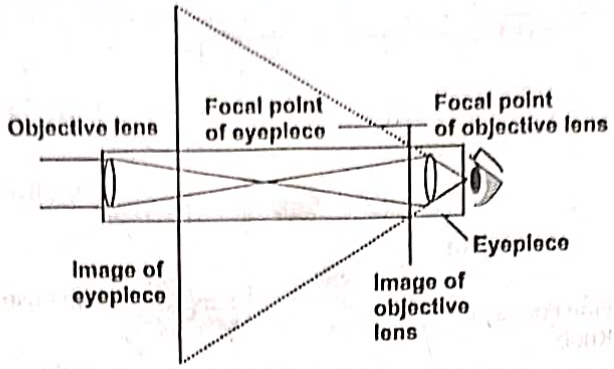
"Telescope is an optical instrument which is used to observe distant objects using lenses or mirrors."

Refracting telescope:

A telescope that uses two converging lenses is called refracting telescope"

Image Nature:

In refracting telescope an objective lens forms a real image of the distant object, while an eye piece forms a virtual image that is viewed by the eye.



An astronomical refracting telescope creates a virtual image that is inverted compared to that object

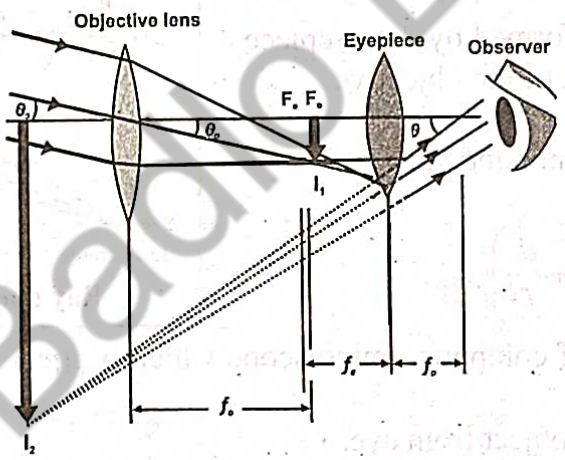
Working of refracting Telescope:

- When parallel rays from a point on a distant object pass through objective lens, a real image I_1 is formed at a focus F_o of the objective lens.
- This image acts as an object for the eye piece.
- A large virtual image I_2 of I_1 is formed by the eye piece at a large distance from the objective lens.
- This virtual image makes an angle θ at the eye piece.

Magnification of Telescope:

The magnification of telescope is given by

$$M = \frac{f_o}{f_e}$$



Ray diagram of refracting telescope

Q.32 Describe the structure and image formation in human eye. (OR) 101112032
Draw a ray diagram to show the formation of image in the normal human eye.

Ans. The Human Eye:

"Eye is an organ used for vision".

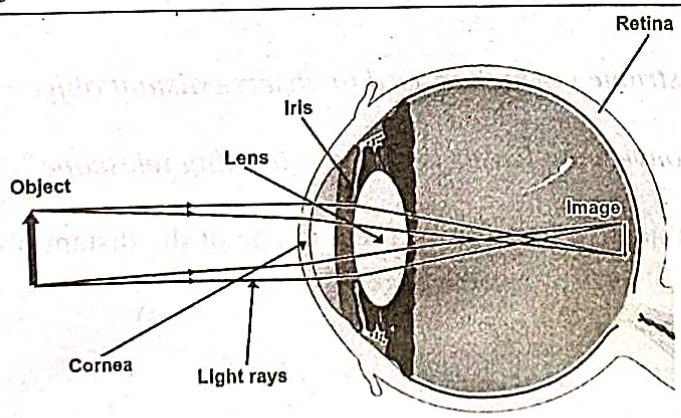


Image formation in human eye

Image formation:

The parts of human eye which play an important role in the image formation are described below:

i) Retina:

Human eye acts like a camera. In place of the film, the retina records the picture. The eye has refracting system containing a converging lens. The lens forms an image on the retina. Retina is light sensitive layer at the back of the eye.

ii) Lens:

In the camera, the distance of lens from film is adjusted for proper focus, but in eye the lens changes focal length. The lens of eye is flexible and accommodates object oyer a wide range of distance.

iii) Cornea:

Light enters the eye through a transparent membrane called the cornea.

iv) Iris:

The iris is colored portion of the eye and controls the amount of light reaching retina. The iris also controls the size of pupil. In bright light, iris contracts the size of pupil while in dim light pupil is enlarged.

v) Pupil:

Iris has an opening at its centre called pupil.

Q.33 What do you mean by Accommodation? Also describe the mechanism for focusing in eye. 101112033

Ans. Accommodation:

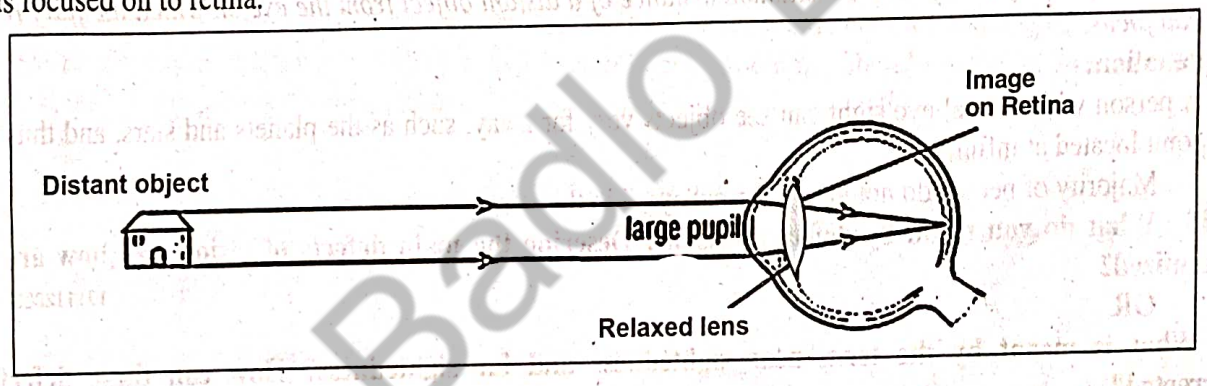
"The variation of focal length of eye lens is called accommodation".

Note:

It is large in young people while it is goes on decreasing with age.

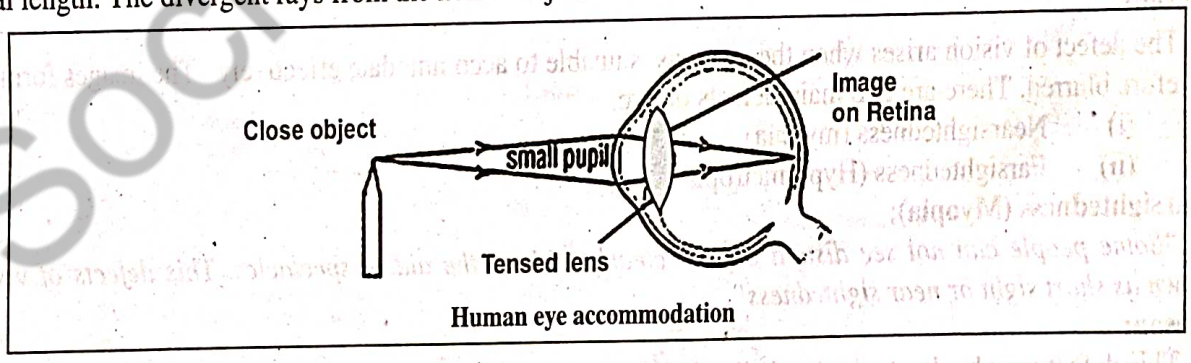
For Distant Objects:

If an object is far away from the eye, the deviation of light through the lens must be less. To do this, the ciliary muscles relax and decrease the curvature of the lens, thereby, increasing the focal length. The rays are thus focused on to retina.



For Close Objects:

If an object is close to the eye, the ciliary muscles increases curvature of the lens, thereby shortening the focal length. The divergent rays from the nearer object are thus bent more so as to come to a focus on the retina.



Mechanism for focusing the image in eye:

- The camera focuses the image of an object at a given distance from it by moving the lens towards or away from the film.
- The eye has different adjusting mechanism for focusing the image of an object on to the retina. Its ciliary muscles control the curvature and thus focal length of the lens, and allow objects at various distances to be seen.

Q.34 Describe near point and far point of an eye. 101112034

Ans. Near Point:

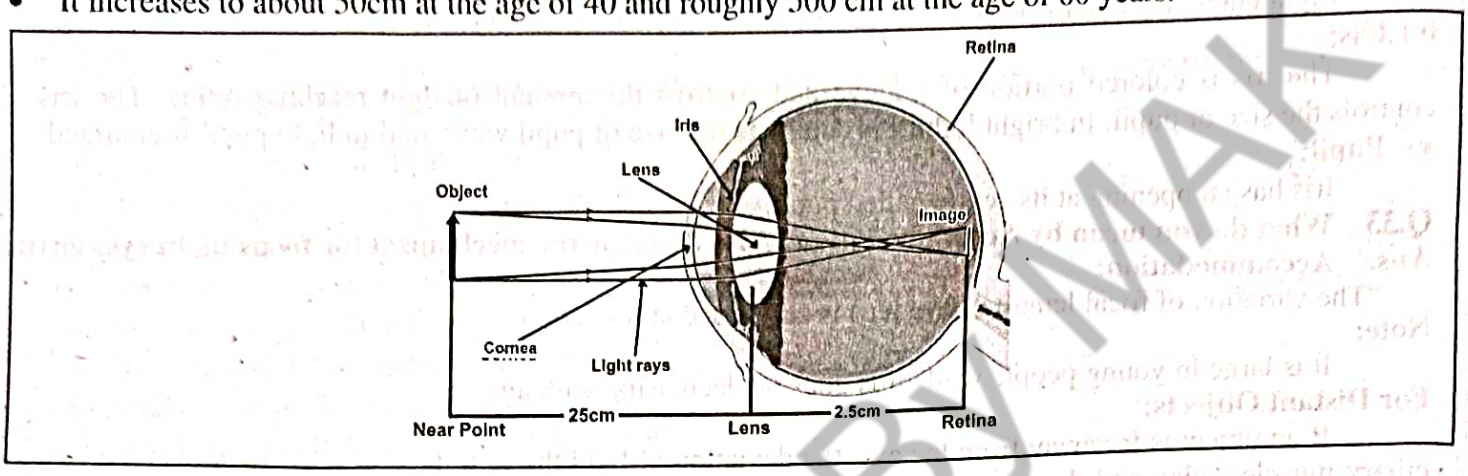
"The near point of an eye is the minimum distance of an object from the eye at which it produces a sharp image on the retina."

This distance is also called the least distance of distinct vision.

Explanation:

When we hold a book too close, the print is blurred because the lens can not adjust enough to bring the book into focus. An object closer to the eye than the near point appears blurred.

- For people in their early twenties with normal vision, the near point is located about 25 cm from the eye.
- It increases to about 50cm at the age of 40 and roughly 500 cm at the age of 60 years.



Far Point:

"The far point of the eye is the maximum distance of a distant object from the eye on which the fully relaxed eye can focus."

Explanation:

A person with normal eye sight can see objects very far away, such as the planets and stars, and thus has a far point located at infinity.

Majority of people do not have "normal eyes" in this sense.

Q.35 What do you mean by defect of vision? Describe the main defects of vision and how are they minimized? 101112035

OR

What is meant by the term near sightedness and far sightedness? How can these defects be corrected?

Ans. Defect of Vision:

"The inability of eye to see the image of objects clearly is called defect of vision."

Reason:

The defect of vision arises when the eye lens is unable to accommodate effectively. The images formed are therefore blurred. There are two main defects of eye.

(i) Nearsightedness (myopia)
(ii) Farsightedness (Hypermetropia)

Nearsightedness (Myopia):

"Some people can not see distant objects clearly without the aid of spectacles. This defects of vision is known as short sight or near sightedness".

Reason:

This defect may be due to the eye ball being too long i.e. focal length is short. Hence the light rays from the distant objects are focused in front of the retina and a blurred image is produced.

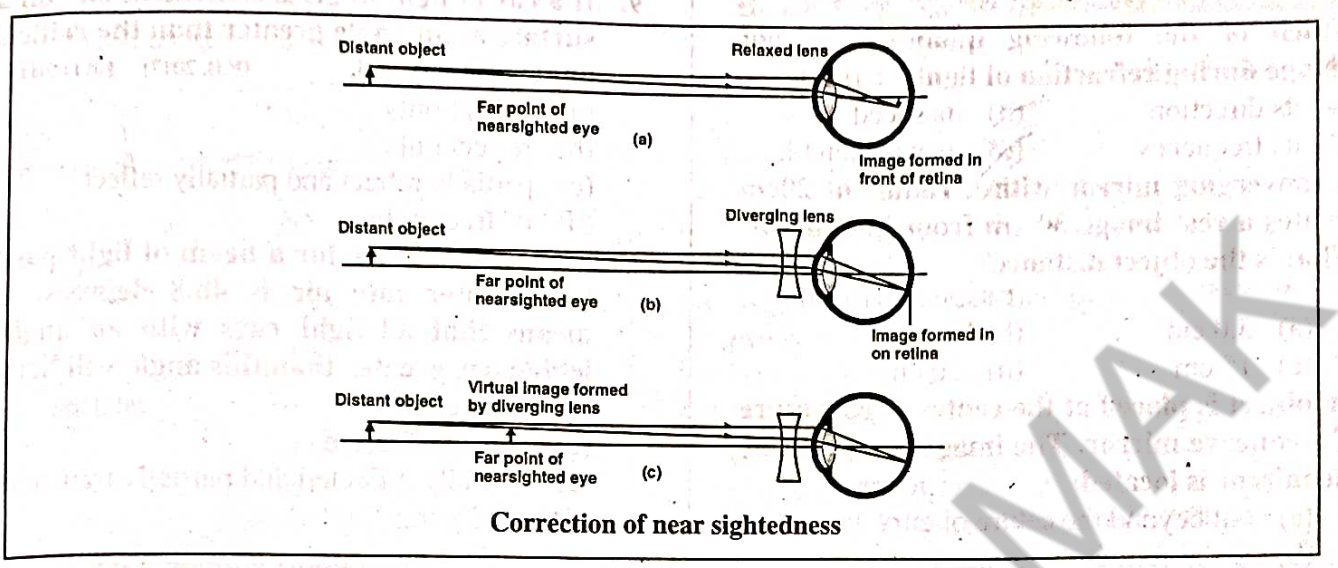
Minimization:

The nearsighted eye can be corrected with glass or contact lens that are used diverging (concave) lenses. Hence, light rays from the distant objects are now diverged by this lens before entering the eye. The light rays appear to come from a far point and are therefore focused on the retina, thus forming a sharp image.

Farsightedness (Hypermetropia)

"The disability of the eye to form distinct images of nearby objects on its retina is known as farsightedness."

Reasons:

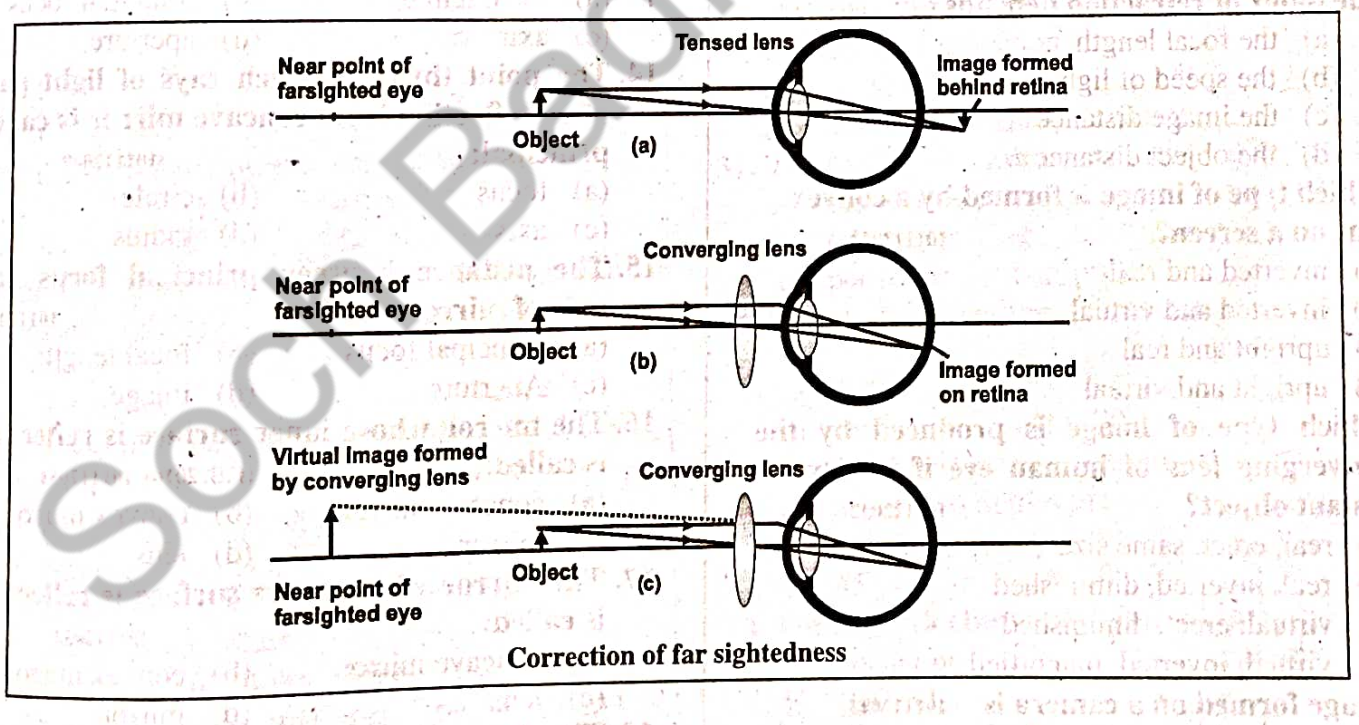


Correction of near sightedness

This defect is caused by an eye ball which is shorter than the normal size or eye lens is thinner. i.e. when a far sighted eye tries to focus on a book held closer than the near point, it shortens its focal length as much as it can. However, even at its shortest, the focal length is longer than it should be. Therefore, the light rays from the book would form a sharp image behind retina.

Minimization:

This defect can be corrected with the aid of a suitable converging (Convex) lens. Hence the lens refracts the light rays and they converge to form an image on the retina. To an observer these rays appear to come from near point to form a sharp virtual image on the retina.



Correction of far sightedness

Multiple Choice Questions

Choose the correct answer from the given choices.

EXERCISE MCQS

1. **Which of the following quantities is not change during refraction of light?** 101112036
   (a) its direction (b) its speed
   (c) its frequency (d) its wavelength
2. **A converging mirror with a radius of 20cm creates a real image 30 cm from the mirror. What is the object distance?** (F.B. 2014) 101112037
   (a) 5.0 cm (b) 7.5 cm
   (c) 15 cm (d) 20 cm
3. **An object is placed at the centre of curvature of a concave mirror. The image produced by the mirror is located:** 101112038
   (a) out beyond the centre of curvature
   (b) at the centre of curvature
   (c) between the centre of curvature and the focal point
   (d) at the focal point
4. **An object is 14 cm in front of a convex mirror. The image is 5.8 cm behind the mirror. What is the focal length of the mirror?** (F.B. 2017) 101112039
   (a) -4.1 cm (b) -8.2 cm
   (c) -9.9 cm (d) -20 cm
5. **The index of refraction depends on:** 101112040
   (a) the focal length
   (b) the speed of light
   (c) the image distance
   (d) the object distance
6. **Which type of image is formed by a convex lens on a screen?** 101112041
   (a) inverted and real
   (b) inverted and virtual
   (c) upright and real
   (d) upright and virtual
7. **Which type of image is produced by the converging lens of human eye if it views a distant object?** 101112042
   (a) real, erect, same size
   (b) real, inverted, diminished
   (c) virtual, erect, diminished
   (d) virtual, inverted, magnified
8. **Image formed on a camera is** 101112043
   (a) real, inverted, and diminished
   (b) virtual, upright and diminished
   (c) virtual, upright and magnified
   (d) real, inverted and magnified
9. **If a ray of light in glass is incident on an air surface at an angle greater than the critical angle, the ray will** (F.B. 2017) 101112044
   (a) refract only
   (b) reflect only
   (c) partially refract and partially reflect
   (d) diffract only
10. **The critical angle for a beam of light passing from water into air is 48.8 degrees. This means that all light rays with an angle of incidence greater than this angle will be:** 101112045
    (a) absorbed
    (b) totally reflected
    (c) partially reflected and partially transmitted
    (d) totally transmitted

Additional MCQS

11. **The diameter of spherical mirror is called:** 101112046
    (a) curvature (b) aperture
    (c) sphere (d) both a and b
12. **The center of curve surface of spherical mirror is called:** 101112047
    (a) focus (b) axis
    (c) centre (d) pole
13. **Half of radius of curvature is called:** 101112048
    (a) focal length (b) principal focus
    (c) axis (d) aperture
14. **The point through which rays of light pass after reflection from concave mirror is called principal:** 101112049
    (a) focus (b) circle
    (c) axis (d) radius
15. **The distance between principal focus and pole of mirror is called:** 10112050
    (a) Principal focus (b) focal length
    (c) Aperture (d) image
16. **The mirror whose inner surface is reflecting is called:** (F.B. 2016) 101112051
    (a) concave mirror (b) convex mirror
    (c) mirror (d) lens
17. **The mirror whose outer surface is reflecting is called:** 101112052
    (a) concave mirror (b) convex mirror
    (c) lens (d) mirror
18. **The line which passes through pole of the mirror and center of curvature is called principal:** 101112053
    (a) axis (b) focus
    (c) line (d) none of these

19. **The ray of light after reflection from concave mirror passes through:** 101112054
(a) centre
(b) principal focus
(c) pole
(d) radius of curvature

20. **Spherical mirrors are used in:** 101112055
(a) medical (b) search light
(c) microscope (d) all of these

21. **Magnification of mirror is given by:** 101112056
(a) $m = \frac{p}{q}$ (b) $m = \frac{q}{p}$
(c) $m = p \times q$ (d) $m = \frac{1}{p+q}$

22. **The distance of the object from the mirror is represented by:** 101112057
(a) q (b) p
(c) m (d) F

23. **The distance of image from mirror is represented by:** 101112058
(a) q (b) p
(c) F (d) m

24. **Snell's law is:** 101112059
(a) $n = \frac{\sin \angle x}{\sin \angle r}$ (b) $n = \frac{\sin \angle i}{\sin \angle r}$
(c) $n = \frac{\sin \angle r}{\sin \angle i}$ (d) $\frac{\angle i}{\angle r}$

25. **Concave mirror formula is given by:** 101112060
(a) $R = 2f$ (b) $\frac{\sin \angle i}{\sin \angle r}$
(c) $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ (d) $\frac{1}{f} = \frac{1}{p} - \frac{1}{q}$

26. **Focal length for concave mirror is:** 101112061
(a) -ve (b) +ve
(c) Same (d) none of these

27. **Bouncing back of light after striking the surface is called:** 101112062
(a) refraction (b) reflection
(c) diffraction (d) interference

28. **The ratio of image height to object height is called:** 101112063
(a) linear magnification
(b) power
(c) refraction
(d) radius of curvature

29. **When a ray of light enters from denser medium to rare medium, the angle of incidence for which angle of refraction is 90° is called:** 101112064
(a) angle of incidence
(b) critical angle
(c) angle of refraction
(d) angle of deviation

30. **The critical angle for glass is:** 101112065
(a) 24° (b) 48°
(c) 42° (d) 50°

31. **The critical angle for water is:** (F.B. 2013) 101112066
(a) 49° (b) 42°
(c) 62° (d) 50°

32. **Critical angle for diamond is:** (F.B.2013) 101112067
(a) 60° (b) 24°
(c) 26° (d) 49°

33. **Angle opposite to the base of triangle of prism is called:** 101112068
(a) angle of incidence
(b) angle of refraction
(c) angle of prism
(d) emerging angle

34. **The unit of power of lens is:** 101112069
(a) watt (b) Js^{-2}
(c) Jowe (d) dioptre

35. **The minimum value of angle of deviation is called:** 101112070
(a) minimum angle
(b) incident angle
(c) angle of minimum deviation
(d) none of these

36. **The angle at which prism deviates the incident ray is called:** 101112071
(a) angle of incident
(b) angle of reflection
(c) angle of deviation
(d) angle of minimum deviation

37. **To see from submarine the ship at the surface of water, we use:** 101112072
(a) telescope (b) microscope
(c) periscope (d) prism

38. **In totally reflecting prism one angle is of:** 101112073
(a) 45° (b) 90°
(c) 180° (d) 120°

39. **In totally reflecting prism one angle is of 90°, and other two angles are of:** 101112074
(a) 30°, 30° (b) 45°, 90°
(c) 45°, 45° (d) 40°, 40°

40. **Totally reflecting prism is used in:**
(a) periscope 101112075
(b) binoculars
(c) periscope and binocular
(d) telescope

41. **Totally reflecting prism turns the incident ray at an angle of:** 101112076
(a) 90° (b) 60°
(c) 75° (d) 45°

42. **The refractive index of internal coating of optical fibre is:** 101112077
(a) 1.56 (b) 1.51
(c) 1.53 (d) 1.58

43. **Optical fibres are:** 101112078
(a) cheap (b) flexible
(c) lighter (d) all of these

44. **To see stomach problems we use:** 101112079
(a) gastroscope (b) bronchoscope
(c) cystoscope (d) stethoscope

45. **Sun light consists of _____ colours:** 101112080
(a) 6 (b) 5
(c) 7 (d) 2

46. **The refractive index of air is:** 101112081
(a) 6 (b) 1.0003
(c) 7 (d) 2

47. **Power of lens is** 101112082
(a) $\frac{q}{p}$ (b) $\frac{1}{q}$
(c) $\frac{1}{p}$ (d) $\frac{1}{f}$

48. **Speed of light in air in ms^{-1} is:** 101112083
(a) 3×10^8 (b) 340
(c) 3×10^5 (d) 3×10^{11}

49. **A normal eye can see near objects clearly at a distance of** 101112084
(a) 20 cm (b) 25 cm
(c) 30 cm (d) 35 cm

50. **Power of a convex lens is 10D. Its focal length is** 101112085
(a) 100 m (b) 10 m
(c) 1 m (d) 0.1 m

51. **Which is always virtual in case of convex mirror?** 101112086
(a) P (b) Image
(c) Object (d) All of these

52. **Focal length of spherical mirror is related to the radius of curvature by:** (F.B. 2017) 101112087
(a) $f = 2R$ (b) $f = \frac{R}{2}$
(c) $f = R$ (d) $f = \frac{1.2}{R}$

53. **The speed of light in water is:** 101112088
(a) $2.1 \times 10^3\ ms^{-1}$ (b) $2.5 \times 10^3\ ms^{-1}$
(c) $2.3 \times 10^8 ms^{-1}$ (d) $2.3 \times 10^{-8}\ ms^{-1}$

54. **A converging lens becomes a magnifying glass when an object is placed:** 101112089
(a) outside of focal length
(b) inside of focal length
(c) equal of focal length
(d) at double of focal length

55. **In compound microscope, the objective have focal length than eye-piece.** 101112090
(a) smaller (b) larger
(c) equal (d) equal and larger

56. **Which animal have ability to move his eye lens?** 101112091
(a) snake (b) fish
(c) ant (d) tiger

57. **The value of refractive index of water is:** (F.B. 2014) 101112092
(a) 2.33 (b) 1.36
(c) 1.33 (d) 1.39

58. **Index of refraction of diamond is:** 101112093
(a) 1.33 (b) 1.52
(c) 2.21 (d) 2.42

59. **Optical fibres works on the principle of _____** 101112094
(a) reflection
(b) refraction
(c) total internal reflection
(d) diffraction

60. **The refractive index of ice is:** 101112095
(a) 1.00 (b) 1.33
(c) 1.31 (d) 2.42

61. **Endoscope which is used to diagnose bladder is called:** (F.B. 2018) 101112096
(a) Gastroscope (b) Cystoscope
(c) Bronchoscope (d) Microscope

62. **The instrument used to see the distant objects is called:** (F.B. 2015) 101112097
(a) Microscope (b) Telescope
(c) Convex lens (d) Spectrometer

63. **The inner part of fibre optics is called:** (F.B. 2015) 101112098
(a) Metal jacket (b) Cladding
(c) Boundary (d) Core

64. **Rainbow is formed due to:** (F.B. 2017) 101112099
(a) Reflection
(b) Total internal reflection
(c) Dispersion
(d) Diffraction

Answer Key

1.	c	2.	c	3.	b	4.	c	5.	b	6.	a	7.	b
8.	a	9.	b	10.	b	11.	b	12.	d	13.	a	14.	a
15.	b	16.	a	17.	b	18.	a	19.	b	20.	d	21.	b
22.	b	23.	a	24.	b	25.	c	26.	b	27.	b	28.	a
29.	b	30.	c	31.	a	32.	b	33.	c	34.	d	35.	c
36.	c	37.	c	38.	b	39.	c	40.	c	41.	a	42.	c
43.	d	44.	a	45.	c	46.	b	47.	d	48.	a	49.	b
50.	d	51.	b	52.	b	53.	c	54.	b	55.	a	56.	b
57.	c	58.	d	59.	c	60.	c	61.	b	62.	b	63.	d
64.	b												

Review Questions

Q12.1 What do you understand by reflection of light? Draw a diagram to illustrate reflection at a plane surface. 101112100

Ans. See Q#2 on Page# 44

Q12.2 Describe the following terms used in reflection
(i) Normal (ii) Angle of incidence (iii) Angle of reflection. 101112101

Ans. (i) Normal:
A line drawn perpendicular to the surface of mirror at the point of incidence of light rays is called normal.

(ii) Angle of incidence:
The angle between the incident ray and normal is called angle of incidence.

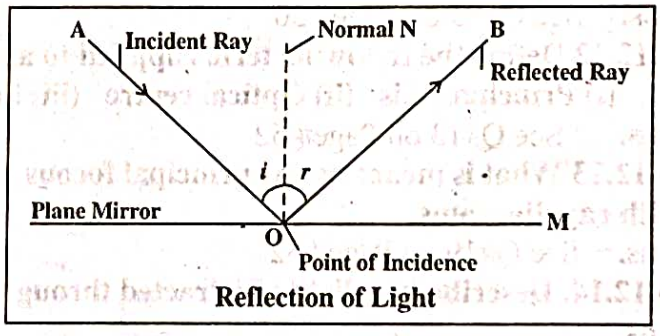
(iii) Angle of reflection:
The reflected ray makes an angle with the normal drawn at the point of incidence is called angle of reflection.

Q12.3 State laws of reflection. Describe how they can be verified graphically. 101112102

Ans. Laws of Reflection
There are two laws of reflection.
(i) The incident ray, the normal and the reflected ray at the point of incidence all lie in the same plane.
(ii) The angle of incidence is equal to angle of reflection i.e. $\angle i = \angle r$

Reflection of light graphically

Explanation:
Reflection of light is illustrated in following figure. When a ray of light from air along path AO falls on a plane mirror M, it is reflected along the path OB. This ray AO is called **incident ray**, while ray OB is called **reflected ray**. The angle between incident ray AO and normal N, i.e. $\angle AON$ is called **angle of incidence** represented by **'i'**. The angle between the normal and reflected ray OB i.e. $\angle NOB$ is called **angle of reflection** represented by **'r'**.



Reflection of Light

Q12.4 Define refraction of light. Describe the passage of light through parallel- sided transparent material. 101112103

Ans. See Q#2 on Page# 47

Q12.5 Define the following terms used in refraction (i) Angle of incidence (ii) Angle of refraction. 101112104

Ans. (i) Angle of incidence:
Incidence ray makes the angle with normal is called angle of incidence.

(ii) Angle of refraction
The angle made by the refracted ray with the normal is called angle of refraction

Q12.6 What is meant by refractive index of a material? How would you determine the refractive inde of a rectangular glass slab? 101112105

Ans. Refractive Index OR index of refraction

Refractive index of a medium is *the ratio of the speed of light (c) in air to the speed of light (v) in the medium.*

$$\text{Refractive index} = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

or

$$n = \frac{c}{v}$$

Refractive index of a glass slab:

$\text{Speed of light} = c = 3\times10^{8}\,\text{ms}^{-1}$

$\text{Speed of light in glass} = 2\times10^{8}\,\text{ms}^{-1}$

$$n = \frac{c}{v} = \frac{3\times10^{8}\,\text{ms}^{-1}}{2\times10^{8}\,\text{ms}^{-1}}$$

$n = 1.5$

Q12.7 State the laws of refraction of light and show how they may be verified using rectangular glass slab and pins. 101112106

Ans. See Q#8,9 on Page# 47

Q.12.8 What is meant by term total internal reflection? 101112107

Ans. See Q#10 on Page# 48

Q.12.9 State the conditions for total internal reflection. 101112108

Ans. Conditions for Total Internal Reflection:

(1) The ray of light should travel from denser medium to rarer medium.

(2) The angle of incidence should be greater than the critical angle.

Q.12.10 What is critical angle? Derive the relationship between critical angle and the refractive index of a substance. 101112109

Ans. See Q#11 on Page# 49

Q.12.11 What are optical fibres? Describe how total internal reflection is used in light propagating through optical fibres. 101112110

Ans. See Q#13 on Page# 50

Q.12.12 Define the following terms applied to a lens: 101112111

(i) Principal axis (ii) Optical centre (iii) Focal length

Ans. See Q#13 on Page# 52

Q.12.13 What is meant by the principal focous of (a) convex lens (b) concave lens? Illustrate your answer with ray diagrams. 101112112

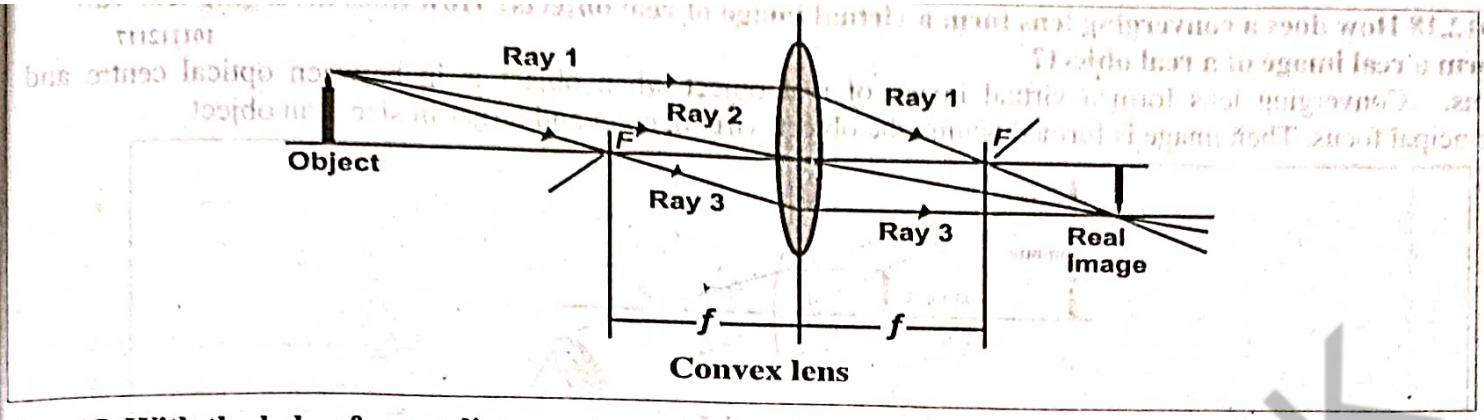
Ans. See Q#19 on Page# 52

Q.12.14. Describe how light is refracted through Convex lens. 101112113

Ans.

(a) Image formation in convex lens with the help of three principal rays:

4. The ray parallel to the principal axis passes through the focal point after refraction by the lens.
5. The ray passing through the optical centre passes straight through the lens and passes undeviated.
6. The ray passing through the focal point becomes parallel to the principal axis after refraction by the convex lens.



Q.12.15. With the help of a ray diagram, how can you show the use of thin converging lens as a magnifying glass. 101112114

Ans.

"A magnifying glass is a convex lens which is used to produce magnified images of small objects. Hence it is also called simple microscope".

Object position:

The object is placed nearer to the lens than the principal focus such that an upright, virtual and magnified image is seen clearly at 25cm from the normal eye.

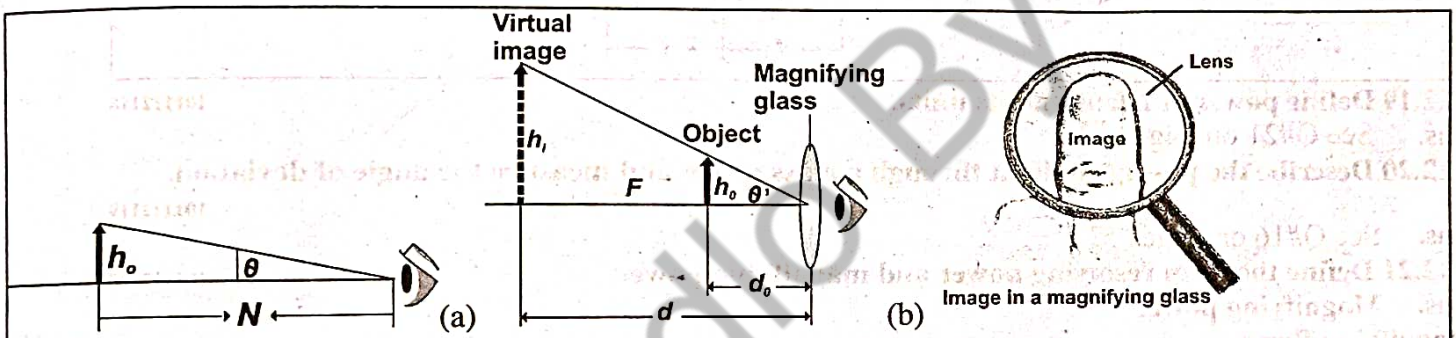
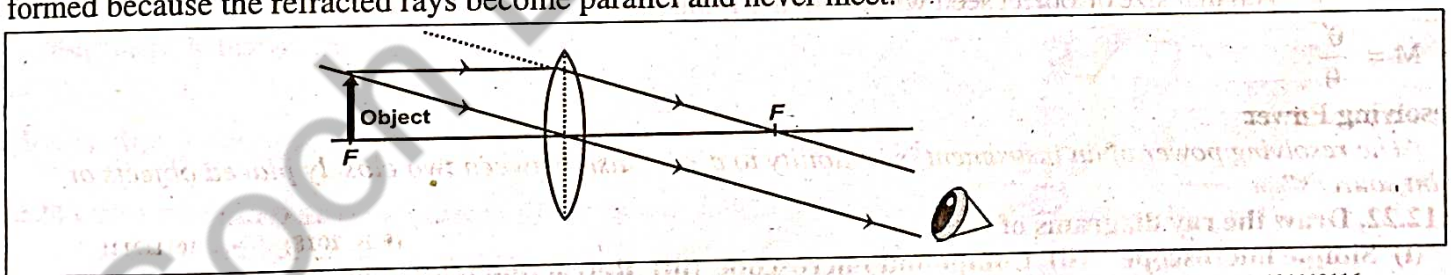


Image formation in magnifying glass

Q.12.16 A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature? 101112115

Ans. When a coin is placed at a focal point (or) Principal focus of a convex lens (converging lens), no image is formed because the refracted rays become parallel and never meet.



Q12.17 What are the differences between real and virtual images? 101112116

Ans. Real Image

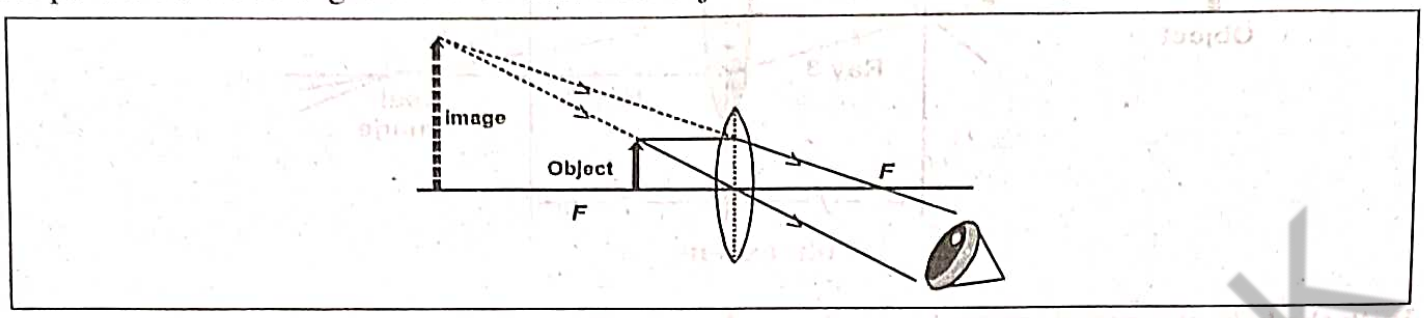
(i) The image that can be obtained on screen is called real image.
(ii) In real image, rays of light actually converge to form image.
(iii)Image is inverted.

Virtual image

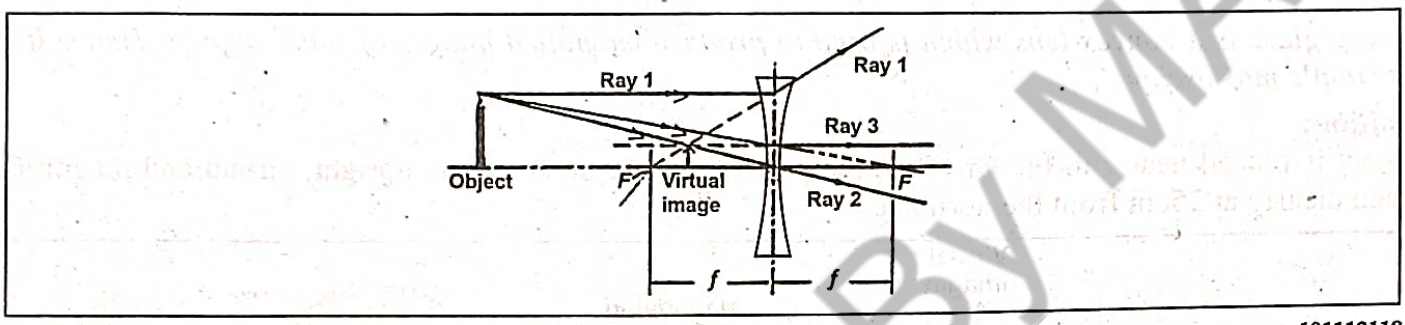
(i) The image that cannot obtained on screen is called virtual image.
(ii) In virtual image, rays of light appear to diverge.
(iii)Virtual image is erect.

Q12.18 How does a converging lens form a virtual image of real objects? How does diverging lens can form a real image of a real object? 101112117

Ans. Converging lens form a virtual image of real object when object is in between optical centre and principal focus. Then image is formed behind the object, virtual, erect and larger in size than object



Diverging lens form a virtual image of real objects. Therefore, it is not possible for a diverging or concave lens to form a real image of real object.



Q12.19 Define power of a lens and its units. 101112118

Ans. See Q#21 on Page# 53

Q12.20 Describe the passage of light through a glass prism and measure the angle of deviation. 101112119

Ans. See Q#16 on Page# 51

Q12.21 Define the term resolving power and magnifying power. 101112120

Ans. Magnifying power

Magnifying Power;

"It is the ratio of angular size of final image produced by magnifying glass to the angular size of object seen without magnifying glass"

Formula:

$$M = \frac{\text{Angular size of final image produced by magnifying glass}}{\text{Angular size of object seen without magnifying glass}}$$

$$M = \frac{\theta'}{\theta}$$

Resolving Power

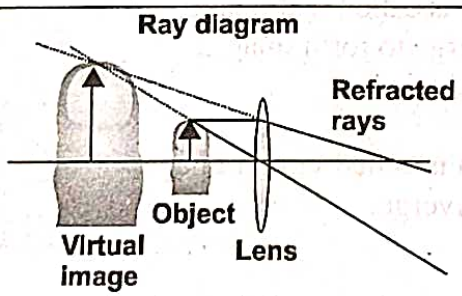
"The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources"

Q.12.22. Draw the ray diagrams of (F.B. 2018) 101112121

(i) Simple microscope (ii) Compound microscope (iii) Refracting telescope

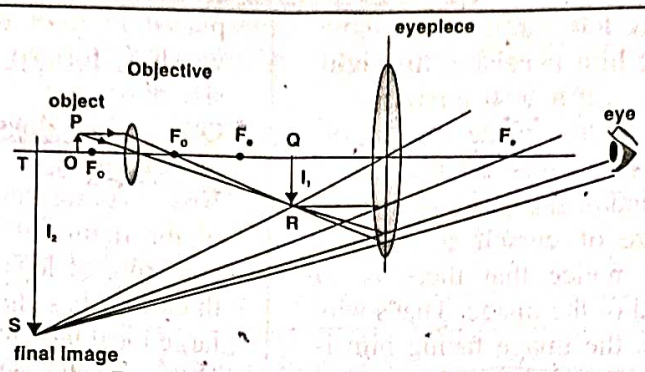
Ans.

(i) Simple Microscope



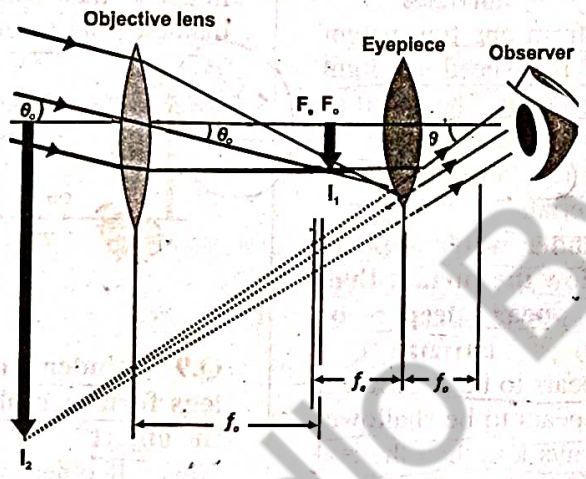
Magnifying glass is a lens that forms a virtual image that is larger than object and appear behind the lens

(ii) Compound Microscope



Ray diagram for compound microscope

(iii) Refracting Telescope



Ray diagram of refracting telescope

Q.12.23 Mention the magnifying powers of following optical instruments. 101112122

(i) Simple microscope (ii) Compound microscope (iii) Refracting Telescope

Ans.

(i) Simple Microscope: $M = 1 + \frac{d}{f}$

(ii) Compound Microscope: $M = \frac{L}{f_0}\left(1 + \frac{d}{f_e}\right)$

(iii)Refracting Telescope: $M = \frac{f_o}{f_e}$

Q12.24 Draw ray diagrams to show the formation of images in the normal human eye. 101112123

Ans. See Q#32 on Page# 60

Q12.25 What is meant by the term near sightedness and far sightedness? How can these defects be corrected? 101112124

Ans. See Q#35 on Page# 62

Conceptual Questions

Q.1 A man raises his left hand in a plane mirror, the image facing him is raising his right hand. Explain why? (F.B. 2014) 101112125

Ans. Images produced by the plane mirror are virtual, upright, left-right reversed, the same distance from the mirror and of same size as object.

If we view an image of ourself in a plane mirror, we will quickly notice that there is an apparent left right reversal of the image. That's why if we raise our left hand, the image facing him is raising his right hand due to the left-right reversal of the orientation.

Q.2 In your own words, explain why light waves are refracted at a boundary between two materials? 101112126

Ans. When light rays enter from one transparent medium to another medium the speed of light changes due to change in wavelength. The speed of light is different in different materials due to difference in densities so light rays are refracted at the boundary between two materials.

Q.3 Explain why a fish under water appears to be at a different depth below the surface than it actually is. Does it appear deeper or shallower? (F.B. 2017) 101112127

Ans. A fish under water appears to be at different depth below the surface, it appears to be shallower because apparent depth is always less than the real depth and image is formed after the refraction of light in water at the apparent depth.

Q.4 Why or why not concave mirrors are suitable for make up? (F.B. 2015) 101112128

Ans. Concave mirrors are suitable for make up because when a man stands between principal focus and pole of mirror, he sees an enlarge erect and virtual image of his face and it is not suitable, when a person is not standing between principal focus and pole of mirror, the image formed will be real and inverted.

Q.5 Why is the driver's side mirror in many cars convex rather than plane or concave? 101112129

Ans. The image formed by the convex mirror is always virtual, erect and diminished so convex mirrors are used in automobiles which enable the driver to see the automobiles coming behind him.

Q.6 When an optician's testing room is small, he uses a mirror to help him test the eye sight of his patients. Explain why? 101112130

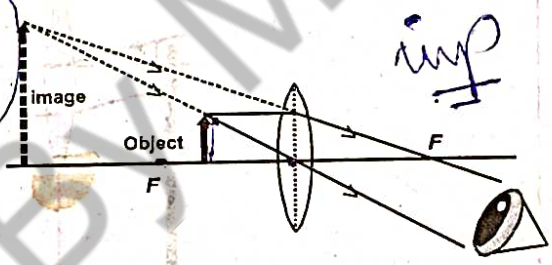
Ans. If the optician's room is small, then for testing the patients eye-sight, original words are placed at the back side of patient and mirror is placed in front of the patient. So, that image of words is formed at the distance doubled than the size of room.

Q.7 How does the thickness of lens affect its focal length? (F.B. 2017) 101112131

Ans. As we know that $f = R/2$ focal length is half of the radius of curvature. Thickness of lens (or) curvature of lens affect the focal length of lens. A thick lens has short focal length and a thin lens has large local length.

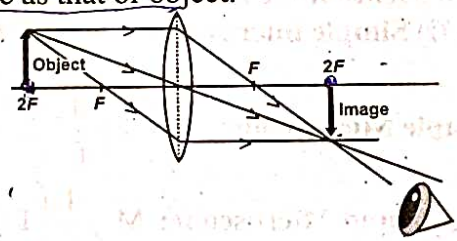
Q.8 Under what conditions will a converging lens form a virtual image? 101112132

Ans. If the object is placed in between principal focus of converging lens and optical centre, the image formed will be virtual, erect and large in size than the object size.



Q.9 Under what conditions will a converging lens form a real image that is the same size as the object? 101112133

Ans. If object is placed at a distance of 2F from the optical centre of converging lens, the image formed at 2F the image will be real, inverted and same size as that of object.



Q.10 Why do we use refracting telescope with large objective lens of large focal length? 101112134

Ans. In telescope, objective lens of large focal length is used in order to collect information of distant object from infinity. Objective lens forms a real, inverted and diminished image at the principal focus of objective lens. This image acts as an object for the eye piece lens and this lens forms the large, virtual image at a large distance from the objective lens.

$$M = \frac{f_o}{f_e}$$

In order to get better magnification we use large focal length objective lens.

Additional Short Questions

Q.11 For which purpose the gastroscope, cystoscope and bronchoscope are used in medical field? 101112135

Ans.

Gastroscope:

It is an instrument which is used to view stomach.

Cystoscope:

This instrument used to examine liver or bladder.

Bronchoscope:

It is an instrument which is used to view sore throat.

Q.12 What are spherical mirrors? Also write their types. 101112136

Ans. A portion of the reflecting surface of a hollow sphere is called spherical mirror. They are of two types.

i). Concave mirror ii) Convex mirror

Concave Mirror

The mirror whose inner curved surface is reflecting, is called concave mirror.

Convex Mirror

The mirror whose outer curved surface is reflecting is called convex mirror.

Q.13 Define principal axis and principal focus. 101112137

Ans. The line passing through center of curvature and pole of mirror is called principal axis and the point at which rays after reflection converge is called principal focus.

Q.14 Define focal length (f). 101112138

Ans. The distance between principal focus and pole of the mirror is called focal length. It is denoted by f.

Q.15 What is linear magnification? 101112139

Ans. The ratio of height of image to the height of the object is called linear magnification. Its formula is

$$m = \frac{\text{height of image}}{\text{height of object}} = \frac{h_i}{h_o} = \frac{q}{p}$$

Q.16 What is endoscope? 101112140

Ans. It is an instrument, which is used for viewing and photographing the internal structure of human body.

Q.17 What should be angle of incidence for total internal reflection? 101112141

Ans. The angle of incidence must be greater than critical angle in order to get total internal reflection.

Q.18 What are the types of defects in vision? Explain. 101112142

Ans. Many people cannot see objects clearly have defects in their vision. There are two main defects of vision (i) Farsightedness (ii) Near sightedness

A person who can see distant objects clearly but cannot see near objects clearly is suffering from farsightedness. This defect can be removed by using convex lens of suitable focal length.

Some people cannot see distant objects clearly without the aid of spectacles. This defect of vision is called near sightedness. This defect can be removed by using concave lens of suitable focal length.

Q.19 Define refractive index? What is its unit? 101112143

Ans. The refractive index 'n' of a medium is the ratio of the speed 'c' of light in a vacuum to the speed 'v' of light in the medium.

$$\text{Refractive index} = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$$

OR $n = \frac{c}{v}$

Unit: It has no unit.

Q.20 What is the difference between regular and irregular reflection. 101112144

(OR) Describe types of reflection.

Ans. There are two types of reflection.

i) Regular reflection.

ii) Irregular reflection.

Regular reflection	Irregular reflection
A smooth surface of silver reflects rays of light in one direction only. The reflection by these smooth surfaces is called regular reflection.	Most of the objects in every-day world are not smooth on the microscopic level. The rough surfaces of these objects reflect the rays of light in many directions. Such type of reflection is called irregular reflections.

101112145

Q.21 Define Snell's law. Write down its formula.

Ans. According to Snell's law "the ratio of $\sin\angle i/\sin\angle r$ is known as the refractive index of second medium with respect to the first medium". So we have

$$\frac{\sin\angle i}{\sin\angle r} = n = \frac{n_1}{n_2}$$

101112146

Q.22 What is the difference between magnifying power and resolving power?

Magnifying Power	Resolving Power
"It is the ratio of angular size of final image produced by magnifying glass to the angular size of object seen without magnifying glass".	"The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources".

101112147

Q.23 Define refraction of light.

Ans. The bending of light as it passes from one transparent medium into another is called refraction.

101112148

Q.24 Describe the simple micro scope.

Ans. A magnifying glass is a convex lens which is used to produce magnified images of small objects. Hence it is called simple microscope.

101112149

Q.25 What are the application of lenses?

Ans. Lenses are used in many optical devices to get images of the objects following are some devices in which lenses are used:

(i) Camera
(ii) Slide projector
(iii)Photograph enlarger

101112150

Q.26 What is prism?

Ans. "Prism is a transparent body (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted."

101112151

Q.27 State the difference between concave and convex mirror.

Ans.

Concave Mirror	Convex Mirror
(i) The mirror whose inner curved surface is reflecting is called concave mirror.	(i) The mirror whose outer curved surface is reflecting is called convex mirror.
(ii) Focous of Concave mirror is real focous.	(ii) Focous of Convex mirror is virtual focous
(iii) Focal length of concave mirror is taken as positive.	(iii) Focal length of convex mirror is taken as negative.
(iv) Both real and virtual image can be formed by concave mirror	(iv) Only virtual and erect image is formed by convex mirror.

101112152

Q.28 Define total internal reflection.

Ans. "When the value of angle of incidence becomes greater than the critical angle, then the ray does not enter in to the second medium, but reflects back in the same medium such reflection of light is called total internal reflection."

101112153

Q.29 Write any three uses of spherical mirrors in our daily life.

Ans. (i) Concave mirrors are used as a reflector in torches, search lights, head lights of motor vehicles etc, to get powerful parallel beam of light.

(ii) Concave mirror is also used as a shaving/makup mirror as it can form erect and magnified image of the face.

(iii) The dentists use concave mirror to observe large image of the teeth of the patients.

(iv) Now a days America and other developed countries use giant concave mirrors in their huge telescope.

(v) Convex mirrors are used in motorcycles and automobiles which enable the driver to see the automobiles coming behind him.

Q.30 Which lenses have greater power, the lens of less focal length or of greater focal length?

Ans. The relation between power of lens and focal length of lens is given by 101112154

$$\text{Power} = \frac{1}{\text{focal length}} \quad \text{OR} \quad P = \frac{1}{f(m)}$$

According to this relation, the system with a shorter focal length has greater optical power than one with longer focal length. Power of the lens is the reciprocal of focal length measured in metre.

Q.31 If the refractive index of ice is 1.31. Find the critical angle. 101112155

Ans. Given data

Refractive index = n = 1.31

Critical angle = C=?

$$n = \frac{1}{\sin\angle c}$$

$$1.31 = \frac{1}{\sin\angle c}$$

$$\text{Sin}\angle c = \frac{1}{1.31}$$

$$\angle c = \sin^{-1}\left(\frac{1}{1.31}\right)$$

$$\angle c = \sin^{-1}(0.7633)$$

$$\angle c = 49.7^0$$

$$\angle c = 50^0$$

Q.32 Describe the difference between compound microscope and simple microscope. 101112156

Ans.

Simple Microscope	Compound Microscope
(i) It has only one lens for magnifying objects.	(i) It has two sets of lenses for magnifying objects, eyepiece lens and objective lens.
(ii) Its total magnification is limited to the magnification of single lens used.	(ii) Its total magnification is the multiplication of the eye piece and objective lens magnification.
(iii) It can only be used in simple ways such as enlarging small letters while reading.	(iii) It has wide range of use such as in studying the structure of different objects e.g. details of cells in living organisms etc.

Side Information

Q.33 How you use a printed page of book and why you "see" some printed words as black areas? 101112157

Ans. We see a page of a book because light reflects from each part of the page in all directions, so that some of the light rays from each part of the page enter our eye. Because almost no light is reflected by the printed words. So, we "see" them as black areas.

Q.34 What was the idea about the nature of light in early 1700s? 101112158

Ans. In early 1700s, there were two ideas about the nature of light: particle nature and wave nature.

Q.35 What were the theories given by the following scientists about the nature of light? 101112159

(i) Newton (ii) Maxwell
(iii)Thomas Young (iv) Planck

Ans. (i) Newton:

Newton put forward the idea of corpuscular nature of light. According to him light consists of tiny, fast-moving particles.

(ii) Maxwell:

Maxwell formulated the wave theory of light.

(iii)Thomas Young:

Thomas Young proved the wave nature of light experimentally in 1802.

(iv)Planck:

In 1900 Planck suggested that light consists of small packets of energy called photon. Later on idea of photon was confirmed by experiments.

Now we know that light has dual nature, light as well as particle nature.

Q.36 Where is image formed in the plane /flat mirror? 101112160

Ans. The image we see in a flat mirror is at the same distance behind the mirror as the object is in front of it.

Q.37 A well polished spoon acts like which type of mirror explain? 101112161

Ans. If we see well polished spoon from back curved ride, an erect image is formed, so it acts like a convex mirror and if we see inner curved surface of well polished spoon, an inverted and enlarged image is formed. Hence, it acts like a concave mirror.

Q.38 Where does the centre of curvature and focus lie in convex mirror? 101112162

Ans. In convex mirror, centre of curvature and focus lies behind the mirror.

Q.39 Why the convex mirrors are used in large shopping centers for security purpose? (F.B. 2015) 101112163

Ans. Convex mirrors are used in large shopping centers for security purpose because convex mirrors produce erect images that are smaller in size than object. This increases the view for the observer.

Q.40 What is the relation between focal length and radius of curvature of a spherical mirror? 101112164

Ans. The focal length of a spherical mirror is one-half of the radius of curvature i.e. $f=\frac{R}{2}$.

However, the focal length of a convex mirror is taken as negative. It is because the rays appear to come from the focal point behind the mirror. Therefore, for convex mirror. $f=\frac{-R}{2}$.

Q.41 In optics, does the word magnification always mean enlargement? 101112165

Ans. The word magnification, as used in optics, does not always mean enlargement, because the image could be smaller than object.

Q.42 Why a light ray passing through a triangular prism deviates from its path? 101112166

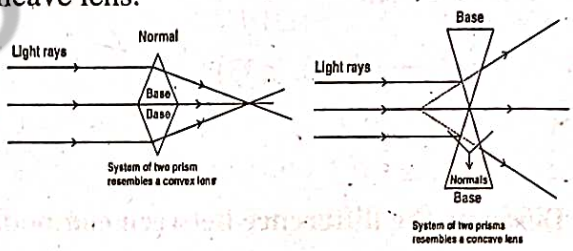
Ans. A light ray passing through a prism deviates from its original path due to refraction.

Q.43 Will the bending of the light be more or less for a medium with high refractive index? 101112167

Ans. The bending of light will be more for a medium with high refractive index.

Q.44 How the combination of two triangular prisms resemble a concave or convex lens? 101112168

Ans. If the base of two triangular prisms are joined together then it resembles a convex lens. And if, two triangular prisms are joined in such a way that their bases held opposite to each other and cones are joined together then it resembles a concave lens.

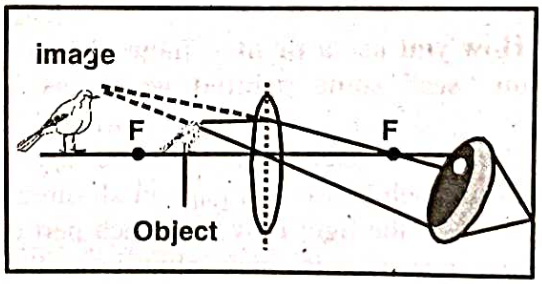


Q.45 What is the similarity of refraction of light through prism and convex lens? 101112169

Ans. The refraction of light by the convex lens causes the ray to deviate from its original path like in prism.

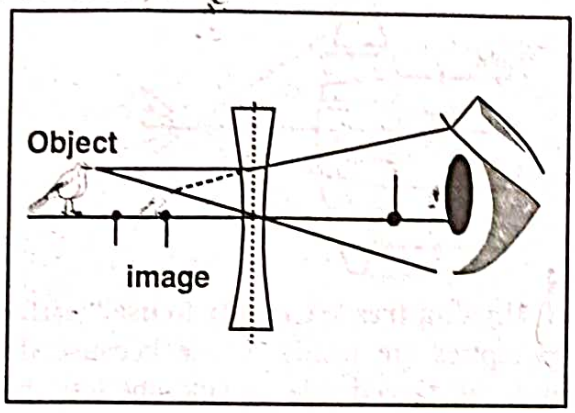
Q.46 What is the nature of image formed by the converging lens, if the object is located inside the focal length of lens? 101112170

Ans. A converging lens becomes a magnifying glass when an object is located inside the focal length of lens hence forms virtual, erect and enlarged image.



Q.47 What is the nature of image formed by diverging lens? 101112171

Ans. A diverging lens always has the same ray diagram wherever the object is placed infront of lens. Hence, it forms real, erect and diminished (smaller in size) image.



Q.48 What is CSP? Why lenses and mirrors are used in CSP? 101112172

Ans. CSP stands for concentrated solar power systems. Lenses or mirrors are used in CSP to focus large area of sunlight into a small beam. This solar power can be used to heat water that can run turbine to produce electricity.

Q.49 Define optics. Also explain the geometrical optics. 101112173

Ans. Optics: "The study of light behavior is called optics".

Geometrical Optics:

"The branch of optics that focuses on the creation of images is called geometrical optics".

iii. It is based on the relationship between angles and lines that describe light rays.

iv. Optics also includes the study of the eye itself because the human eye forms an image with a lens.

Q.50 What is the procedure to estimate the focal length of converging lens? 101112174

Ans. To estimate the focal length of a converging lens, stand next to the wall on the opposite side of the room to the window. Hold up the lens and use it is to focus an image of the window on the wall. Measure the distance from the lens to the wall. This will be a good estimate of the focal length of converging lens.

Q.51 What is a pinhole camera?

(F.B. 2014) 101112175

Ans. Camera with only one lens is called pin hole camera. It is much simpler than a camera.

To make a pinhole camera, a tiny pinhole is made in one side of a box. An inverted real image is formed on the opposite side of the box.

Q.52 Where a pen is placed in front of convex lens if the image is equal to the size of the pen? What will be the power of lens in dioptres? 101112176

Ans.

(a) A pen must be placed at the double distance of focal length i. e. 2F, to get the image of pen equal in size.

(b) As the power of lens is reciprocal to the focal length i.e. $P=\frac{1}{f}$ hence it is independent of image height or object height.

Q.53 What is magnifying glass also describe the nature of image formed by the magnifying glass? 101112177

Ans. Magnifying glass is a lens that forms a virtual image that is larger than object and appears behind the magnifying glass.

Q.54 At which part of an eye, the image of an object is formed? 101112178

Ans. We see because the eye forms images on the retina at the back of the eyeball.

Q.55 What is astronomical telescope? Describe the focal length of objective lens and eye piece in astronomical telescope? 101112179

Ans. Object lens has larger focal length than the eye piece. Distance between the objective lens and eye piece is equal to f_o+f_e. It is used to see distant astronomical objects.

Q.56 What is difference between terrestrial telescope and refracting telescope? 101112180

Ans. Terrestrial telescope is similar to refracting telescope except with an extra lens between objective and eye piece.

Q.57 Describe the magnification of a combination of lenses? 101112181

Ans. The magnification of a combination of lenses is equal to the product of the magnification of each lens.

Q.58 Can a telescope make stars look bigger? 101112182

Ans. A telescope cannot make stars look bigger because they are too far away but it can make dim stars look brighter, and stars that are too faint to see come into view.

Q.59 How many individual stars we can see with naked eye and with telescope? 101112183

Ans. Without a telescope we can see 3000 individual stars in the night sky. A small telescope can increase this by a factor of at least 10. So, a telescope is better than the naked eye for seeing dim stars. The reason is that the telescope gathers more light than the eye.

Q.60 How the size of the pupil of our eye will change? 101112184

a. In dim light?

b. In bright light?

Ans. (a) In dim light pupil becomes enlarged, and allows the maximum light to come in the eye.

(b) In bright light pupil contracts, to control the intensity of light.

Q.61 What are contact lenses? Also describe what keeps the lens in place? 101112185

Ans. Contact lenses produce the same results as eyeglasses do. These small, thin lenses are placed directly on the corneas. A thin layer of tears between the cornea and lens keeps the lens in place.

Q.62 How the animals like fish can see the objects around them? 101112186

Ans. Some animals like fish has the ability to move their eye lenses forward or backward and hence, are able to see clearly objects around them.

Q.63 How can we prevent the glare of reflected light? 101112187

Ans. A thin film can be placed on the lenses of eyeglasses to keep them from reflecting wavelengths of light that are highly visible to the human eye. This prevents the glare of reflected light.

Q.64 Why dispersion of light occur? 101112188

Ans. Dispersion of light is due to the variation in refractive index with the colours.

Q.65 What is the effect of dispersion on water drops? 101112189

Ans. Dispersion in drops of water separates the colors of sunlight into a rainbow.

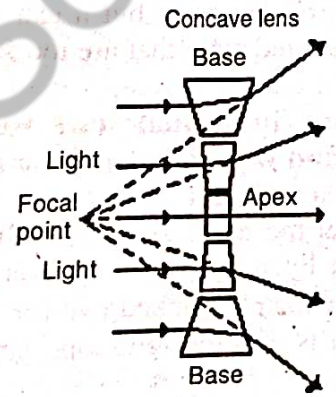
Q.66 What happened to the light when it pass through 101112190

i) Concave lens

ii) Convex lens?

Ans. Concave lens:

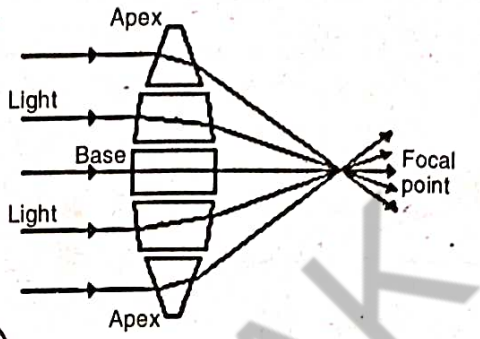
Concave lens spread light away from the principal axis of the lens after refraction.



Convex lens:

Convex lens bends the light towards the principal axis i.e. the thickest part of the lens after refraction.

Convex lens



Q.67 Why dioptres are handy to use? 101112191

Ans. Dioptres are handy to use because if two thin lenses are placed side by side, the total power is simply the sum of the individual powers.

For example an ophthalmologist places a 2.00 dioptre lens next to 0.35 dioptre lens and immediately knows that the power of the combination is 2.35 dioptres.

Q.68 How can you compare lenses simply by looking at them? 101112192

Ans. We can compare lenses simply by looking at them.

- A lens with a long focal length is thin; its surfaces are not very strongly curved.
- A lens with a short focal length is fatter; its surfaces are more strongly curved.

Q.69 How can you measure the focal length of a magnifying glass? 101112193

Ans. On a sunny day, hold the magnifying glass, which is a converging lens, above a non-flammable surface, such as a sidewalk, so that a round spot of light is formed on the surface, Note where the spot formed by the lens is most distinct, or smallest. Use the ruler to measure the distance between the magnifying glass and the surface. This distance is the approximate focal length of the lens.

Q.70 What is compound microscope? What should be the distance between objective and eyepiece of compound microscope? 101112194

Ans. "Compound microscope is used to investigate the structure of very small objects".

Objective lens has smaller focal length than the eyepiece. Distance between the objective lens and the eye piece is greater than $f_o + f_e$.

Solved Examples

12.1 A convex mirror is used to reflect light from an object placed 66 cm in front of the mirror. The focal length of the mirror is f= -46 cm (note the minus sign). Find the location of the image. 101112195

Given p = 66 cm
f = -46 cm

To find q = ?

Solution: Using mirror formula.

$$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$$

$$\frac{1}{q}=-\frac{1}{46}-\frac{1}{66}$$

$$\frac{1}{q}=-\frac{1}{27}$$

q= - 27 cm

Result:

The negative sign indicates that the image is behind the mirror and, therefore, is a virtual image.

12.2 An object is placed 6 cm in front of a concave mirror that has 10 cm focal length. Determine the location of the image. 101112196

Given: p = 6 cm
f = 10 cm,

To find: q = ?

Solution: Using the mirror formula

$$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$$

$$\frac{1}{q}=\frac{1}{10}-\frac{1}{6}$$

$$\frac{1}{q}=-\frac{1}{15}$$

q= - 15 cm

Result:

The negative sign indicates that the image is virtual i.e. behind the mirror.

12.3 A ray of light enters from air into glass surface. The angle of incidence is 30° If the refractive index of glass is 1.52, then find the angle of refraction r. **(F.B. 2017)** 101112197

Given: $\angle i = 30°$
n = 1.52

To find: $\angle r$ = ?

Solution:

$$\frac{\sin\angle i}{\sin\angle r}=n$$

$1.52 \sin\angle r = \sin 30°$

Or $\sin\angle r = \sin 30°/ 1.52$

$\sin\angle r = 0.33$

$\angle r = \sin^{-1}(0.33)$

$\angle r = 19.3°$

Result:

Hence angle of refraction is 19.3°.

12.4 Find the value of critical angle for water if the refracted angle is 90°. The refractive index of water is 1.33 and that of air is 1. 101112198

Given:

r = 90°
n=1.33

To find

$\angle c$ = ?

Solution: When light enters in air from water Snell's law becomes,

$$\frac{\sin\angle r}{\sin\angle i}=n$$

$\angle i = \angle c$ when $\angle r = 90°$

$n \sin\angle c = \sin\angle r$

$n \sin\angle c = \sin 90°$

$n \sin\angle c = 1$

$$\sin\angle c = \frac{1}{n}$$

$$\sin\angle c = \frac{1}{1.33}$$

$$\angle c = \sin^{-1}\left(\frac{1}{1.33}\right)$$

$\angle c = \sin^{-1}(0.751879)$

$\angle c = 48.8°$

Result:

∴ Critical angle of water is 48.8°

12.5 A person 1.70 m tall is standing 2.5 m in front of a camera. The camera uses a convex lens whose focal length is 0.05m. Find the image distance (the distance between the lens and the film) and determine whether the image is real or virtual. 101112199

Given: p = 2.5m
f = 0.05m

To find: q = ?

Solution:

$$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$$

$$=\frac{1}{0.05}-\frac{1}{2.50}$$

$$\frac{1}{q} = 19.6$$

or q = 0.05m

Result:

Since the image distance is positive, so a real image is formed on the film at the focal point of the lens.

12.6 A concave lens has focal length of 15 cm. At what distance should the object from the lens be placed so that it forms an image at 10 cm from the lens? Also find the magnification of the lens. 101112200

Given:

A concave lens always forms a virtual, erect image on the same side of the object.

Image distance = q = -10 cm

Focal length = f = -15 cm

To find:

Object distance p =?

Solution

Using the lens formula:

$$\frac{1}{f} - \frac{1}{q} = \frac{1}{p}$$

$$\frac{1}{-15} - \left(\frac{1}{-10}\right) = \frac{1}{p}$$

$$\frac{1}{-15} + \frac{1}{10} = \frac{1}{p}$$

$$\frac{-2+3}{30} = \frac{1}{p}$$

$$\frac{1}{30} = \frac{1}{p}$$

$$\boxed{p = 30cm}$$

Result:

Thus the object distance is 30 cm, on the left side from the concave lens.

Magnification of the lens is $m = \frac{q}{p} = \frac{10}{30} = \frac{1}{3}$

Result:

The image is reduced to one- third in size than the object.

Numerical Problems

12.1 An object 10.0 cm in front of a convex mirror forms an image 5.0 cm behind the mirror. What is the focal length of the mirror? 101112201

Given Data:

Distance of object = p = 10.0 cm

Distance of image = −q = 5.0 cm (convex mirror)

To Find

Focal length of mirror = f = ?

Calculation:

According to mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{f} = \frac{1}{10} - \frac{1}{5}$$

$$= \frac{1-2}{10}$$

$$\frac{1}{f} = -\frac{1}{10}$$

Hence,

$$\boxed{f = -10cm.}$$

Result:

The image formed by convex mirror is virtual, erect and diminished.

12.2 An object 30.0 cm tall is located 10.5 cm from a concave mirror with focal length 16.0 cm. (a) Where is the image located? (b) How high is it? (F.B. 2017) 101112202

Given Data:

Object height = h_o = 30.0 cm

Distance of object = p = 10.5cm

Focal length = f = 16.0 cm

To Find:

Distance of image = q = ?

Image height = h_i = ?

Calculation:

(a) According to the mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \Rightarrow \frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By multiplying pqf on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq - qf = pf$$

$$q(p-f) = pf$$

$$\boxed{q = \frac{pf}{(p-f)}}$$

$$q = \frac{10.5 \times 16}{10.5 - 16}$$

$$= -\frac{168}{5.5}$$

$$q = -30.54\text{cm}$$

$$-q = 30.54\text{cm}$$

Result:

As the object is placed in mirror's focal length hence negative sign indicates that image is virtual and erect.

(b) As we know that

$$\text{Magnification} = m = \frac{q}{p}$$

$$m = \frac{30.54}{10.5}$$

$$m = 2.90$$

As, $m = \frac{h_i}{h_o}$

Hence $h_i = m \times h_o$

$$= 2.90 \times 30.0$$

$$h_i = 87.27\text{cm}$$

Result:

Height of image is 87.27cm.

12.3 An object and its image in a concave mirror are of the same height, yet inverted, when the object is 20.0 cm from the mirror. What is the focal length of the mirror?

(F.B. 2018) 101112203

Given data:

If an object is placed at '2F' in front of concave mirror. Then, image will also be formed at '2F', inverted and of same height hence

As, Object distance = p = 20.0 cm

Image distance = q = 20.0cm

To find:

Focal length = f = ?

Calculation:

According to the mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying pqf on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq = f(q + p)$$

$$\frac{pq}{p+q} = f$$

$$\frac{20 \times 20}{(20+20)} = f$$

$$\frac{400}{40} = f$$

$$10\text{cm} = f$$

Hence $f = 10\text{cm}$

Result:

Hence, the focal length of concave mirror is 10cm.

12.4 Find the focal length of a mirror that forms an image 5.66 cm behind a mirror of an object placed at 34.4 cm in front of the mirror.

101112204

Given data:

Distance of image = q = –5.66 cm

Distance of object = p = 34.4 cm

To find:

Focal length = f = ?

Calculation:

According to the mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying 'pqf' on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq = f(q + p)$$

$$\frac{pq}{(q+p)} = f$$

$$\frac{34.4 \times -5.66}{(5.66+34.4)} = f$$

$$\frac{194.704}{28.74} = f$$

$$-6.77\text{ cm} = f$$

Hence $f = -6.77$ cm

Result:

As the image formed behind the mirror and negative sign with focal length indicates that mirror is convex.

12.5 An image of a statue appears to be 11.5 cm behind a convex mirror with focal length 13.5 cm. Find the distance from the statue to the mirror.

101112205

Given data:

Image distance = q = -11.5 cm (For virtual image)

Focal length = f = -13.5 cm (For convex mirror)

To find:

Object distance = p = ?

Calculation:

According to the mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying 'pqf' on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq - pf = qf$$

$$p(q - f) = qf$$

$$p = \frac{qf}{(q-f)}$$

$$p = \frac{-11.5 \times -13.5}{-11.5-(-13.5)}$$

$$= \frac{155.25}{-11.5+13.5}$$

$$= \frac{155.25}{2}$$

$$p = 77.62\text{cm}$$

Result:

The distance from the statue to the convex mirror is 77.62 cm.

12.6 An image is produced by a concave mirror of focal length 8.70 cm. The object is 13.2 cm tall and at a distance 19.3 cm from the mirror. (a) Find the location and height of the image.

(b) Find the height of the image produced by the mirror of the object is twice as far from the mirror.

101112206

Given data:

Focal length = f = 8.70 cm

Object height = h_o = 13.2 cm

Distance of object = p = 19. 3 cm

To Find:

Distance of image = q = ?

Image height = h_i = ?

Calculation:

According to the mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying 'pqf' on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq - qf = pf$$

$$q(p - f) = pf$$

$$q = \frac{pf}{(p-f)}$$

$$p = \frac{19.3 \times 8.70}{(19.3-8.70)}$$

$$q = \frac{167.91}{10.6}$$

$$q = 15.84\text{ cm}$$

Now by using the formula of magnification.

$$m = \frac{h_i}{h_o} = \frac{q}{p}$$

$$\frac{h_i}{h_o} = \frac{q}{p}$$

$$\frac{h_i}{13.2} = \frac{15.84}{19.3}$$

$$h_i = \frac{15.84 \times 13.2}{19.3}$$

$$h_i = \frac{209.088}{19.3}$$

$$h_i = 10.83\text{ cm}$$

(b) If 'p' is doubled then distance of image from the lens will be changed.

$$p = 2p$$

$$= 2 \times 19.3$$

$$p = 38.6\text{cm}$$

$$f = 8.70\text{cm}$$

$$q = ?$$

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

$$\frac{1}{q} = \frac{p-f}{fp}$$

$$q = \frac{fp}{p-f}$$

$$q = \frac{8.70 \times 38.6}{38.6-8.70}$$

$$q = \frac{335.82}{29.9}$$

$$q = 11.23\text{cm}$$

If

$$h_o = 13.2\text{cm}$$

$$h_i = ?$$

$$\frac{h_i}{h_o} = \frac{q}{p}$$

$$h_i = \frac{q}{p} \times h_o$$

$$= \frac{11.23}{38.6} \times 13.2$$

$$\boxed{h_i = 3.84\text{cm}}$$

Result:

(a) Thus the image is formed at a distance of 15.84cm from the mirror and image height is 10.83. cm.

(b) If object distance is doubled the image will be formed at a distance of 11.23cm from the mirror and height of image will be 3.84cm.

12.7 Nabeela uses a concave mirror when applying makeup. The mirror has a radius of curvature of 38.0 cm. (a) What is the focal length of the mirror? (b) Nabeela is located 50 cm from the mirror. Where will her image appear? (c) Will the image be upright or inverted?

101112207

Given data:

Radius of curvature = R = 38 cm

Distance of object = p = 50 cm

To Find:

(a) Focal length = f = ?

(b) Distance of image = q = ?

(c) Nature of image = ?

Calculation:

(a) As the focal length (f) of the mirror is half of the radius of curvature (R).

Hence $f = \frac{1}{2}R$

$$f = \frac{1}{2} \times 38$$

$$f = 19\text{cm}$$

(b) According to mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying 'pqf' on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq - qf = pf$$

$$q(p - f) = pf$$

$$q = \frac{pf}{(p-f)}$$

$$q = \frac{50 \times 19}{(50-19)}$$

$$q = \frac{950}{31}$$

$$q = 30.64\text{ cm}$$

Image is formed at a distance of 30.64cm from the mirror.

(c) Nature of image:

The image formed is real, inverted and small in size.

12.8 An object 4 cm high is placed at a distance of 12 cm from a convex lens of focal length 8cm. Calculate the position and size of the image. Also state the nature of the image.

101112208

Given data:

Object height = h_o = 4 cm

Distance of object = p = 12 cm

Focal length = f = 8cm

To Find:

(a) Distance of image = q = ?

(b) Image height = h_i = ?

(c) Nature of image = ?

Calculation:

(a) According to the mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying 'pqf' on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$

$$pq - qf = pf$$

$$q(p - f) = pf$$

$$q = \frac{pf}{(p-f)}$$

$$q = \frac{12 \times 8}{(12-8)} = \frac{96}{4}$$

$$q = 24\text{ cm}$$

Result:

Image is formed at a distance of 24cm from the convex lens.

(b) Now by using the formula of magnification:

$$\frac{h_i}{h_o} = \frac{q}{p}$$

$$h_i = \frac{24}{12} \times 4$$

$$h_i = 8\text{cm}$$

Result:

Height of image is 8cm.

(c) Nature of image:

Image formed is real, inverted and magnified.

12.9 An object 10 cm high is placed at a distance of 20 cm from a concave lens of focal length 15 cm. Calculate the position and size of the image. Also state the nature of the image.

101112209

Given data:

Object height = h_o = 10 cm
Distance of object = p = 20 cm
Focal length = f = − 15 cm
(for concave lens)

To find:

(a) Distance of image = q = ?
(b) Image height = h_i = ?
(c) Nature of image = ?

Calculation:

(a) According to mirror formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By multiplying 'pqf' on both sides

$$\frac{pqf}{f} = \frac{pqf}{p} + \frac{pqf}{q}$$

$$pq = qf + pf$$
$$pq - qf = pf$$
$$q(p-f) = pf$$
$$q = \frac{pf}{(p-f)}$$
$$q = \frac{20\times(-15)}{20-(-15)} = -\frac{300}{35}$$
$$q = -8.57 \text{ cm}$$

Result:

Virtual image is formed at a distance of 8.57cm from the concave lens.

(b) By using the formula of magnification

$$\frac{h_i}{h_o} = \frac{q}{p}$$
$$h_i = \frac{q}{p} \times h_o = \frac{8.57}{20}\times 10 = 4.28\text{cm}$$

(c) Nature of image:

Image is virtual, erect and diminished.

12.10 A convex lens of focal length 6 cm is to be used to form a virtual image three times the size of the object. Where must the lens be placed?

101112210

Given data:

Focal length = f = 6 cm
Magnification = m = 3

To Find:

(a) Distance of object = p = ?

Calculation:

As virtual image is required so take 'q' as negative.

Hence

$$m = \frac{-q}{p} \text{ (for virtual image)}$$
$$3 = -\frac{q}{p}$$
$$3p = -q$$
$$q = -3p$$

According to lens formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$
$$\frac{1}{f} = \frac{1}{p} + \frac{1}{(-3p)}$$
$$\frac{1}{f} = \frac{1}{p} - \frac{1}{3p}$$
$$\frac{1}{6} = \frac{3-1}{3p}$$
$$\frac{1}{6} = \frac{2}{3p}$$
$$3p = 12$$
$$p = 4\text{cm}$$

Result:

Hence, to get the virtual image three times the size of object, lens must be placed at the distance of 4 cm from the object.

12.11 A ray of light from air is incident on a liquid surface at an angle of incidence 35°. Calculate the angle of refraction if the refractive index of the liquid is 1.25. Also calculate the critical angle between the liquid air inter-face.

101112211

Given data:

Angle of incidence = ∠i = 35°
Refractive Index = n = 1.25

To find:

Angle of refraction = ∠r = ?
Critical angle = ∠c = ?

Calculation:

As we know that

$$n = \frac{\sin \angle i}{\sin \angle r}$$
$$1.25 = \frac{\sin 35^\circ}{\sin \angle r}$$
$$\sin \angle r = \frac{0.5736}{1.25}$$
$$\sin \angle r = 0.459$$

$$\angle r = \sin^{-1} 0.459$$
$$\angle r = 27.3°$$

We also know that

$$n = \frac{1}{\sin \angle c}$$

Hence

$$1.25 = \frac{1}{\sin \angle c}$$
$$\sin \angle c = \frac{1}{1.25}$$
$$\sin \angle c = 0.8$$
$$\angle c = \sin^{-1} 0.8$$
$$\angle c = 53.13°$$

Result:

Angle of refraction is 27.3° and angle between the liquid-air interface is 53.13°.

12.12 The power of a convex lens is 5D. At what distance the object should be placed from the lens so that its real and 2 times larger image is formed?

(F.B. 2014) 101112212

Given data:

Power = P = 5 D

Magnification = m = 2

To Find:

Distance of object = p = ?

Calculation:

As we know that

$$P = \frac{1}{f}$$
$$f = \frac{1}{P}$$

$$f = \frac{1}{5} = 0.2\text{m} = 0.2 \times 100\text{cm}$$

or $$f = 20 \text{ cm}$$

By using the formula of magnification

$$m = \frac{q}{p}$$
$$2 = \frac{q}{p}$$
$$2p = q$$
$$q = 2p$$

According to lens formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$
$$\frac{1}{f} = \frac{1}{p} + \frac{1}{2p}$$
$$\frac{1}{20} = \frac{2+1}{2p}$$
$$\frac{1}{20} = \frac{3}{2p}$$
$$2p = 20 \times 3$$
$$p = \frac{60}{2}$$
$$p = 30 \text{ cm}$$

Result:

The object should be placed at 30 cm from the lens to get real and 2 times larger image.

UNIT 13

Electrostatics

101113001

Q.1 Define Electrostatics.

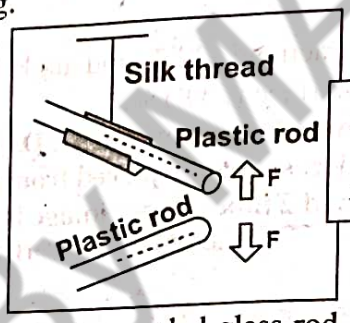
Ans. *The study of charges at rest is called electrostatics or static electricity.*

Q.2 How is the charge produced on a body by rubbing? OR How can you show by simple experiments that there are two types of Electric Charges? 101113002

Ans. Study of charges at rest is called electrostatics or static electricity. The property of attraction or repulsion between substances is due to the electric charges they acquire during rubbing. We can produce electric charge by rubbing a neutral body with another neutral body. The following activities show that we can produce two types of electric charges through the process of rubbing.

Activity 1:

Take a plastic rod. Rub it with fur and suspend it horizontally by a silk thread. Now take another plastic rod and rub it with fur and bring near to the suspended rod. We will observe that both the rods will repel each other. It means during the rubbing both the rods were charged.



Two plastic rods rubbed with fur repel each other

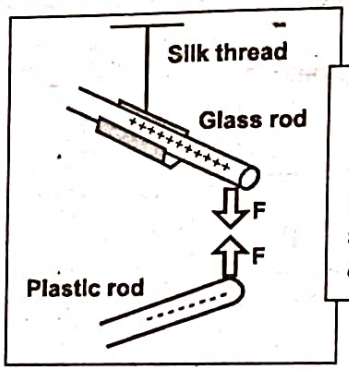
Activity 2:

Now take a glass rod and rub it with silk and suspend it horizontally. When we bring the plastic rod rubbed with fur near to the suspended glass rod, we observe that both the rods attract each other.

In the first activity, both rods are of plastic and both of them have been rubbed with fur. Therefore, we assume that charge on both rods would be of the same kind.

In the second activity, rods are unlike and their attraction imply that charge on the two rods are not of the same kind but of opposite nature.

These opposite charges are conventionally called positive and negative charge. During the process of rubbing negative charge is transferred from one object to another object. From these activities we conclude that:



Plastic rod rubbed with fur and glass rod rubbed with silk attract each other.

Conclusion:

1. Charge is a basic property of a material body due to which it attracts or repels another object.
2. Friction produces different types of charge on different materials (such as glass and plastic.)
3. Like charges always repel each other.
4. Unlike charges always attract each other.
5. Repulsion is the sure test of charge on a body.

Charge on glass rod by rubbing:

When a glass rod is rubbed with silk, the loosely bounded electron of glass are transferred to silk due to which number of electrons in the glass rod decrease. Therefore glass rod is charged.

Conclusion:

(i) Solid bodies are charged due to transfer of electrons.

(ii) If electrons are transferred to the body, then it is negatively charge and if electrons leave it, it gets positive charge.

(ii) In metallic substance, electrons in last orbit are loosely bounded, that their motion is no longer confined in the orbit, so they can freely move through the whole of the metal. These are called free electrons.

For your information

In the list given below, different materials have been arranged in such a way that if any of the two materials are rubbed together, the material occurring first in the list would have positive charge and that occurring next would have negative charge, for example, among cat's skin and lead, skin has positive charge whereas lead has negative charge.

1. Asbestos 2. Glass 3. Mica 4. Woollen cloth 5. Cat's skin
6. Lead 7. Silky cloth 8. Aluminium 9. Cotton cloth
10. Wood 11. Copper 12. Rubber 13. Plastic

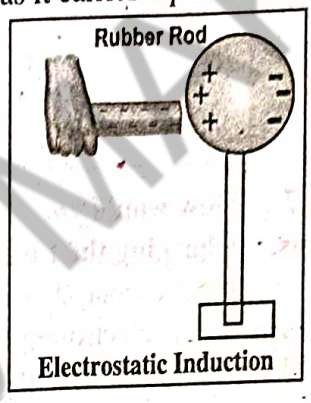
Q.3 Explain the phenomenon of electrostatic induction. 101113004

Ans. *"If in the presence of a charged body, an insulated conductor develops positive charge at one end and negative charge at the other end, this process is called the electrostatic induction".*

Experiment:

Consider a metallic sphere placed on an insulated stand. The sphere is neutral as it carries equal number of positive and negative charges. Now bring a negatively charged rubber rod near the conducting sphere. Left part of the sphere that is close to the rod becomes positively charged while the right part that is away from the rod becomes negatively charged. Negative charge in the rod repels the negative charge of the sphere and shifts it to the opposite region of the sphere that is away from the rod. Thus there is excess of positive charge in the region of sphere close to the rod while there is excess of negative charge in the region of the sphere away from the rod. But as a whole the sphere is still neutral, since no charge has been added or subtracted.

Now if we remove the rod away from the sphere the charge again will spread uniformly on the whole surface of the sphere.



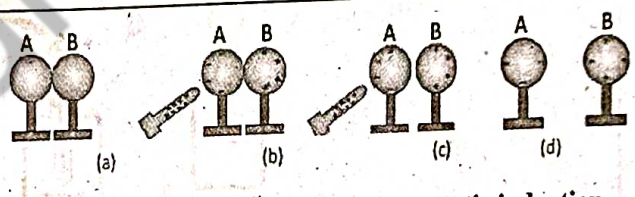
Electrostatic Induction

Q.4 Describe the method of charging bodies by electrostatic induction. 101113004

Ans. Bring two metal spheres A and B and place them on an insulating stand. Now bring a positively charged rod near sphere A. Rod will attract negative charge towards it and repel positive charge away from it. Negative charge will be developed on the left surface of the sphere A which is close to the rod. While positive charge will be developed on the right surface of the sphere B.

Now separate the spheres by a small distance while the rod is still near the sphere A. The two spheres will be oppositely charged and attract each other. Remove the rod. The charges on spheres rearrange themselves. Now separate the spheres by a large distance. The charges are uniformly distributed over the surfaces of the spheres.

In this process, an equal and opposite charge will be developed on each metal sphere. This is charging by induction.



Charging a neutral sphere by electrostatic induction

Since in this phenomenon all charges remain static that is why it is known as electrostatics.

Q.5 What is gold leaf electroscope? Discuss its working principle with a labelled diagram. 101113005

Ans. Electroscope:

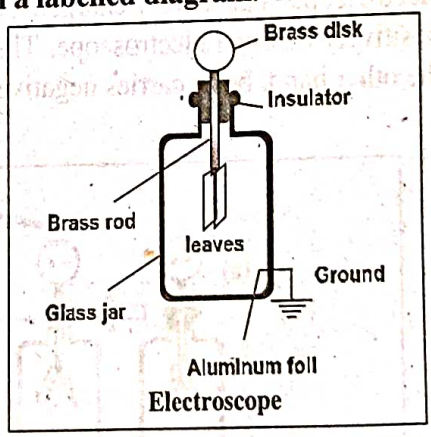
"The gold leaf electroscope is a sensitive instrument used for detecting and testing the nature of charges on a body".

Working Principle:

Working Principle of gold leaf electroscope is electrostatic induction.

Construction:

It consists of a brass rod with brass disk on the top and two thin leaves of gold foil hanging at bottom. The rod passes through an insulator that keeps the rod in place and also retain the charges. Charges can move freely from the disk to the leaves through that rod. A thin aluminum foil is attached on the lower part inside the jar. Aluminum foil is grounded with the help of copper wire. This protects the leaves from the external.

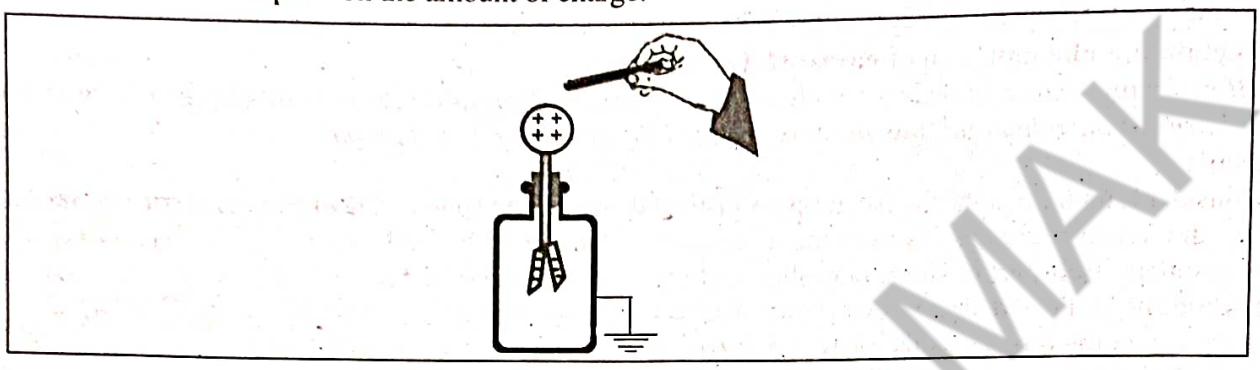


Electroscope

Q.6 With the help of electroscope how can you find presence of charge on a body. 101113006

Ans. Detection of Presence of Charge

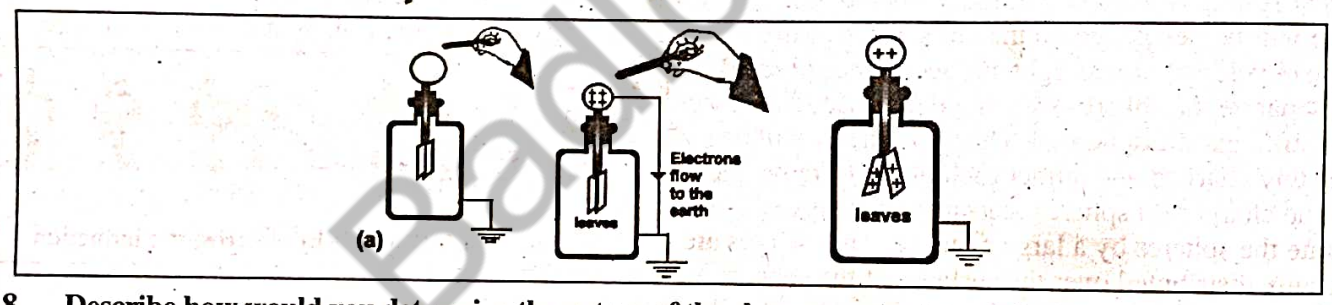
In order to detect the presence of charge on anybody, bring the body near the disk of an uncharged electroscope. If the body is neutral, there will be no deflection of the leaves. But if the body is positively or negatively charged, the leaves of the electroscope diverge. For example, if the body is negatively charged then due to electrostatic induction, positive charge will appear on the disk while negative charge will appear on the leaves. The leaves of electroscope repel each other and diverge because each leave gets similar charger. The divergence of leaves will depend on the amount of charge.



Q.7 How would you charge the electroscope Positively. 101113007

Ans. Charging the Electroscope by Electrostatic Induction:

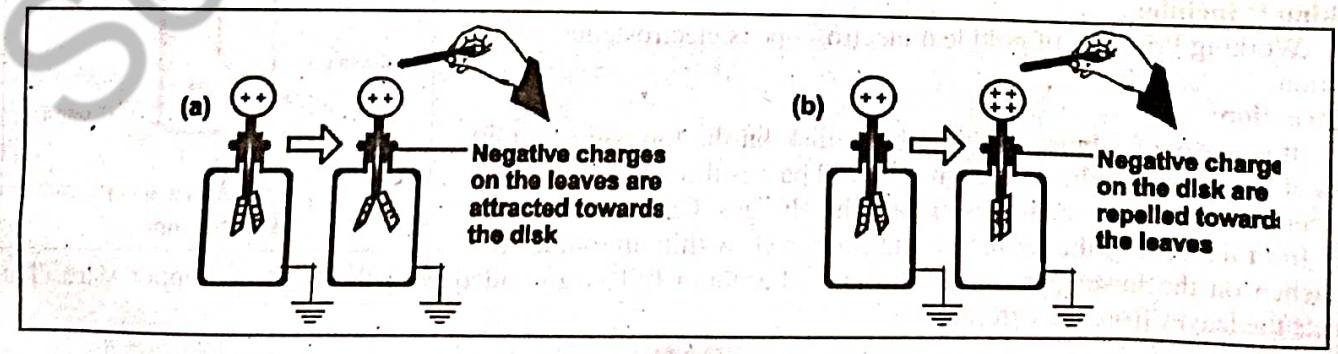
Electroscope can be charged by the process of electrostatic induction. In order to produce positive charge on the electroscope, bring a negatively charged body near the disk of the electroscope. Positive charge will appear on the disk of the electroscope while negative charges will shift to the leaves. Now connect the disk of electroscope to the earthed aluminum foil by a conducting wire. Charge of the leaves will flow the Earth through the wire. Now if we first break the Earth connection and then remove the rod, the electroscope will be left with positive charge.



Q.8 Describe how would you determine the nature of the charge on a body by using electroscope?

Ans. Detection of types of Charges: (F.B. 2017) 101113008

For detection of charge on a body electroscope is first charged either negatively or positively. Suppose electroscope is positively charged. Now for detection of type of charge, bring the charged body near the disk of positively charged electroscope. The body carries positive charge if the divergence of the leaves increases on the other hand, body carries negative charge if the divergence decreases.



Q.9 How can we identify the conductors and insulators with the help of Charged Electroscope?

(F.B. 2017) 101113009

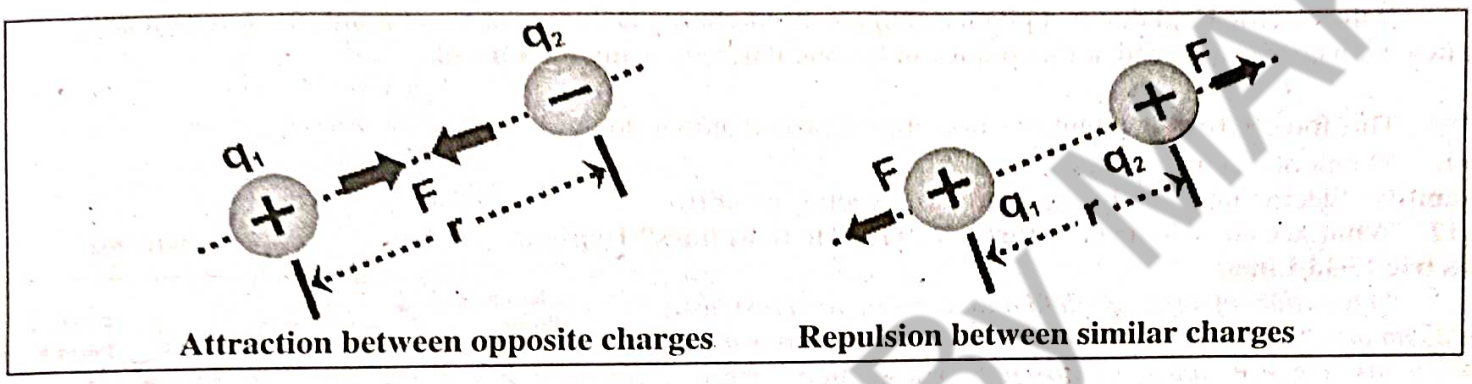
Ans. Identification of Insulators and Conductors:

Insulators and conductors can also be identified by using electroscope. Touch the disk of charged electroscope with material under test. If leaves collapse from diverged position then body would be a good conductor. If there is no change in divergence of leaves, it will show that body under test is an insulator.

Q.10 State and explain Coulomb's Law. OR Explain Coulomb's law of electrostatics and write its mathematical form. **(F.B. 2013) 101113010**

Ans. This law was put forward by French scientist Charles Coulomb in 1785. This law states that

"The force of attraction or repulsion between two point charges is directly proportional to the product of the magnitude of charges, and inversely proportional to the square of the distance between them."



Attraction between opposite charges **Repulsion between similar charges**

Point Charge:

If the distance between two charges is much greater as compared to their size then these bodies are considered as point charge.

Mathematical Form:

If q_1 and q_2 are two point charges, separated by distance 'r' then according to Coulomb's Law:

$F \propto q_1 q_2$ ---------- (1) and $F \propto \frac{1}{r^2}$ ---------- (2)

by combining (1) and (2)

$$F \propto \frac{q_1 q_2}{r^2} \quad \Rightarrow \quad F = \frac{k q_1 q_2}{r^2}$$

Where 'k' is constant of proportionality and its value depends upon medium between two charges and system of unit in which F, q and 'r' are measured.

In SI, if the medium between the two charges is space or air then in this case the value of k will be $9 \times 10^9\ Nm^2\ C^{-2}$.

In order to show the dependence of k upon the medium, usually it is expressed in terms of a property of medium known as **permitivity.** In case of free space it is represented by ε_o. The relation between k and ε_o is given by:

$$k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9\ Nm^2\ C^{-2}$$

By substituting the value of k

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2} \quad \text{---------- (3)}$$

By using this equation we can find the force between two point charges placed in free space or air.

Q.11 What is meant by electric field and electric field intensity? **101113011**

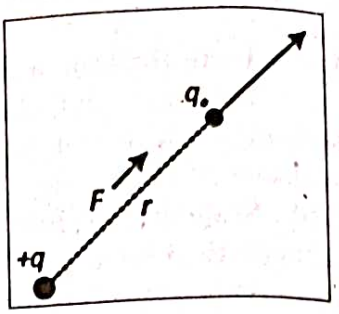
Ans. Electric Field:

"The electric field of a charge is a region of space surrounding it, in which a charge can feel its electrostatic effect in the form of force." **OR**

"The electric field is a region around a charge in which it exerts electrostatic force on another charge".

Explanation:

Consider a positive charge q and bring a test charge q_o at a distance 'r'. The q_o will experience a force. According to Coulomb's law, the value of this force will depend upon the distance between two charges.



If charge 'q_o' is moved away from q this force will decrease till a certain distance, the force would practically reduce to zero.

Electric Field Intensity:

"The strength of electric field at any point in space is called electric field intensity".

If 'F' is the force acting on test charge q_o, the electric field intensity would be

$$E = \frac{F}{q_o}$$

If the electric field due to a given arrangement of charge is known at some point, the force on any particle with charge q placed at that point can be calculated by using the formula

$$F = qE$$

This force acting on a unit positive charge placed at that point.

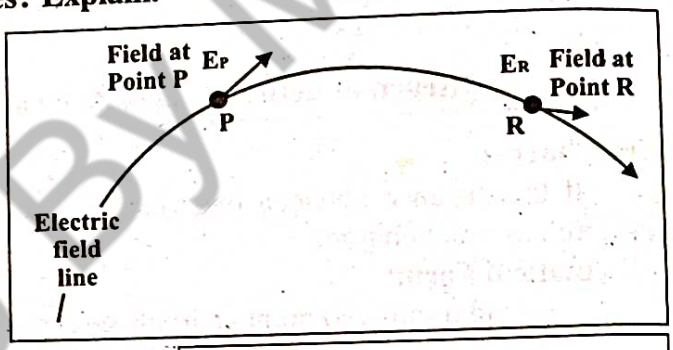
Unit: SI unit of electric intensity is NC^{-1}.

Quantity: Electric intensity being a force is a vector quantity.

Q.12 What are electric lines of forces or electric field lines? Explain. 101113012

Electric Field Lines:

"Direction of electric field intensity in an electric field can also be indicated by drawing lines. These lines are known as electric lines of force." These lines were introduced by **Michael Faraday**.

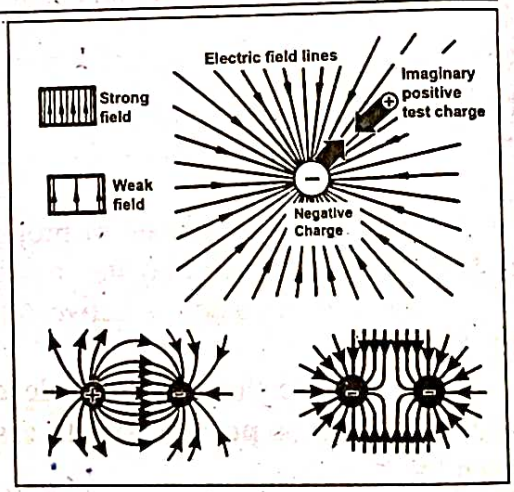


The field lines are imaginary lines around a field charge with an arrow head indicating the direction of force.

Origin:

Field lines move away from positive charge but move towards negative charge.

These lines are originated from positive charge and terminated at negative charge. The spacing between them shows the strength of electric field. These lines are related to electric field intensity in the following way: **(F.B. 2018)**



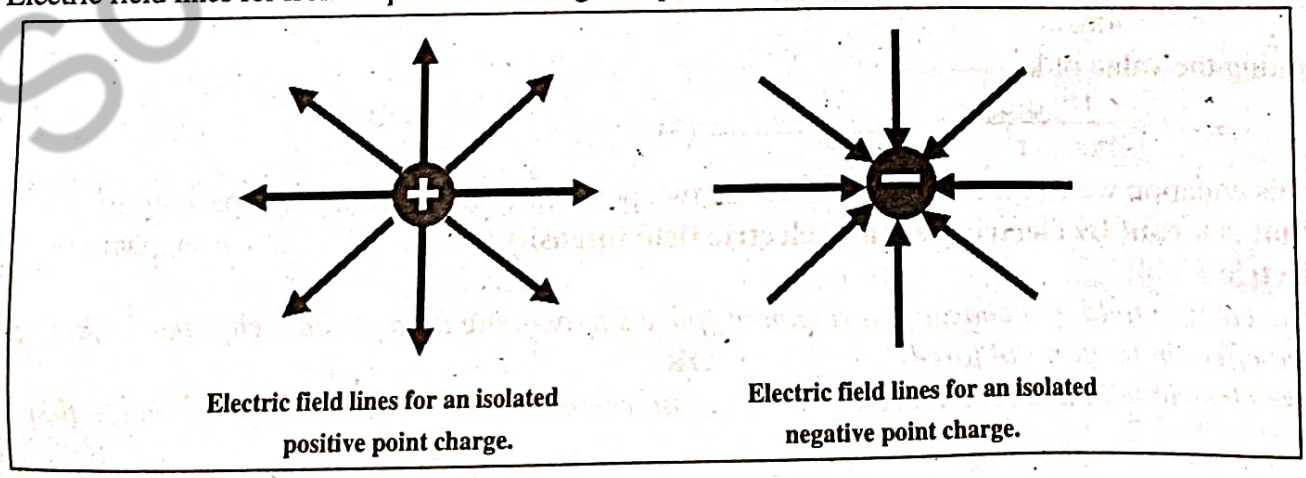
Properties of electric field lines:

(i) Electric field intensity is tangent to the electric field lines at each point.

(ii) The number of lines per unit area through a surface perpendicular to lines is proportional to the electric field strength.

(iii) Electric field is strong when the lines are close to each other and weak when these are far apart. Two field lines do not cross each other.

(iv) Electric field lines for isolated positive and negative points are shown below.



Electric field lines for an isolated positive point charge.

Electric field lines for an isolated negative point charge.

Q.13 What do you mean by Electrostatic Potential? Explain. 101113013

Ans. The gravitational potential at a point in the gravitational field is the gravitational potential energy of a unit mass placed at that point.

Electric Potential:

Electric potential at a point in an electric field is equal to the amount of work done in bringing a unit positive charge from infinity to that point.

If 'W' is work done on charge 'q' bringing a unit positive charge from infinity to a certain point in a field then the electric potential 'V' would be given by

$$V = W/q$$

Unit: SI unit of electric potential is volt, which is equal to JC^{-1}.

Volt:

If the potential energy of one coulomb of a charge at a point in an electric field is 1 Joule, the potential of that point will be one volt. **OR**

If one Joule of work is done against the electric field in bringing one coulomb positive charge from infinity to a point in the electric field then the potential at that point will be one volt.

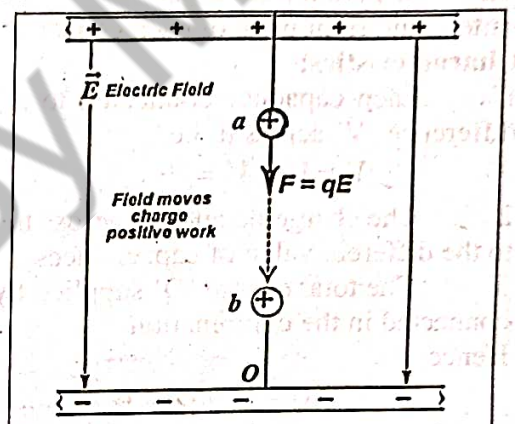
Quantity: Electric potential is a scalar quantity.

Explanation:

In gravitational field, a body always tends to move from a point of higher potential energy to a point of lower potential energy. If the potential of point 'a' is V_a and that of point 'b' is V_b, Similarly, when a charge is released in an electric field, it moves from a point of higher potential to a point of lower potential. The potential energy of charge will be qV_a and qV_b respectively. The change in potential energy would be $qV_a - qV_b$. This energy is used in doing some useful work. Therefore,

Energy supplied by the charge $= qV_a - qV_b$

$$= q(V_a - V_b) \text{.....(1)}$$



Potential difference between two points.

If 'q' is equal to one unit, then the potential difference between two points becomes equal to energy supplied by the charge.

Potential Difference:

The potential difference between two points is the energy supplied by a unit charge as it moves from one point to the other in the direction of field.

The energy would have to be supplied, as a positive charge is moved from a point of lower potential to a point of higher potential. i.e. against the field direction, energy would have to be supplied to it. When we release a negative charge in an electric field, its behaviour will be opposite to that of a positive charge.

Unit: Useful unit for the electrical energy is **electron volt (eV).**

Q.14 What are capacitors? Describe its construction. 101113014

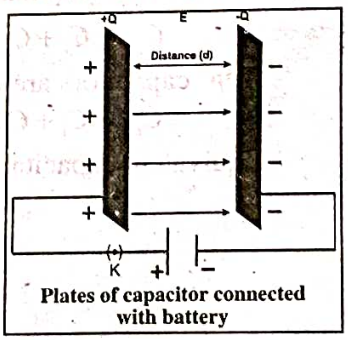
Ans. Capacitor:

"Capacitor is an electric device which is used to store electric charge for a long period of time".

In circuit, symbol of capacitor is: ⊣⊢

Construction:

It consists of two thin metal plates parallel to each other separated by a very small distance. The medium between the two plates is air or a sheet or some insulating material. This medium is called **dielectric**. If +Q amount of charge is given to plate A then due to electrostatic induction –Q charge would be induced on the inner surface of plate 'B' and +Q on its outer surface. Force of attraction exists between charges +Q and –Q. These charges remain bounded within the plates and are stored for a long period.



Plates of capacitor connected with battery

Due to the presence of the charges on the plates a potential difference 'V' is developed across the plates which is directly proportional to the charge 'Q' deposited on plate 'A'.

$$Q \propto V$$

$$Q = CV$$

Where 'C' is the constant of proportionality called the **capacitance** of the capacitor and is the ability of the capacitor to store charge. It is given as:

$$C = Q/V$$

Unit of capacitance:

The unit of capacitance is **'farad'** and is defined as *"If one coulomb of charge given to the plates of capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance would be one farad."*

Farad is a big unit, usually smaller units called **micro farad** and **pico farad** are used.

Q.15 How capacitors are connected in parallel? Describe the characteristic features of this combination. 101113015

Ans. In parallel combination, the left plate of each capacitor is connected to the positive terminal of the battery and right plate of each capacitor is connected to the negative terminal of battery by a conducting wire.

Characteristics:

1. Each capacitor connected to a battery of voltage 'V' has the same potential difference 'V' across it. i.e.

$$V_1 = V_2 = V_3 = V$$

2. The charge developed across the plates of each capacitor will be different due to the different value of capacitances.
3. The total charge 'Q' supplied by the battery is divided among the capacitors connected in the combination.

Hence

$$Q = Q_1 + Q_2 + Q_3 \quad \text{.....(1)}$$

As $Q = CV$

Similarly $Q_1 = C_1 V$

$$Q_2 = C_2 V$$

$$Q_3 = C_3 V$$

Putting value of Q_1, Q_2, Q_3 in eq. (1) then it become

$$Q = C_1 V + C_2 V + C_3 V$$

$$Q = V(C_1 + C_2 + C_3)$$

$$\frac{Q}{V} = C_1 + C_2 + C_3 \qquad as\ Q/V = C$$

$$C = C_1 + C_2 + C_3$$

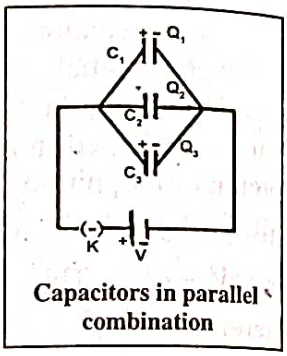
4. Parallel combination of capacitors can be replaced by one equivalent capacitor having capacitance C_{eq}

$$C_{eq} = C_1 + C_2 + C_3$$

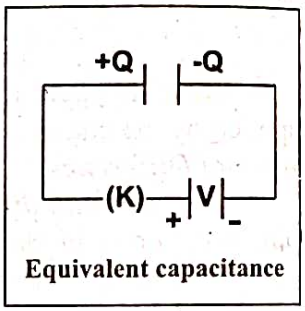
If 'n' capacitors are connected in parallel then the equivalent capacitance would become

$$C_{eq} = C_1 + C_2 + C_3 + \text{.....} + C_n$$

5. Equivalent capacitance of parallel combination is greater than any of the individual capacitances.



Capacitors in parallel combination

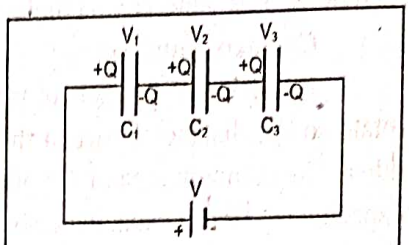


Equivalent capacitance

Q.16 How capacitors are connected in series? Describe the features of this combination.

Or (F.B. 2015, 17) 101113016

Derive the formula for the equivalent capacitance for a series combination of a number of capacitors.



Capacitors in series combination

Ans. In this combination capacitors are connected side by side i.e., the right plate of one capacitor is connected to left plate of the next capacitor.

Characteristics:

1. Each capacitor has the same charge. If battery supplies +Q charge to the left plate of the capacitor C_1, due to induction –Q charge is induced on its right plate i.e.,

$$Q_1 = Q_2 = Q_3 = Q$$

2. The potential difference across each capacitor is different due to different value of capacitances.
3. The battery voltage has been divided among the various capacitors. Hence

$$V = V_1 + V_2 + V_3$$

As $Q = CV$

$$V = Q/C$$

$$V = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

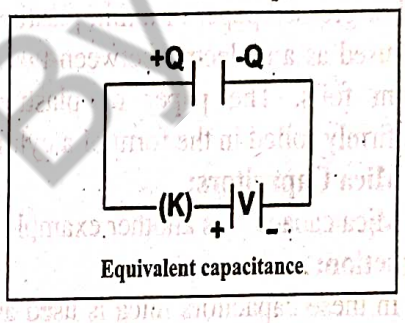
$$V = Q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$\frac{V}{Q} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

As $Q = CV$

Hence $V/Q = \frac{1}{C}$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$



Equivalent capacitance

4. Series combination of capacitors can be replaced with one equivalent capacitor having capacitance $C_{eq.}$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

If 'n' capacitors are connected in series then

$$\frac{1}{C_{eq.}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots\ldots\ldots + \frac{1}{C_n}$$

5. Equivalent capacitance of a series combination of capacitors is smaller than any individual capacitance. Capacitors connected in series decrease the value of capacitance.

Q.17 What are capacitors? Describe their types. 101113017

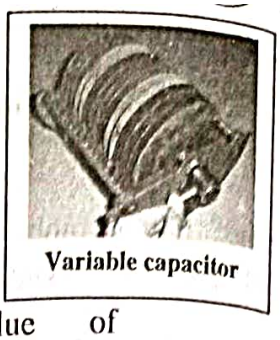
OR

Discuss different types of capacitors.

Ans. In order to store charge for a long period, an instrument is used called capacitor.

Types:

Capacitors have different types depending upon their construction and nature of dielectric used between them.


Variable capacitor

1. Variable Capacitors:

In variable capacitors, the value of capacitance can be increased or decreased. In these capacitors some arrangements are made to change the area of the plates facing each other. It is generally a combination of many capacitors with air as dielectric.

Construction:

It consists of two sets of plates one set remains fixed while other set can rotate so the distance between the plates does not change and they do not touch each other. The common area of the plates of two sets which faces each other determines the value of capacitance. Hence capacitance of the capacitor can be increased or decreased by turning the rotatable plates in or out of the space between the static plates.

Use: Such capacitors are usually utilized for tuning in radio sets.

2. Fixed Capacitor:

"If the plates of the capacitor are immoveable then such capacitors are called fixed capacitors. The capacitance of such capacitor cannot be changed".

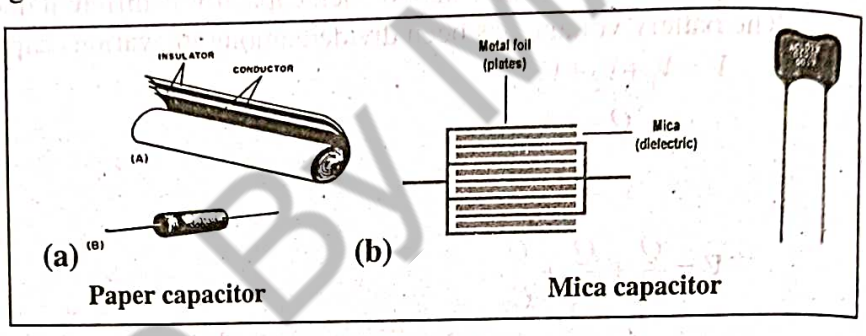
Types:

(i) Paper Capacitors:

Paper capacitor is an example of fixed capacitor.

Construction:

It has a cylindrical shape. Usually an oiled or greased paper or a thin plastic sheet is used as a dielectric between two aluminum foils. The paper or plastic sheet is firmly rolled in the form of a cylinder and is then enclosed into the plastic case.



Paper capacitor Mica capacitor

(ii) Mica Capacitors:

Mica capacitor is another example of fixed capacitor.

Construction:

In these capacitors mica is used as a dielectric between the two metal plates. It is enclosed in a plastic case, or in a case of some insulator for safety and convenience. Wires attached to plates project out of the case for making connection. If the capacitance is to be increased, large number of plates is piled up, one over the other with layers of dielectric in between and alternative plates are connected with each other.

(iii) Parallel Plate Capacitor:

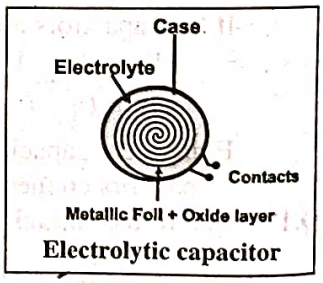
Parallel plate capacitor has a dielectric between its plates and is made of a flexible material that can be rolled into the shape of cylinder. We can increase the area of each plate while the capacitor can fit into a small space.

(iv) Electrolytic Capacitor:

Electrolytic capacitors are used to store large amount of charge at relatively low voltages.

Construction:

It consists of a metal foil in contact with an electrolyte (a solution that conducts charge due to motion of the ions contained in it. When voltage is applied between the foil and the electrolyte, a thin layer of metal oxide (an insulation) is formed on the foil, and this layer serves as a dielectric.



Electrolytic capacitor

Q.18 Write the uses of capacitors. **(OR)**

101113018

Write two uses of capacitors. **(OR)**

Enlist some uses of capacitors.

Ans. Uses of Capacitors:

Capacitors have wide range of applications in different fields.

(i) Capacitors are used in different electrical and electronic circuits. For example, they are used for tuning transmitters, receivers and transistor radios.

(ii) Capacitors are also used for table fans, ceiling fans, exhaust fans, fan motors in air conditioners, coolers, motors of washing machines, and in many appliances for their smooth working.

(iii) Capacitors are also used in electronic circuits of computers.

(iv) Capacitors can be used to differentiate between high frequency and low frequency signals which make them useful in electronic circuits.

(v) Capacitors are used in the resonant circuits that tune radios to particular frequencies. Such circuits are called **filter circuits**.

(vi) Ceramic capacitors are superior to other types and therefore can be used in vast ranges of application.

Q.19 Which capacitor is superior to other? OR What is Ceramic Capacitors. 101113019

Ans. Ceramic capacitors are generally superior to other types and can be used in vast ranges of applications. Ceramic capacitors has ceramic materials as dielectric.

Q.20 What are the applications of electrostatics? Explain. 101113020

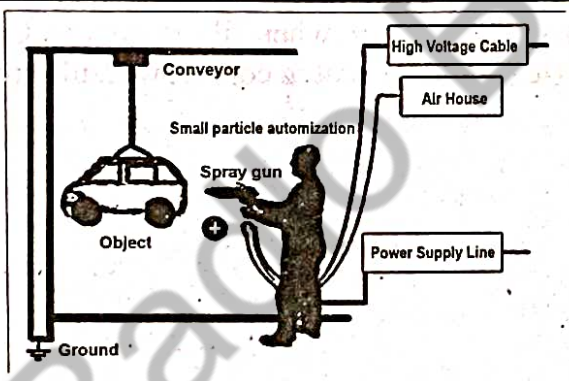
OR

Discuss one application of static electricity.

Ans. Static electricity has importance in our daily life, which includes photocopying, car painting, extraction of dust from carpets and from chimneys of industries.

1. Spray Painting:

Automobile manufacturers use static electricity to paint new cars. The body of car is charged and then paint is given the opposite charge by charging the nozzle of sprayer. Due to mutual repulsion charge particles coming out of the nozzle form a fine mist and are evenly distributed on the surface of the object. The charged

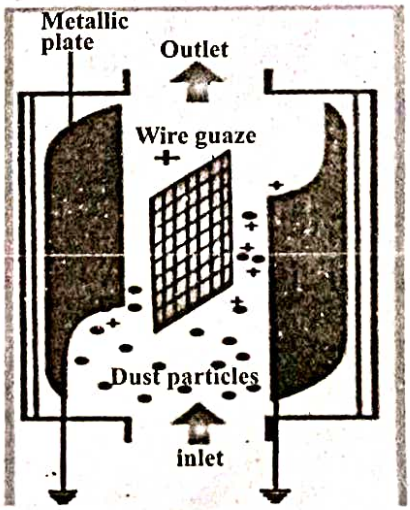


Schematic diagram of electrostatic spray painting system.

paint particles are attracted to the car and stick to the body, just like a charged balloon sticks to a wall. Once the paint dries; it sticks better to the car and is smoother because it is uniformly distributed. This is very effective, efficient and economical way of painting automobiles on large scale.

2. Electrostatic Air Cleaner:

It is used in homes to relieve the discomfort of allergy sufferers. Air mixed with dust and pollen enters the device across a positively charged mesh screen. The airborne particles become positively charged when they make contact with the screen. They pass through a second, negatively charged mesh screen. The electrostatic force of attraction between the positively charged particles in the air and negatively charged screen causes the particles to precipitate out on the surface of the screen. Through this process we can remove a very high percentage of contaminants from the air stream.



Q.21 What are the hazards of static electricity?

Ans.

(a) Lightning

The phenomenon of lightning occurs due to a large quantity of electric charge which builds up in the heavy thunderclouds. The thunderclouds are charged by friction between the water molecules and the air molecules. When thunderclouds charge becomes sufficiently high, it can produce positive and negative charges in the air. The huge amount of charge is discharged to the highest object on the ground and can harm them.

This explains why it is very dangerous to swim in the open sea, play in an open field or hide under a tree during a thunderstorm.

Prevention from lightning

To prevent lightning from damaging tall building, lightning conductors are used. The purpose of the lightning conductor is to provide a steady discharge path for the large amount of negative charge in the air to flow from the top of the building to the Earth. In this way, the chances of lightning damage due to sudden discharge can be minimized.

(b) Fires or Explosions:

Static electricity is a major cause of fires or explosions at many places, A fire or an explosion may occur due to excessive build up of electric charges produced by friction. Static electricity can be generated by the friction of gasoline being pumped into a vehicle or container. If static charges are allowed to discharge through the areas where there is petrol vapours a fire can occur. Portable oil containers can build up a static electric charge during transport. When the container is not placed on the ground for filling, its static electricity could be discharged and result in fire when filling begins. Containers should be placed on the ground during filling and the nozzle should be kept in contact with the containers. Containers should not be filled while inside a vehicle.

Multiple Choice Questions

Choose the correct answer from the following choices.

Exercise MCQs

1. A positive electric charge: 101113022

(a) Attracts other positive charge
(b) Repels other positive charge
(c) Attracts a neutral charge
(d) Repels a neutral charge

2. An object gains excess negative charge after being rubbed against another object, which is: 101113023

(a) neutral
(b) negatively charged
(c) positively charged
(d) either, a, b or c

3. Two uncharged objects A and B are rubbed against each other. When object B is placed near a negatively charged object C, the two objects repel each other. Which of these statements is true about object A. 101113024

(a) remains uncharged
(b) becomes positively charged
(c) becomes negatively charged
(d) unpredictable

4. When you rub a plastic rod against your hair several times and put it near some bits of paper, the pieces of papers are attracted towards it. What does this observation indicate? 101113025

(a) the rod and the paper are oppositely charged
(b) the rod acquires a positive charge
(c) the rod and the paper have the same charges
(d) the rod acquires a negative charge

5. According to Coulomb's law, what happens to the attraction of two oppositely charged objects as their distance of separation increases? 101113026

(a) increases
(b) decreases
(c) remains unchanged
(d) can not be determined

6. The Coulomb's law is valid for the charges which are: 101113027

(a) moving and point charges
(b) moving and non-point charges
(c) stationary and point charges
(d) stationary and large size charges

7. A positive and a negative charge are initially 4 cm apart. When they are moved closer together so that they are now only 1cm apart, the force between them is: 101113028

(a) 4 times smaller than before
(b) 4 times larger than before
(c) 8 times larger than before
(d) 16 times larger than before

8. Five joules of work is needed to shift 10 C of charge from one place to another. The potential difference between the places is: (F.B. 2014) 101113029

(a) 0.5 V (b) 2 V
(c) 5 V (d) 10 V

9. Two charged spheres are separated by 2 mm. Which of the following would produce the greatest attractive force? (F.B. 2017) 101113030

(a) +1q and +4q (b) –1q and –4q
(c) +2q and +2q (d) +2q and –2q

10. Electric field lines 101113031

(a) always cross each other
(b) never cross each other
(c) cross each other in the region of strong field
(d) cross each other in the region of weak field

11. Capacitance is defined as: (F.B. 2016,17) 101113032

(a) VC (b) Q/V
(c) QV (d) V/Q

Additional MCQs

12. One micro coulomb charge is equal to:

(a) $10^{-3}C$ (b) $10^{3}C$ 101113033
(c) $10^{6}C$ (d) $10^{-6}C$

13. In SI the unit of charge is: 101113034

(a) Joule (b) Volt
(c) Coulomb (d) Watt

14. One coulomb is equal to charge of electrons. 101113035

(a) 6.25×10^{-19} (b) 6.25×10^{19}
(c) 6.25×10^{18} (d) 6.25×10^{-18}

15. If we double the distance between two charges, then columns force becomes: (F.B 2018) 101113036

(a) increase 4 times (b) decrease 4 times
(c) increase 2 times (d) decrease 2 times

16. The electrostatic force acting on two charges each of 1C separated by 1m is about: 101113037

(a) $9\times10^{9}N$ (b) $9\times10^{-9}N$

(c) $9\times10^{8}N$ (d) $9\times10^{-8}N$

17. Formula for electric potential is: 101113038

(a) $v=\frac{q}{w}$ (b) $v=\frac{w}{q}$

(c) $v=wq$ (d) $v=c/q$

18. The symbol used for capacitor is: 101113039

(a)  (b) 

(c)  (d) 

19. Big unit of capacitance is: 101113040

(a) Farad (b) Volt

(c) Watt (d) Coulomb

20. 1 nano Farad is equal to: 101113041

(a) $1\times10^{-12}F$ (b) $1\times10^{9}F$

(c) $1\times10^{-9}F$ (d) $1\times10^{-6}F$

21. 1 Pico Farad is equal to: 101113042

(a) $10^{-9}F$ (b) $10^{12}F$ (F.B 2018)

(c) 10^{-12} F (d) $10^{-6}F$

22. SI unit of electric intensity is: 101113043

(a) watt (b) NC^{-1}

(c) NS^{-1} (d) Nm

23. Electric intensity is a quantity: 101113044

(a) Scalar (b) Vector

(c) Base (d) None

24. Electric potential is a quantity: 101113045

(a) Scalar (b) Vector

(c) Base (d) All

25. SI unit of electric potential is: 101113046

(a) Watt (b) Volt

(c) Coulomb (d) Joule

26. 1 volt is equal to: 101113047

(a) JC (b) JC^{-1}

(c) JC^{-2} (d) JC^{-3}

27. SI unit of capacitance is: (F.B. 2014) 101113048

(a) Joule (b) Volt

(c) Watt (d) Farad

28. 1 μF = 101113049

(a) 10^{-6} F (b) 10^{-5} F

(c) 10^{-9} F (d) 10^{-10} F

29. Three capacitors of capacitance of 3μF, 4μF, and 5μF are connected in parallel. Its equivalent capacitance is: 101113050

(a) 10μF (b) 12μF

(c) 15μF (d) 20μF

30. Give the number of factors which affect the ability of a capacitor to store charge. 101113051

(a) 2 (b) 3

(c) 4 (d) 5

31. The value of K in SI unit is: 101113052

(a) $9\times10^{20}\ Nm^2C^{-2}$

(b) $8\times10^{9}\ Nm^2C^{-2}$

(c) $9\times10^{9}\ Nm^2C^{-2}$

(d) $10\times10^{-9}\ Nm^2C^{-2}$

32. To protect the gold leaves of electroscope from the external electric disturbances, the aluminium foil is grounded by a thin wire, which is made up of 101113053

(a) Aluminium (b) Silver

(c) Copper (d) Brass

33. Capacitors are used to store: 101113054

(a) Current (b) Voltage

(c) Charge (d) Resistance

34. Electroscope is used for detecting. 101113055

(a) Current (b) Charge

(c) Voltage (d) Resistance

35. If the distance between two point charges is reduced to half, the Coulomb's force becomes: 101113056

(a) half (b) two times

(c) one fourth (d) four times

36. If the distance between the charged bodies is much greater as compared to their sizes then the bodies are considered as: 101113057

(a) positive charge

(b) negative charge

(c) point charge

(d) zero charge

37. If capacitors of 3μF and 6μF are connected in series then their equivalent capacitance is: 101113058

(a) 9μF (b) 2μF

(c) 12μF (d) 18μF

38. Positive charge can be produced by: 101113059

(a) combing in hair

(b) rubbing glass rod on silk

(c) by rubbing ebonite rod on wool

(d) by rubbing glass rod wool

39. If a neutral body brought near to the electroscope its leaves: 101113060
(a) diverge
(b) contract
(c) shut
(d) remain in normal position

40. If the field is stronger than lines of force are to each other: 101113061
(a) far away (b) separated
(c) closer (d) no effect

41. If the potential energy of one coulomb charge is one joule then its potential will be:
(a) 5 volt (b) 2 volt 101113062
(c) 3 volt (d) 1 volt

42. The product of charge 'q' and potential difference is equal to: 101113063
(a) power (b) force
(c) capacitance (d) energy

43. The capacitance of capacitor by joining them in parallel is: 101113064
(a) increased (b) much less
(c) decrease (d) no change

44. Two opposite charges of 500μc and 100μc are placed at a distance of 0.5m then force of attraction between them is: 101113065
(a) 1850 N (b) 1900 N
(c) 1800 N (d) 1880 N

45. When a positive charge of 2 coulombs is placed at a point in an electric field, it experiences a force of 6N. The intensity of electric field at this point is: 101113066
(a) 6 NC^{-1} (b) 3 NC^{-1}
(c) 12 NC^{-1} (d) 1.5 NC^{-1}

46. In electrostatic all charges are in: 101113067
(a) the same direction
(b) opposite direction
(c) motion
(d) static state

47. 1μC = 101113068
(a) $10^{-6}C$ (b) $10^{-12}C$
(c) $10^{-10}C$ (d) $10^{-11}C$

48. Which type of capacitor is cylindrical in shape? 101113069
(a) paper capacitor
(b) mica capacitor
(c) variable capacitor
(d) plates capacitor

49. Each volt of lightning contains energy: 101113070
(a) 4×10^6 joules (b) 1000 joules
(c) 1000 million joules (d) 10 joules

50. Capacitors that are used in resonant circuits that tune radios to particular frequencies, such circuits are called: 101113071
(a) series circuits (b) filter circuits
(c) parallel circuits (d) AC circuits

51. The capacitance of a parallel plate capacitor is 100 pF and the potential difference between its plate is 50 volts. What is the quantity of charge on its plates? 101113072
(a) 5000 C (b) 50 C
(c) 5 nC (d) 5 μC

52. If there is divergence of leaves by touching a body with electroscope then the body is: 101113073
(a) semi conductor (b) neutral
(c) charge body (d) insulator

53. In fixed capacitor dielectric used is:
(a) paper 101113074
(b) metal
(c) mica
(d) paper & mica

54. Instrument used for detecting and testing the nature of charge on a body is called: 101113075
(a) incubator (b) spectroscope
(c) voltmeter (d) electroscope

55. The phenomena used in capacitor is:
(a) electrostatic induction 101113076
(b) induced current
(c) electric field
(d) electroscope

56. The phenomena which is used in applying paints on the surface of different articles is called: 101113077
(a) electroplating
(b) electroscope
(c) electrostatic induction
(d) electrolytes

57. The substance in which electric current flows easily is called: 101113078
(a) transistor (b) semi conductor
(c) insulator (d) conductor

58. Study of charges at rest is called: 101113079
(a) acoustics (b) electrostatics
(c) electronics (d) electricity

59. Coulomb's force is given by: 101113080
(a) $F = k$ (b) $F = k\, q_1 q_2$
(c) $F = kq_1\, q_2 r^2$ (d) $F = \frac{kq_1q_2}{r^2}$

60. Electroscope can also be charged by the process of: 101113081

(a) electrostatics (b) electricity
(c) convection (d) conduction

61. F = 101113082

(a) qE (b) q – E
(c) q/E (d) q + E

62. Electric field is weak when: 101113083

(a) lines are far apart
(b) lines are close together
(c) no lines are present
(d) lines are directed outside

63. Which is a major cause of fires and explosions at many places? 101113084

(a) match sticks
(b) bombs
(c) static electricity
(d) magnetism

64. Which can be used to distinguish between insulators and conductors? 101113085

(a) electricity (b) telescope
(c) temperature (d) electroscope

65. An electrolytic capacitor is used to store large amounts of charge at: 101113086

(a) low voltage (b) high voltage
(c) neutral (d) positive

66. Parallel plate consists of 2 metal plates separated by: 101113087

(a) conductor (b) insulator
(c) wooden plate (d) plastic foam

67. The insulator between the plates of capacitor is called: 101113088

(a) dielectric (b) capacitance
(c) resistivity (d) permitivity

68. Which device is used to store charge? 101113089

(a) resistor (b) capacitor
(c) dielectric (d) fuse

69. In series combination of capacitors, each capacitor will have same: 101113090

(a) voltage
(b) charge
(c) capacitance
(d) charge and voltage

70. One joule per coulomb is called: 101113091

(a) volt (b) farad
(c) ampere (d) tesla

71. Which is the unit of energy? 101113092

(a) KWh
(b) Electron Volt
(c) Joule
(d) All of above

72. Application of electrostatic is: 101113093

(a) Car painting
(b) Photocopying
(c) Extracting of dust
(d) All of these

73. Which process is invovled to store charge in capacitors? 101113094

(a) Rubbing
(b) Electrostatic induction
(c) Conduction
(d) Electromagnetic induction

74. The presence of fish by the other fish can be detected by 101113095

(a) Magnetic field
(b) Electric field
(c) Gravitational field
(d) All of above

75. 1.6×10^{-19} J= 101113096

(a) 1F (b) 1C
(c) 1N (d) 1eV

76. The direction of electric field lines due to positive charge is: 101113097

(a) Away from the charge
(b) Towards the charge
(c) Both a and b
(d) None of these

77. A capacitor stores 0.24 coulombs at 10 volts. It capacitance is: 101113098

(a) 0.024F (b) 0.12F
(c) 0.6F (d) 0.8F

78. If three 15μF capacitors are connected in series, the net capacitance is: 101113099

(a) 5μF (b) 45μF
(c) 30μF (d) 50μF

79. A dielectric must be: 101113100

(a) resistor
(b) insulator
(c) good conductor
(d) semi conductor

80. A paper capacitor is usually available in the form of: 101113101

(a) tubes (b) rolled foil
(c) disc (d) plates

81. Capacitors are mainly used for radio frequency tuning: 101113102

(a) Paper Capacitor
(b) Air Capacitor
(c) Mica Capacitor
(d) Electrolytic Capacitor

82. A unit of electric charge, euqal to the charge of 6.25×10^{18} electrons is: 101113103

(a) Electricity (b) Coulomb
(c) Electric potential (d) Volt

83. The electric potential energy per unit charge is called: 101113104

(a) Electric field
(b) Electric potential
(c) Electric intensity
(d) All of above

84. The substances which do not have free electrons are called: 101113105

(a) Insulators (b) Conductors
(c) Semiconductors (d) None of these

85. If a dielectric medium is present between two point charges then electrostatic force will be: 101113106

(a) Increased (b) Decreased
(c) Vanishes (d) Remain same

Answer Key

1.	b	2.	b	3.	b	4.	d	5.	b	6.	c	7.	d
8.	a	9.	d	10.	b	11.	b	12.	d	13.	c	14.	c
15.	b	16.	a	17.	b	18.	d	19.	a	20.	c	21.	c
22.	b	23.	b	24.	a	25.	b	26.	b	27.	d	28.	a
29.	b	30.	b	31.	c	32.	c	33.	c	34.	b	35.	d
36.	c	37.	b	38.	b	39.	d	40.	c	41.	d	42.	d
43.	a	44.	c	45.	b	46.	d	47.	a	48.	a	49.	c
50.	b	51.	c	52.	c	53.	d	54.	d	55.	a	56.	c
57.	d	58.	b	59.	d	60.	d	61.	a	62.	a	63.	c
64.	d	65.	a	66.	b	67.	a	68.	b	69.	b	70.	a
71.	d	72.	d	73.	b	74.	b	75.	d	76.	a	77.	a
78.	a	79.	b	80.	b	81.	b	82.	b	83.	b	84.	a
85.	b												

Review Questions

Q13.1 How can you show by simple experiments that there are two types of electric charges? 101113107

Ans. See Q# 2 on Pg # 86

Q13.2 Describe the method of charging bodies by electrostatic induction. 101113108

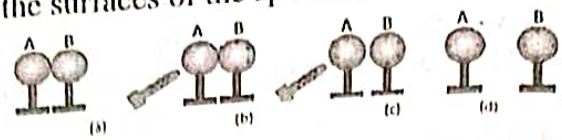
Ans. See Q# 4 on Pg# 87

Q13.3 How does electrostatic induction differ from charging by friction. 101113109

Ans.

Charging by friction	Charging by Electrostatic Induction
• During the process of charging by friction, we rub a neutral body with another neutral body.	• In the process of electrostatic induction, we charge a conductor without making any contact with the charged body.
• Bodies acquire the charges during rubbing process. When a neutral body is rubbed with another neutral body, transfer of charge take place. The body that gains electrons become negatively charged body and the body that loses electron becomes positively charged body.	• In electrostatic induction a charged body is brought near a neutral body, opposite charges appear at one end and same charges appear at the other end of neutral body
• When we run plastic comb through our hair, the electrons from hair shifted to the comb. The comb become negatively charged body and hair become positively charged body.	• Bring two metal spheres A and B and first them on insulted stand such that they touch each other.
• Friction also produces charges e.g. When we walk across a carpet, the friction between the carpet and person's shoes produces a charge on the bodies.	• Now bring a positively charged rod near sphere A, rod will attract the negative charge and will repel positive charge. Negative charge will appear on the left surface of sphere A positive charge will appear on the right surface of the sphere B. Now separate the spheres while the

rod is still near the sphere A. After removing the rod, the charges are uniformly distributed over the surfaces of the spheres.



Charging a neutral sphere by electrostatic induction

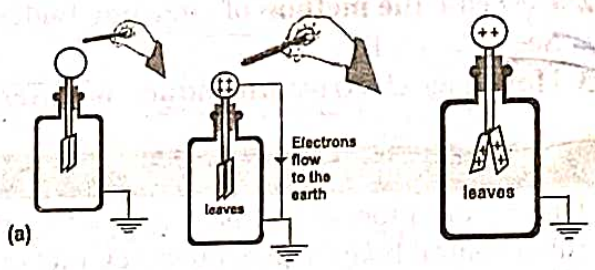
- This process in which an equal and opposite charge appear on each sphere is called charging by induction.

Q.13.4 What is gold leaf electroscope? Discuss its working principle with a labelled diagram. 101113110

Ans. See Q#5 on Pg# 87

Q13.5 Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe how would you charge the electroscope (i) negatively (ii) Positively (F.B. 2016) 101113111

Ans.

(i) Negatively charged electroscope.	(ii) Positively charged electroscope
Electroscope can be charged negatively with the help of a positively charged rod that is glass rod rubbed with wool. A positive charged rod is brought close to the electroscope. Electrons on the electroscope are attracted to the positive rod and move towards the disk. This makes the leaves positively charged and diverged from its position. A ground wire is attached to the electroscope. Some electrons move onto the positively charged part of the electroscope from the ground through the ground wire. The electrons distribute themselves over the electroscope. The ground wire is removed from the electroscope. Then remove the positive rod, the electrons redistribute themselves evenly over the electroscope. Now the electroscope is negatively charged. **(OR)** Electroscope can also be charged by the process of conduction. Touch a negatively charged rod with the disk of a neutral electroscope. Negative charge from the rod will transfer to the electroscope and will cause its leaves to diverge.	In order to produce positive charge on the electroscope, bring a negatively charged body near the disk of the electroscope, Positive charge will appear on the disk of electroscope while negative charge will shift to the leaves. Now connect the disk of electroscope to the earthed aluminum foil by a conducting wire. The electrons on the electroscope move away through the ground wire. Now if we first break the Earth connection and then removed the rod. The electroscope will be left with positive charge. 

Q.13.6 With the help of electroscope how can you find presence of charge on a body. 101113112

Ans. See Q.No.6 on Pg# 88

Q.13.7 Describe how you would determine the nature of the charge on a body by using electroscope. 101113113

Ans. See Q#8 Pg# 88

Q.13.8 Explain coulomb's law of electrostatics and write its mathematical form. 101113114

Ans. See Q#10 Pg# 89

Q.13.9 What is meant by electric field and electric intensity? 101113115

Ans. See Q#11 Pg# 89,90

Q.13.10 Is electric intensity a vector quantity? What will be its direction? 101113116

Ans. Electric intensity is a vector quantity. The direction of electric intensity is along the direction of force which acts on test charge. If a test charge get free in the electric field, it will move in the direction of electric intensity.

Q13.11 How would you define potential difference between two points? Define its unit. 101113117

Ans. Potential difference

Potential difference between two points is defined as:

"The energy supplied by a unit charge as it moves from one point to the other in the direction of the field."

Unit: Potential difference is a scalar quantity and its unit is volt. It is equal to Jc^{-1}.

Volt: *"If one Joule of work is done against the electric field in bringing one coulomb positive charge from infinity to a point in the electric field then the potential at that point will be one volt."*

Q13.12. Show that potential difference can be described as energy transfer per unit charge between two points. 101113118

Ans.

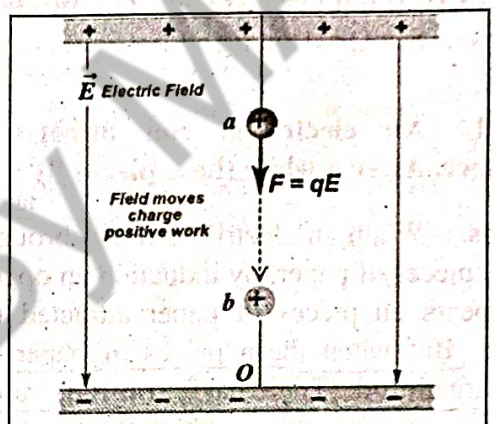
Potential difference as energy transfer:

In gravitational field, a body always tend to move from a point of higher potential energy to a point of lower potential energy. If the potential of point 'a' is V_a and that of point 'b' is V_b, the potential energy of charge will be qV_a and qV_b respectively. The change in potential energy would be $qV_a - qV_b$. This energy is used in doing some useful work. Therefore,

Energy supplied by the charge $= qV_a - qV_b$

$$= q(V_a - V_b)$$

If 'q' is equal to one unit, then the potential difference between two points becomes equal to energy supplied by the charge.



Potential difference between two points.

Q13.13 What do you mean by the capacitance of a capacitor? Define units of capacitance. 101113119

Ans. Capacitance:

It is defined as the ability of the capacitor to store charge. It is given by the ratio of charge and electric potential.

$$C = \frac{Q}{V}$$

'C' is the capacitance of capacitor.

Unit of Capacitance:

SI unit of capacitance is farad. It is defined as:

"If one coulomb of charge is given to the plates of a capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance would be one farad."

$$1F = \frac{1C}{1V}$$

Or

$$1F = 1CV^{-1}$$

Q.13.14 Derive the formula for the equivalent capacitance for a series combination of a number of capacitors. 101113120

Ans. See Q#16 on Pg# 93

Q.13.15 Discuss different types of capacitors. 101113121

Ans. See Q#17 on Pg# 93,94

Q.13.16 What is difference between fixed and variable capacitors. 101113122

Ans.

Fixed Capacitor	Variable Capacitor
If the plates of the capacitor are immoveable then such capacitors are called fixed capacitors. The capacitance of such capacitor cannot be changed	In variable capacitors, the value of capacitance can be increased or decreased. In these capacitors some arrangements are made to change the area of the plates facing each other. It is generally a combination of many capacitors with air as dielectric

Q.13.17 Enlist some uses of capacitors. 101113123

Ans. See Q#18 on Pg # 94

Q.13.18 Discuss one application of static electricity. 101113124

Ans. See Q#20 on Pg # 95

Q.13.19 What are hazards of static electricity? 101113125

Ans. See Q#21 on Pg # 96

Conceptual Questions

Q.1 An electrified rod attracts pieces of paper. After a while these pieces fly away! Why? 101113126

Ans. When an electrified rod is brought closer to the pieces of paper, by induction an opposite charge appears on pieces of paper attracted towards the rod. But when these pieces of paper touches the charged rod. The charge of rod transfer to the pieces of paper due to which there will be the force of repulsion between rod and pieces of paper, hence the pieces of paper fly away from the rod.

Q.2 How much negative charge has been removed from a positively charged electroscope, if it has a charge of 7.5×10^{-11} C? 101113127

Ans. Charge = q = 7.5×10^{-11} C

Charge on one electron = 1.6×10^{-19} C

No. of electron removed

n = ?

q = ne

$n = \frac{q}{e}$

$= \frac{7.5 \times 10^{-11}}{1.6 \times 10^{-19}}$

$n = 4.7 \times 10^{8}$

Result: 4.7×10^{8} amount of negative charge will be removed from electroscope.

Q.3 In what direction will a positively charged particle move in an electric field? 101113128

Ans. In an electric field a positive charge will move from a point of higher potential to the point of lower potential.

Q.4 Does each capacitor carry equal charge in series combination? Explain. (F.B. 2017, 18) 101113129

Ans. Each capacitor has the same charge across each capacitor in series combination if battery supplies +Q charge to the left plate of the capacitor C_1, due to induction '–Q'. Charge is induced on its right plate and +Q charge on the left plate of the capacitor i.e. on each plate of capacitor charge is same.

Q.5 Each capacitor in parallel combination has equal potential difference between its two plates. Justify the statement. 101113130

Ans. Each capacitor carries equal potential because each plate of capacitor is individually connected to the same battery.

Perhaps you have seen a gasoline truck trailing a metal chain beneath it. What purpose does the chain serve? 101113131

Ans. The metal chain beneath the Gasoline truck is attached so that the charge arises due to air friction may be grounded.

Q.6 If a high-voltage power line fell across your car while you were in the car, why should you not come out of the car? (F.B. 2018) 101113132

Ans. When a high voltage power line fell across our car, we are advised not to come out of the car because during coming out of the car there may arise a potential difference which results in a severe electric shock.

Q.7 Explain why, a glass rod can be charged by rubbing when held by hand but an iron rod

cannot be charged by rubbing, if held by hand? 101113133

Ans. The bonding of glass rod is weaker than iron rod so electrons from glass rod are easily transferred to our hands. That's why glass rod becomes charged.

Additional Short Questions

Q.8 What are the factors which affects the ability of a capacitor to store charge?

Or (F.B. 2016)

On what fact does the capacitance of capacitor depends? (F.B. 2015) 101113134

Ans.
(i) Size of plates of the capacitor
(ii) Distance between the plates of capacitor.
(iii) Type of insulator used between the plates.

Q.9 Define static electricity. 101113135

Ans. Study of charges at rest is called electrostatics or static electricity.

Q.10 Define electrostatic induction. 101113136

Ans. If in the presence of a charged body, an insulated conductor develops positive charge at one end and negative charge at the other end, this process is called the electrostatic induction.

Q.11 What is an electroscope?

(OR) 101113137

Define electroscope. Describe its construction.

Ans. Electroscope:

The gold leaf electroscope is sensitive instrument for detecting charges.

Construction:

It consists of a brass rod with brass disk on the top and two thin leaves of gold foil hanging at bottom. The rod passes through an insulator that keeps the rod in place and also retain the charges. Charges can move freely from the disk to the leaves through that rod. A thin aluminum foil is attached on the lower part inside the jar. Aluminum foil is grounded with the help of copper wire.

Q.12 State the Coulomb's Law. 101113138

Ans. The force of attraction or repulsion between two point charges is directly proportional to the product of the quantity of charges and inversely proportional to the square of the distance between them".

$$F = K\frac{q_1 q_2}{r^2}$$

Q.13 Define electric field. 101113139

Ans. The electric field is a region around a charge in which it exerts electrostatic force on another charges.

Q.14 Define electric Intensity and write its unit. 101113140

Ans. The force acting on a unit positive charge placed at a point. Its SI unit is NC^{-1}.

$$E = \frac{F}{q}$$

Q.15 Define electric lines of force. Who introduced them? 101113141

Ans. The direction of electric field intensity in an electric field can also be represented by drawing lines. These lines are known as electric lines of force.

It was first introduced by Micheal Faraday.

Q.16 Define electric potential. 101113142

Ans. Electric potential at a point in an electric field is equal to the amount of work done in bringing a unit positive charge from infinity to that point.

$$V = \frac{W}{q}$$

Q.17 Define potential difference. 101113143

Ans. The energy supplied by the unit charge as it moves from one point to the other in the direction of the field. $E = q(V_a - V_b)$

Q.18 What is meant by dielectric? 101113144

Ans. The medium between the two plates of capacitor is air or a sheet or some insulator is called dielectric.

Q.19 What is capacitor and capacitance? State its SI unit. 101113145

Ans. In order to store charge, a device is used called capacitor.

Capacitance: It is the ability of the capacitor to store charge.

Farad: A capacitor has capacitance of one farad for a charge of one columb will give the plates a potential difference of one volt. Its SI unit is 'farad'.

Q.20 What is meant by point charge? 101113146

Ans.

Point Charge:

If the distance between two charges is much greater as compared to their size then these bodies are considered as point charge.

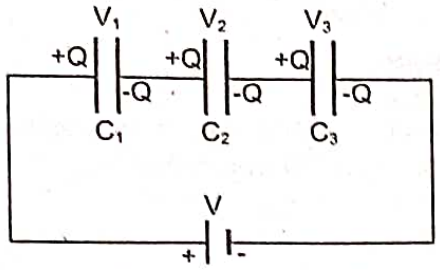
Q.21 Write the formula of parallel combination of capacitor. 101113147

Ans: Formula for parallel combination of capacitor is:

$$C_{eq} = C_1 + C_2 + C_3 \ldots\ldots + C_n$$

Q.29 Connect three capacitors in series and draw their circuit diagrams. 101113148

Ans.



capacitors in series combination

Q.30 What is the difference between capacitors and dielectric? 101113149

Ans.

Capacitor	Dielectric
Capacitor is an electric device which is used to store electric charge for a long period of time.	The medium between two plates of capacitors is known as dielectric. This medium is air or sheet or some insulating material.

Q.32 Write the names of different types of capacitors? 101113150

Ans.
i) Paper capacitor
ii) Mica capacitor
iii) Parallel plate capacitor
iv) Electrolytic capacitor

Q.33 Static electricity is a major cause of fires and explosions at many places. Describe briefly. 101113151

Ans. A fire or an explosion may occur due to excessive build up of electric charges produced by friction. Static electricity can be generated by the friction of gasoline being pumped into a vehicle or container. If static charges are allowed to discharge through the areas where there is petrol vapours a fire can occur. Portable oil containers can build up a static electric charge during transport. When the container is not placed on the ground for filling, its static electricity could be discharged and result in fire when filling begins. Containers should be placed on the ground during filling and the nozzle should be kept in contact with the containers. Containers should not be filled while inside a vehicle.

Q.35 What do you mean by electrolytic capacitor? 101113152

Ans. Electrolytic Capacitor:
Electrolytic capacitors are used to store large amount of charge at relatively low voltages.

Construction: It consists of a metal foil in contact with an electrolyte (a solution that conducts charge due to motion of the ions contained in it. When voltage is applied between the foil and the electrolyte, a thin layer of metal oxide (an insulation) is formed on the foil, and this layer serves as a dielectric very large capacitors can be attained because the dielectric layer is very thin.

Q.36 What is a mica capacitor? 101113153

Ans. Mica Capacitors:
Mica capacitor is another example of fixed capacitor.

Construction:
In these capacitors mica is used as a dielectric between the two metal plates. It is enclosed in a plastic case, or in a case of some insulator for safety and convenience. Wires attached to plates project out of the case for making connection. If the capacitance is to be increased, large number of plates is piled up, one over the other with layers of dielectric in between and alternative plates are connected with each other.

Q.37 What is electrostatic air cleaner? (F.B. 2014) 101113154

Ans. Electrostatic Air Cleaner:
It is used in homes to relieve the discomfort of allergy sufferers. Air mixed with dust and pollen enters the device across a positively charged mesh screen. The airborne particles become positively charged when they make contact with the screen. They pass through a second, negatively charged mesh screen. The electrostatic force of attraction between the positively charged particles in the air and negatively charged screen causes the particles to precipitate out on the surface of the screen. Through this process we can remove a very high percentage of contaminants from the air stream.

Q.38 Define Farad. 101113155

Ans. Unit of capacitance:
The unit of capacitance is **'farad'** and is defined as *"If one coulomb of charge given to the plates of capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance would be one Farad."*

Farad is a big unit, usually smaller units called **micro farad** and **pico farad** are used.

Q.39 What is the difference between gravitational potential and electric potential? 101113156

Ans. Gravitational Potential
The gravitational potential at a point in the gravitational field is the gravitational potential energy of a unit mass placed at that point.

Electric Potential

The electric potential at any point in the electric field is the electric potential energy of a unit positive charge placed at that point.

Q.40 How can electroscope be charged by conduction? 101113157

Ans. Electroscope can also be charged by the process of conduction. Touch a negatively charged rod with the disk of a neutral electroscope. Negative charge from the rod will transfer to the electroscope and cause its leaves to diverge.

Q.41 How many methods are there to charge a body? 101113158

Ans. A body can be charged by following methods.

(i) Charging by friction
(ii) Charging by conduction
(iii) Charging by Induction

Q.42. Why are lightning conductors used in tall building? (F.B. 2016) 101113159

Ans. To prevent lightning from damaging tall buildings, lightning conductors are used. The purpose of the lightning conductor is to provide a steady discharge path for the large amount of negative charge in air to flow from the top of the building to earth. In this way, the chances of lightning damage due to sudden discharge.

Q.43. Why is a metallic chain of a petrol supply tanker made to roll on the road? 101113160

Ans. Older fuel trucks were supplied with a chain to discharge static electricity. During the motion of vehicle due to air friction a powerful static charge is appeared on the chassis of the vehicle. To discharge the static charges from the vehicle, a metal chain is hanging down the fuel tanker to avoid any fire or explosions.

Q.44 On a dry day if we walk in a carpeted room and then touch some conductor we will get a small electric shock. Can you tell why does it happen? (F.B. 2014) 101113161

Ans. When we walk in a carpeted room, due to friction, static charges are appeared on both, the bodies. When we touch some conductor, a sudden transfer of charges happens resulting a small electric shock. This is usually happened in a dry and low humidity days.

Q.45 What is "Faraday cage"? How does it work? 101113162

Ans. A Farady cage is a metallic enclosure that prevents the entry of an electromagnetic field. For best performance, the cage should be directly connected to an earth ground. A Farady cage can protect against direct lightening strikes. When properly connected to earth ground, the cage conducts high current harmlessly to ground. A Farady cage is a hollow conductor, in which charge remains on the external surface of the cage.

Q.46 Why is it very dangerous to swing in the open sea, play in an open field or hide under a tree during a thunderstorm? 101113163

Ans. The thunderclouds are charged by friction between the water molecules and the air molecules. When thunderclouds charge becomes sufficiently high, it can produce positive and negative charges in the air. The huge amount of charge is discharged to the highest object on the ground and can harm them. That's why it is dangerous to swim in the open sea, play in an open field or hide under the tree during a thunderstorm.

Q.47 Rubber tyres get charged from friction with the road. What is the polarity of the charge? 101113164

Ans. Since the earth has zero potential so negative charge is shifted to earth due to which tyre of a car acquires positive charge. Friction is also the reason of removal of electrons which are loosely bounded.

Self Assessment

Q.48 Do you think amount of positive charge on the glass rod after rubbing it with silk cloth, will be equal to the amount of negative charge on the silk? Explain. 101113165

Ans. Charges can never be created nor destroyed during charging process. However it can be transferred from one body to another body in the form of electrons. So after rubbing, the overall charge on the system of two bodies is same. The amount of positive charge on the glass rod after rubbing it with silk cloth will be equal to the amount of negative charge on the silk.

Q.49 What would happen if a positively glass rod is brought near a neutral charged glass rod? 101113166

Ans. When a positively charged glass rod is brought near to the neutral glass rod. Then electron from the neutral glass rod will shift towards that end where the positively glass rod is brought. And positive charge will be at the other end of neutral glass rod. But the total charge on glass rod is still zero. In the presence of a charge body, an insulated conductor develops positive charge at one end and negative charge at the other end. This process is called electrostatic induction.

Q.50 What is the value of electrostatic force when two charges of one Coulomb are separated by one meter? 101113167

Ans. The electrostatic force acting on two charges each of 1C separated by 1 m is about 9×10^{9}N. This force is equal to the gravitational force that the Earth exerts on a billion kilogram object at sea level.

Q.51 Define coulomb, the unit of charge. 101113168

Ans. In SI, the unit of charge is coulomb (C). It is equal to the charge of 6.25×10^{18} electrons. This is very big unit. Usually charge is measured in micro coulomb. One micro coulomb is equal to 10^{-6}C.

Q.52 How potential energy and electric potential shift related with electric field. 101113169

Ans. Electric potential is a characteristic of field source charge and is independent of a test charge that may be placed in the field. But, potential energy is a characteristic of both the field and test charge. It is produced due to the interaction of the field and the test charge placed in the field.

Q.53 Who invented the first practical battery? 101113170

(OR) Who invented voltaic pile and when?

Ans. The volt is named after the Italian physicist **Alessandro Volta (1745-1827),** who developed the first practical electric battery, known as a **voltaic pile.** Because potential difference is measured in units of volts, it is sometimes referred to as voltage.

Q.54 What is the range of energy of lightning? 101113171

Ans. The energy in lightning is enough to crack bricks and stone in unprotected buildings, and destroy electrical equipments inside. Each bolt of lightning contains about 1000 million joules of energy! This energy is enough to boil a kettle continuously for about two weeks. A flash of lightning is brighter than 10^{7} light bulbs each of 100 watt.

Q.55 What is the danger of static electricity and how it can be avoided? 101113172

Ans. Static electricity can spark a fire or explosions. Care must be taken to avoid sparks when putting fuel in cars or aircraft. Spark may be produced due to friction between the fuel and the pipe. This can cause a serious explosion. The spark can be avoided if the pipe nozzle is made to conduct by connecting an earthing strap to it. The earthing strap connects the pipe to the ground.

Q.56 Why leaves of charged electroscope diverge if you touch its disk with a metal rod but they do not diverge if you touch the disk with a rubber rod? 101113173

Ans. Leaves of charged electroscope diverge in the presence of metal rod because metal rod carries charge on it and rubber rod is neutral that's why electroscope does not show any divergence.

Q.57 What is amount of force required to pull back the positive and negative charge, which is separated by a pencil point? 101113174

Ans. If you could separate the positive and negative charge in a pencil point, the force pulling the charge back together exceeds the weight of a billion trucks.

Q.58 If we double the distance between two charges, what will be the change in the force between the charges? 101113175

Ans. The force will become one-fourth, if we double the distance between the charges.

As,

$$F=\frac{kq_1q_2}{r^2} \quad \text{.... (i)}$$

If $r=2r$

$$F'=\frac{kq_1q_2}{(2r)^2}$$

$$F'=\frac{kq_1q_2}{4r^2}$$

$$F'=\frac{1}{4}\left(\frac{kq_1q_2}{r^2}\right)$$

$$F'=\frac{1}{4}F$$

Q.59 How much gravitational force would be equal to 9×10^{9} N electrostatic force? 101113176

Ans. The electrostatic force acting on two charges each of 1C separated by 1m about 9×10^{9} N. This force is equal to the gravitational force that the Earth exerts on a billion-kilogram object at sea level.

Q.60 Are electric field line physical entities? Justify your answer. 101113177

Ans. Electric field lines themselves are not physical entities. They are just used for pictorial representation of another physical quantity i.e. electric field at various position.

Q.61 Is voltage and potential difference considered as same quantity? (F.B. 2015) 101113178

Ans. A voltage across a device, such as capacitors has the same meaning as the potential

difference across the device. For instance, if we suppose that the voltage across a capacitor is 12 V, it also means that the potential difference between its plates is 12V.

Q.62 In which form capacitors stores energy between its plates? 101113179

Ans. Capacitor stores energy in an electric field between two plates in the form of electrostatic potential energy.

Q.63 How an aeroplane get charged and discharged? OR Why is some conducting material used in the tyres of aeroplane? 101113180

Ans. During flight, body of aeroplane gets charged. As the aeroplane lands, this charge is transferred to ground through the specially designed tyres, in which synthetic carbon is used.

Q.64 Is the equivalent capacitance of parallel capacitors larger or smaller than the capacitance of any individual capacitor in the combination? 101113181

Ans. Equivalent capacitors of parallel combination capacitors is larger than the capacitance of any individual capacitor in the combination.

Q.65 Is the equivalent capacitance of series capacitors larger or smaller than the capacitance of any individual capacitor in the combination? 101113182

Ans. Equivalent capacitors of series combination capacitors is smaller than the capacitance of any individual capacitor in the combination.

Q.66 Capacitors block DC but allow AC to pass through a circuit. How does this happen? 101113183

Ans. Direct current only flows in one direction and it will stop when the capacitor is fully charged. Current cannot flow in between the gap of the plates.

AC current switches polarity continuously. It does this faster than it takes the capacitor to fully charge. Before the capacitor is fully charged, the polarity is switched and the capacitor wants to change the polarity of the plates as well.

Solved Examples

13.1 Two bodies are oppositely charged with 500 μ C and 100 μ C. Find the force between the two charges if the distance between them in air is 0.5 m. 101113184

Given Data:

$q_1 = 500\ \mu C = 500 \times 10^{-6}$ C,

$q_2 = 100\ \mu C = 100 \times 10^{-6}$C,

Distance between charges= r = 0.5m

$K = 9\times10^9 Nm^2C^{-2}$

To Find: Force = F = ?

Calculation:

Substituting these values in equation of Coulomb's law, we have

According to Coulomb's Law

$$F = K\frac{q_1q_2}{r^2}$$

$$F = \frac{9\times10^9\times500\times10^{-6}\times100\times10^{-6}}{(0.5)^2}$$

$$= \frac{9\times5\times10^9\times10^2\times10^{-6}\times10^2\times10^{-6}}{0.5\times0.5}$$

$$= \frac{45\times10^{9+2-6+2-6}}{0.25}$$

$$= \frac{45\times10}{0.25}$$

$$F = 1800\ N$$

Result: The force between two charges is 1800N.

13.2 The capacitance of a parallel plate capacitor is 100 pF. If the potential difference between its plates is 50 Volts, find the quantity of charge that capacitor can store. What will be the charge on each plate? 101113185

Given that:

Potential difference = V = 50V

Capacitance: C = 100pF

$= 100 \times 10^{-12}$F.

To Find:

Charge = Q = ?

Calculation:

Using the formula $Q = CV$

Putting the Values $Q = 100 \times 10^{-12} \times 50$

$= 5 \times 10^{-9}$ C = 5nC

Result:

Charge on each plate will be 5 nC, because each plate has equal amount of charge.

13.3 Three capacitors with capacitances of 3.0 μF, 4.0 μF, and 5.0 μF are arranged in parallel

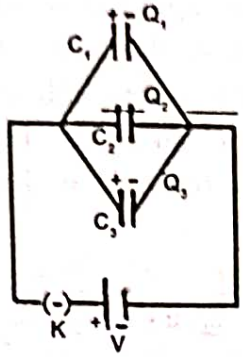
combination with a battery of 6V ($1\mu F = 10^{-6}F$). Find 101113186

(a) The total capacitance

(b) The voltage across the capacitors

(c) The quantity of charge on each plate of the capacitor

Calculation: Diagram is shown in



(a) Total capacitance is given by

$C_{eq} = C_1+C_2+C_3$

$C_{eq} = 3.0 + 4.0 + 5.0$

$C_{eq} = 12\ \mu F$

(b) As three capacitors are connected in parallel, the voltage across each capacitor will be same and is equal to the voltage of the battery i.e. 6V

(c) Charge on a capacitor with capacitance, C_1.

$Q_1 = C_1V$

$Q_1 = 3.0 \times 10^{-6} \times 6$

$Q_1 = 18\mu C$

$Q_2 = C_2V$

$= 4 \times 10^{-6} \times 6 = 24\ \mu C$

$Q_3 = C_3V$

$= 5 \times 10^{-6} \times 6 = 30\ \mu C$

Result: Equivalent capacitance is 12μF and charge on each capacitor is 18μC, 24μC, and 30μC.

13.4 Three capacitors with capacitances of 3.0 μF, 4.0 μF, and 5.0 μF are arranged in series combination to a battery of 6V ($1\mu F = 10^{-6}F$). Find. 101113187

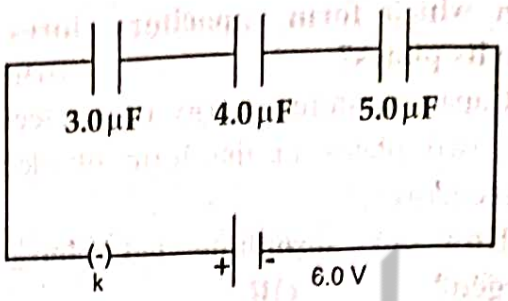
(a) The total capacitance of the series combination.

(b) The quantity of charge across each capacitor.

(c) The voltage across each capacitor (F.B. 2016)

Solution:

(a) For total capacitance.



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_{eq}} = \frac{1}{3} + \frac{1}{4} + \frac{1}{5}$$

$$\frac{1}{C_{eq}} = \frac{47}{60}$$

$$C_{eq} = 1.3\mu F$$

(b) In series combination, charge across each capacitor is same and can be found as:

$Q = VC$

$= (6)(1.3)$

$= 7.8\ \mu C$

(c). Voltage across capacitor C_1

$$V_1 = \frac{Q}{C_1} = \frac{7.8}{3.0} = 2.6V$$

Voltage across capacitor C_2

$$V_2 = \frac{Q}{C_2} = \frac{7.8}{4.0} = 1.95V$$

Voltage across capacitor C_3

$$V_3 = \frac{Q}{C_3} = \frac{7.8}{5.0} = 1.56V$$

Result: Equivalent capacitance is 1.3μF and charge on each capacitor is 7.8uC and voltage across each capacitor is 2.6V, 1.95V, and 1.56V.

Numerical Problems

13.1 The charge of how many negatively charged particles would be equal to 100 μ C. Assume that charge on one negative particle is 1.6×10^{-19} C? 101113188

Given Data:

Charge = q = 100 μ C = 100×10^{-6}C

Charge of one negative particle = e = 1.6×10^{-19} C

To Find:

No. of charge particles = n = ?

Calculation: As we know that

q = ne

$$n = \frac{q}{e} = \frac{100\times10^{-6}}{1.6\times10^{-19}}$$

$$= 62.5 \times 10^{13}$$

$$n = 6.25 \times 10^{14} \text{ Particles}$$

Result: 6.25×10^{14} charged particles would be equal to 100 μC.

13.2 Two point charges q_1 = 10μC and q_2 = 5μC are placed at a distance of 150 cm. Find the Coulomb's force between them. Also find the direction of this force? 101113189

Give data: (F.B. 2013)

$q_1 = 10\mu C = 10 \times 10^{-6} C$

$q_2 = 5\mu C = 5 \times 10^{-6} C$

$r = 150 \text{ cm} = 1.5 m$

$k = 9 \times 10^9 Nm^2C^{-2}$

To Find:

$F = ?$

Calculation: As we know that

$$F = K\frac{1}{4\pi\in_o}\frac{q_1q_2}{r^2}$$

Putting values we get.

$$F = \frac{(9\times10^9)\times5\times10^{-6}\times10\times10^{-6}}{(1.5)^2}$$

$$= \frac{9\times5\times10^{9-6+1-6}}{2.25} = \frac{45\times10^{-2}}{2.25}$$

$$= 0.2N$$

$F = 0.2$ N Ans.

Result: 0.2 N is force of repulsion between the two same charges. Its direction is away from the charge.

13.3 The force of repulsion between two identical positive charges is 0.8 N, when the charges are 0.1 m apart. Find the value of each charge. (F.B. 2017) 101113190

Given Data:

$F = 0.8N$

$d = 0.1m$

$k = 9 \times 10^9 Nm^2C^{-2}$

To Find:

$q_1 = q_2 = q = ?$

Calculation:

$$F = k\frac{q_1q_2}{d^2}$$

$$F = k\frac{q.q}{d^2}$$

$$0.8 = \frac{9\times10^9\times q^2}{(0.1)^2}$$

$$0.8 = \frac{9\times10^9\times q^2}{0.01}$$

$$\Rightarrow \frac{0.8\times0.01}{9\times10^9} = q^2$$

$$9.4\times10^{-7} C = q$$

Hence,

$$q = 9.4\times10^{-7} C \Rightarrow \begin{matrix} q_1 = 9.4\times10^{-7} C \\ q_2 = 9.4\times10^{-7} C \end{matrix}$$

Result: The value of charge on each identical positive charge is 9.4×10^{-7}C.

13.4 Two charges repel each other with a force of 0.1 N when they are 5cm apart. Find the forces between the same charges when they are 2 cm apart? 101113191

Given Data:

Force = F = 0.1 N

Separation = r_1 = 5cm = 0.05 m

Separation = r_2 = 2cm = 0.02 m

$K = 9\times10^9 Nm^2C^{-2}$

To Find:

$F' = ?$

Calculation:

We know that

$$F = \frac{Kq_1q_2}{r^2}$$

$$0.1 = \frac{Kq_1q_2}{(0.05)^2}$$

$$(0.1).(0.05)^2 = Kq_1q_2$$

Force F' when r = 0.02 m

We have

$$F' = \frac{Kq_1q_2}{r^2}$$

Putting the value of Kq_1q_2

$$F' = \frac{(0.1)(0.05)^2}{(0.02)^2}$$

$$= \frac{0.1\times0.05\times0.05}{0.02\times0.02}$$

$$F' = \frac{0.00025}{0.0004} = 0.625N$$

Result: Thus the force between the same charges when they are 2 cm apart will be 0.625 N.

13.5 The potential at a point in an electric field is 10^4 V. If a charge of + 100 μ C is brought from infinity to this point. What would be the amount of work done on it? 101113192

Given data:

Electric potential: $V = 10^4 V$

Charge = $q = +100\mu C = 100 \times 10^{-6} C = 10^{-4} C$

To Find:

Work done = $W = ?$

Calculation:

$$W = qV$$

$$W = 10^{-4} \times 10^4$$

$$= 10^{-4+4}$$

$$= 10^0 = 1$$

$$W = 1J$$

Result: Thus 1 J of work would be done to bring the charge from infinity to the point in electric filed.

13.6 A point charge of +2C is transferred from a point at potential 100V to a point at potential 50V, what would be the energy supplied by the charge? 101113193

Given data

Charge = $q = +2C$

Potential at point 'a' = $V_1 = 100V$

Potential at point 'b' = $V_2 = 50V$

To Find: energy supplied by the charge.

$W = ?$

Calculation:

$$W = q(V_1 - V_2)$$

$$W = 2(100 - 50)$$

$$W = 2(50)$$

$$W = 100J$$

Result: Thus, 100 J of energy would be supplied by the charge.

13.7 A capacitor holds 0.06 coulombs of charge when fully charged by a 9 volt battery. Calculate capacitance of the capacitor. 101113194

Given data:

Charge = $Q = 0.06C$

Voltage = $V = 9V$

To Find:

Capacitance = $C = ?$

Calculation:

$$Q = CV$$

$$C = \frac{Q}{V}$$

$$= \frac{0.06}{9}$$

$$C = 6.67 \times 10^{-3} F$$

Result: Thus the capacitance of the capacitor would be 6.67×10^{-3} F.

13.8 A capacitor holds 0.03 coulombs of charge when fully charged by a 6 volt battery. How much voltage would be required for it to hold 2 coulombs of charge? (F.B. 2015) 101113195

Given data:

$Q = 0.03C$

$V = 6V$

We know that

$Q = CV$

$$C = \frac{Q}{V} = \frac{0.03}{6}$$

$$C = 5 \times 10^{-3} F$$

To Find

Voltage required = $V' = ?$

(When Q=2C)

Calculation:

$$V' = \frac{Q}{C}$$

$$= \frac{2}{5 \times 10^{-3}}$$

$$V' = 0.4 \times 10^3$$

$$V' = 400V$$

Result: Thus 400V would be required to hold 2C charge.

13.9 Two capacitors of capacitances 6 μ F and 12 μ F are connected in series with 12V battery. Find the equivalent capacitance of the combination. Find the charge and the potential difference across each capacitor.

Given data: (F.B. 2017) 101113196

$C_1 = 6\mu F$

$C_2 = 12\mu F$

$V = 12$ volt

To Find:

(i) $C_e = ?$

(ii) $V_1 = ?, V_2 = ?$

(iii) $Q_1 = ?, Q_2 = ?$

Calculation:

We know that

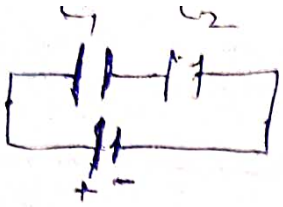
$$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{Ce} = \frac{1}{6} + \frac{1}{12}$$

$$= \frac{2+1}{12}$$

$$= \frac{3}{12}$$

$$\frac{1}{C_e} = \frac{1}{4}$$



Thus, equivalent capacitance is 4×10^{-6}F.

$$C_e = 4\mu F = 4\times10^{-6} F$$

$$Q = C_e V$$

$$Q = 4\times10^{-6}\times12$$

$$Q = 48\times10^{-6}$$

$$Q = 48\mu C$$

Charge on the palates of capacitor will be 48 μC.

In series combination, charge across each capacitor is same so

$$Q = Q_1 = Q_2$$

$$V_1 = \frac{Q_1}{C_1}$$

$$= \frac{48\times10^{-6}}{6\times10^{-6}}$$

$$V_1 = 8\ volts.$$

Voltage across first capacitor is 8 volt.

$$V_2 = \frac{Q_2}{C_2}$$

$$= \frac{48\times10^{-6}}{12\times10^{-6}}$$

$$V_2 = 4 Volts$$

Voltage on the second capacitor is 4 volt.

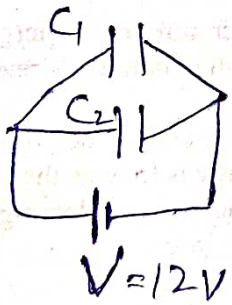
13.10 Two capacitors of capacitances 6 μ F and 12 μ F are connected in parallel with a 12 V battery. Find the equivalent capacitance of the combination. Find the charge and the potential difference across each capacitor. 101113197

Given data:

$C_1 = 6\mu F$

$C_2 = 12\mu F$

$V = 12$ Volts



To Find:

(i) $C_e = ?$

(ii) $Q_1 = ?\ , Q_2 = ?$

(iii) $V_1 = ?\ , V_2 = ?$

Calculation:

$$V = V_1 = V_2$$

We know that

$$C_e = C_1 + C_2$$

$$= 6 + 12$$

$$= 18\mu F$$

$$C_e = 18\times10^{-6} F$$

$$Q_1 = C_1 V$$

$$Q_1 = 6\times10^{-6}\times12$$

$$= 72\times10^{-6} C$$

$$Q_1 = 72\mu C$$

$$Q_2 = C_2 V$$

$$= 12\times10^{-6}\times12$$

$$= 144\times10^{-6} C$$

$$Q_2 = 144\mu C$$

Since combination is parallel so potential across each capacitor is same i.e. 12 volts.

$$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$= \frac{1}{6\mu F} + \frac{1}{12\mu F}$$

$$= \frac{1}{6\times10^{-6} F} + \frac{1}{12\times10^{-6} F}$$

$$= \left[\frac{1}{6} + \frac{1}{12}\right] \times \frac{1}{10^{-6} F}$$

$$= \left[\frac{2+1}{12}\right] \times \frac{1}{10^{-6}}$$

$$= \frac{3}{12} \times \frac{1}{10^{-6}}$$

$$= \frac{1}{4} \times \frac{1}{10^{-6}} = \frac{1}{4\times10^{-6}}$$

$$\frac{1}{C_e} = \frac{1}{(4\times10^{-6})F} \Rightarrow C_e = 4\times10^{-6} F$$

UNIT 14 Current Electricity

(F.B. 2017) 101114001

Q.1 Define and Explain Electric Current.

Ans. *The rate of flow of electric charge through any cross-sectional area is called current.* If charge Q is passing through any area in atime 't' then current 'I' flowing through it will be given by

Formula:

$$\text{Current} = \frac{Charge}{Time}$$

$$I = Q/t$$

Unit:

In SI the unit of current is Ampere

Ampere:

If one Coulomb charge passes through any cross section in one second then current will be equal to one ampere. $1A = 1Cs^{-1}$

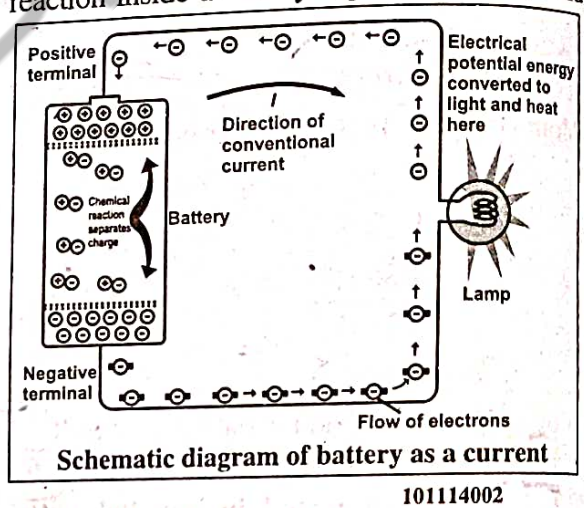
Smaller units of current are milliamp ere, micro ampere.

$1mA = 10^{-3}A$

$1\mu A = 10^{-6}A$

Explanation:

Battery is one of the sources of current. The electrochemical reaction inside a battery separates positive and negative electric charges. This separation of charges setup potential difference between the terminal of the battery. When we connect a conducting wire across the battery the charge can move from one terminal to other due to potential difference. The chemical energy of the battery changes to electrical potential energy. The electric potential energy decreases as the charges moves around the circuit. This electrical energy can be converted to other useful form of energy (heat, light, sound etc) . It is the only energy which changes form but the number of charge carriers and the charge on each carrier always remains the same. Instead of electrical potential energy we use the electric potential which is potential energy per unit charge.



Schematic diagram of battery as a current

101114002

Q.2 Explain Conventional Current.

Ans. Conventional Current:

Current flowing from positive to negative terminal of battery due to flow of positive charges is called conventional current.

Explanation:

When the ends of a copper wire are at different temperature, heat energy flows from the end of higher temperature to the end of lower temperature. The flow stops when both ends reach the same temperature. Water in a pipe also flows from higher level to lower level.

Similarly when a conductor is connected to battery it pushes positive charges to flow current from higher potential to lower potential.The flow of current continues as long as there is potential difference.

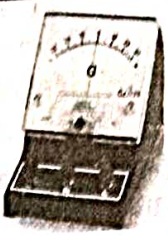
Conventional current produces the same effect as the current flowing from negative terminal to the positive terminal due to the flow of negative charges.

Q.3 What is Galvanometer? 101114003

Ans. *Galvanometer is a very sensitive instrument which is used to detect a small current in a circuit.*

Explanation:

A current of few milli amperes is sufficient to cause full scale deflection in it. While making the connection polarity of the terminals of the galvanometer should be taken into consideration.



A Galvanometer

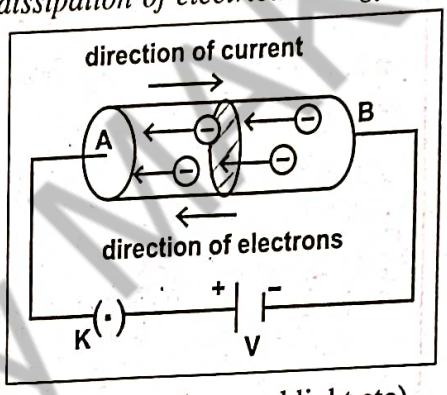
The terminal of the galvanometer with red colour shows positive polarity while that of with black colour shows negative polarity.

Ideal Galvanometer should have very small resistance to pass the maximum current in the circuit.

After suitable modification galvanometer can be converted into an ammeter. Ammeter is also connected in series. So the current flowing in the circuit also passes through ammeter.

Q.4 What is potential difference? And write the name of its Unit. **(Board 2014)** **101114004**

Ans. *Potential difference across the two ends of a conductor causes the dissipation of electrical energy into other forms of energy as charges flow through the circuit.*



Unit:

In S.I unit of potential difference is **Volt**.

Explanation:

When one end A of a conductor is connected to positive terminal of a battery and its other end B is connected to the negative terminal of the battery then the potential of A becomes higher than the potential of B as shown in fig.

As the current flows from higher potential to the lower potential through the conductor, the electrical energy (due to current) is converted in to other forms (heat and light etc).

When current flows through the conductor it experiences a resistance in the conductor, the energy supplied by the battery is utilized in overcoming this resistance and is dissipated as heat and other forms of energy.

The dissipation of this energy is accounted for the potential difference across the two ends of light bulb.

Unit of Potential Difference

SI Unit of potential difference isvolt. A potential difference of 1V across a bulb means that each coulomb of charge or one Ampere of current that passes through the bulb consumes 1 Joule of energy. When a bulb is lit, the energy is taken from the current and is transformed into light and heat energy.

101114005

Q.5 What is meant by electromotive force?

Or

What do we mean by the term e.m.f? Is it really a force? Explain.

Ans. *"It is the energy supplied by a battery to a unit positive charge when it flows through the closed circuit".*

OR

"It is the energy converted from non-electrical forms to electrical form when one coulomb of positive charge passes through the battery".

$$\text{e.m.f} = \frac{\text{energy}}{\text{charge}}$$

$$E = W/Q$$

Where E is e.m.f. Thus W is energy converted from non-electrical form to electrical forms and Q is a positive charge.

Unit of e.m.f

The unit of e.m.f is JC^{-1} which is equal to volt in S.I system. For example if the e.m.f of a battery is 2V the total energy supplied by battery is 2 joules e.g. when one coulomb of charge flows through the closed circuit.

101114006

Q.6 Write some sources of electromotive force.

Ans. Sources of electromotive force (e.m.f) converts non electrical energy (chemical, thermal, mechanical etc) into electrical energy. Sources of e.m.f are

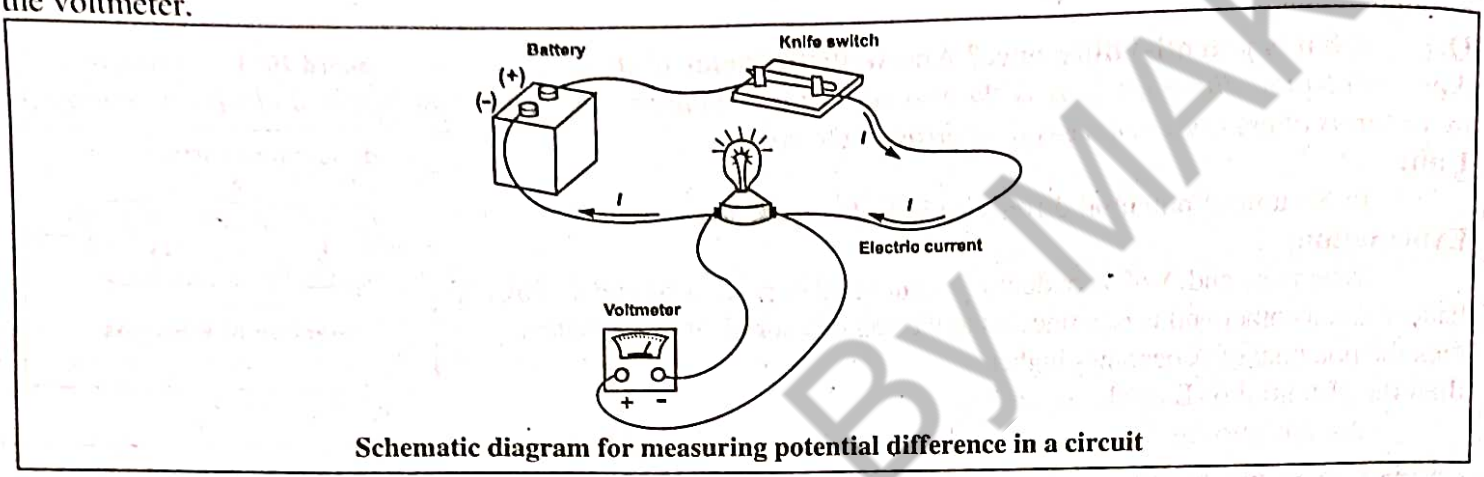
(i) **Batteries:**
Batteries convert the chemical energy into electrical energy.

(ii) **Thermocouples:**
Thermocouples convert the thermal energy into electrical energy.

(iii) **Generators:**
Generators convert the mechanical energy into electrical energy.

Q.7 How is potential difference measured? 101114007

Ans. The potential difference across a circuit component (e.g. light, bulb) can be measured by a voltmeter connected directly across the terminal of the component. The positive terminal of the battery is connected to the positive terminal of the voltmeter and negative terminal of the batteryis connected to the negative terminal of the voltmeter.



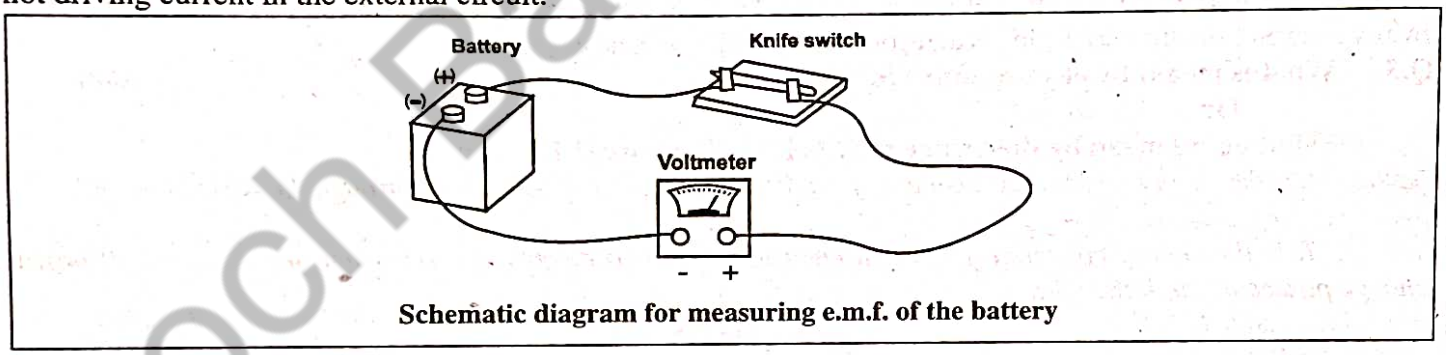
Schematic diagram for measuring potential difference in a circuit

Ideal Voltmeter

An ideal voltmeter should have very large value of resistance so that no current pass through it. Voltmeter is always connected in parallel with the device across which the potential difference is to be measured.

Q.8 How e.m.f of a battery is measured? 101114008

Ans. In order to measure e.m.f of the battery, we connect voltmeter directly with the terminals of the battery as shown in fig. In general, e.m.f refers to the potential difference across the terminals of the battery when it is not driving current in the external circuit.



Schematic diagram for measuring e.m.f. of the battery

Q.9 Define and Explain Ohm's Law. What are its limitations? (F.B. 2014) 101114009

Ans. Definition:

"The amount of current I passing through a conductor is directly proportional to the potential difference V applied across its ends provided the temperature and physical state of the conductor does not change".

Mathematically

$$V \propto I$$

Or

$$V = IR$$

Where R is the constant of proportionality and is the resistance of conductors.

Its unit is **ohm**. If a graph is plotted between the current I and the potential difference V, a straight line will be obtained.

Limitations of Ohm's Law:

i) Ohm's Law is applicable in conductors only.

ii) Ohm's Law is applicable when temperature and physical state of conductor does not change.

Q.10 Define resistance and its unit. 101114010

Ans. *"The property of a substance which offers opposition to the flow of current through it is calledits resistance".*

This opposition comes from the collisions of moving electrons with atoms of substance.

Unit of Resistance (ohm):

"When a potential difference of one volt is applied across the ends of a conductor and one ampere of current passes through it, then its resistance will be one ohm."

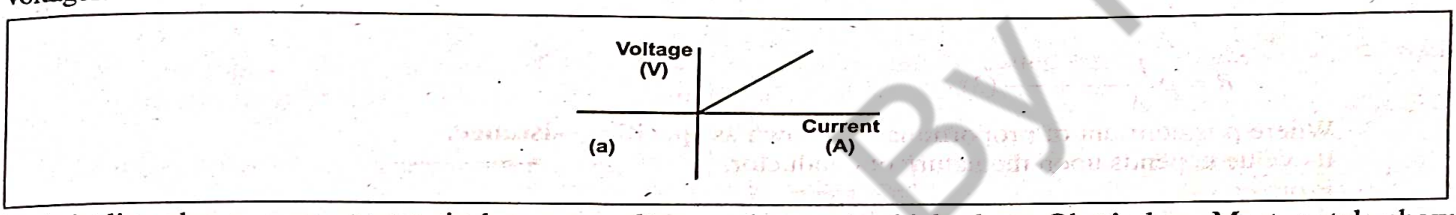
It is denoted by the symbolΩ called ohm.

The SI unit of resistance is ohm. If we put V = 1Volt& I = 1 ampere, the value of R will be one ohm.

Q. 11 Explain Characteristics of Ohmic and non-ohmic conductors. (F.B. 2014) 101114011

Ohmic conductors:

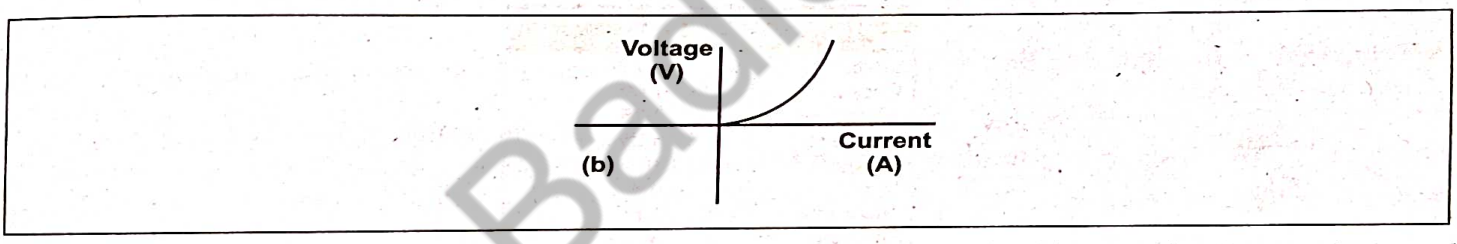
"Materials that obey Ohm's law and have a constant resistance over a wide range of voltages are said to be ohmic conductors."Ohmic conductors have a linear current-voltage relationship over a wide range of applied voltages.



Straight line shows a constant ratio between voltage and current which obeys Ohm's law. Most metals show ohmic behavior.

Non-Ohmic Conductors:

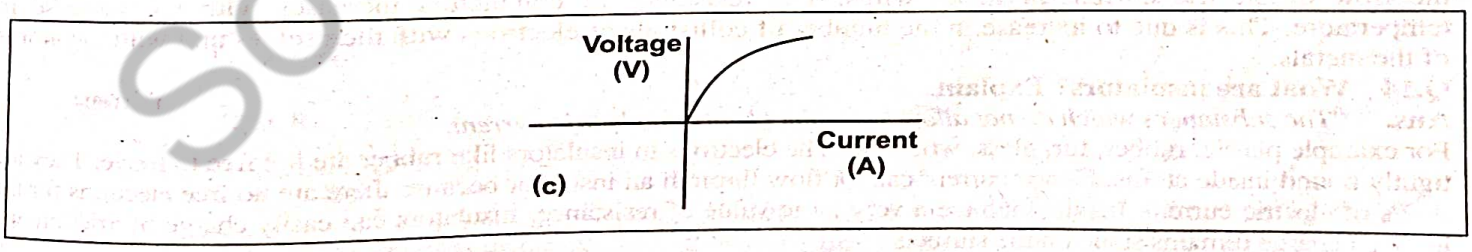
Materials having resistance that changes with voltage or current are non-ohmic.



Non-ohmic materials have a non-linear voltage-current relationship for example filament lamp and thermister.

(a) The resistance of filament rises (current decreases) as it gets hotter which is shown by gradient getting steeper. (F.B. 2016)

(b) **A thermister** (a heat, sensitive resistor) behaves in the opposite way. Its resistance decreases (current increases) as it gets hotter. This is because on heating more free electrons become available for conduction of current.



Q.12 Define specific resistance (Resistivity).On which factor does the resistance R of a conductor depend. Calculate its value. (F.B. 2016, 18) 101114012

Ans. *"The resistance of one meter cube of a substance is called its specific resistance".*

It is represented byρ. The unit of specific resistance (ρ) is ohm – meter (Ωm).

At a certain temperature and for a particular substance the resistance R depends upon the length of wire, area of cross-section and nature of material.

1- Length of wire:

The resistance R of the wire is directly proportional to length of the wire i.e.

$$R \propto L \text{.....(1)}$$

It means if we double the length of the wire its resistance will also be doubled and if its length is halved its resistance would become one half.

2- Cross-sectional area of wire:

The resistance R of the wire is inversely proportional to the area of cross-section A of the wire.

$$R \propto \frac{1}{A} \text{ .....(2)}$$

It means that a thick wire would have smaller resistance than a thin wire.

After combining eq. (1) and (2) we get

$$R \propto \frac{L}{A}$$

$$R = \rho \frac{L}{A} \text{------(3)}$$

Where ρ is constant of proportionality known as **specific resistance**.

Its value depends upon the nature of conductor.

From eq (3)

$$\rho = \frac{R \times A}{L} \text{------(4)}$$

If we put L = 1m and A = $1m^2$ then eq-(4) becomes.

$$\rho = R$$

Metal	Specific resistance ($10^{-8}\Omega m$)
Silver	1.7
Copper	1.69
Aluminium	2.75
Tungsten	5.25
Platinum	10.6
Iron	9.8
Nichrome	100
Graphite	3500

Q.13 What are conductors? Explain? OR Define conductors. 101114013

Ans. *"Conductors are materials through which electricity passes easily".*

Metals like silver and copper have excess of free electrons which are not held strongly with any particular atoms of metals. When we apply external electric field these electrons can easily move in a specific direction.

This movement of free electrons in a particular direction under the influence of an external field causes the flow of electric current in metal wires. The resistance of conductors increases with the increase in temperature. This is due to increase in the number of collisions of electrons with themselves and with the atoms of the metals.

Q.14 What are insulators? Explain. 101114014

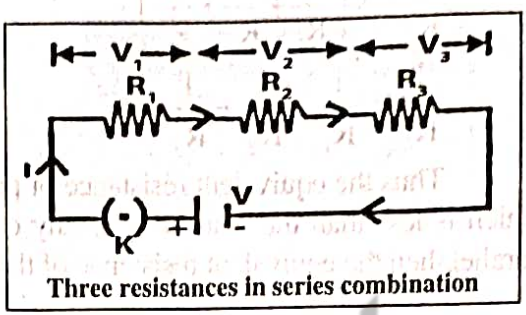
Ans. *"The substances which do not allow to conduct heat and electric current.*

For example plastic, rubber, fur, glass, wood etc. The electrons in insulators like rubber are not free to move. They are tightly bound inside atoms. Hence current cannot flow through an insulator because there are no free electrons for the flows of electric current. Insulators have a very large value of resistance. Insulators can easily charge by friction and induced charge remains static on the surface.

Q.15 Discuss the main features of series combination of resistors and determine the equivalent resistance also. 101114015

Ans. In series combination resistors are connected end to end and electric current has a single path through the circuit. This means that the current passing through each resistor is same which is equal to the current provided by the battery.

$I = I_1 = I_2 = I_3$



Three resistances in series combination

Total voltage in a series circuit divides among the individual resistors so the sum of the voltage across the resistance of each individual resistor is equal to the total voltage supplied by the source.

Thus we can write

$$V = V_1 + V_2 + V_3 \text{-------(1)}$$

Where V is the voltage across the battery and V_1, V_2, V_3 are the voltage across resistors R_1, R_2, R_3 respectively.

If I is the current passing through each resistor, then from Ohm's law

$$V = I R_1 + I R_2 + I R_3$$

$$V = I [R_1 + R_2 + R_3] - (2)$$

We can replace the combination of resistors with a single resistor called equivalent resistance R_e such that the same current passes through the circuit. From Ohm's Law.

$$V = I R_e$$

Eq (2) becomes $$IR_e = I [R_1 + R_2 + R_3]$$

$$R_e = [R_1 + R_2 + R_3]$$

$$R_e = R_1 + R_2 + R_3 \text{ --- (3)}$$

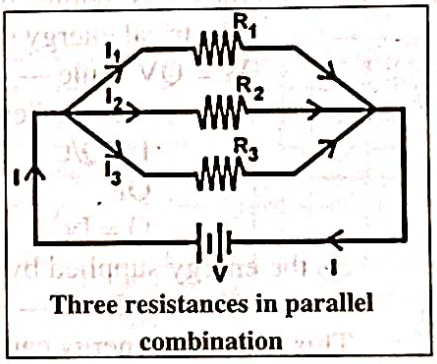
Thus the equivalent resistance of a series combination is equal to the sum of the individual resistances of the combination.

If R_1, R_2, R_3, ------ R_n are connected in series then the equivalent resistance of the combination will be given by

$$R_e = R_1 + R_2 + R_3 + \text{-----} + R_n.$$

Q.16 Discuss the main features of parallel combination of resistors and also determine the equivalent resistance. (F.B. 2017) 101114016

Ans. In parallel combination one end of each resistor is connected with positive terminal of battery while the other end of each resistor is connected with the negative terminal of battery. Therefore, the voltage is same across each resistor.



Three resistances in parallel combination

Which is equal to the voltage provided by the battery i.e.

$V = V_1 = V_2 = V_3$

In parallel circuit, the total current equals to the sum of the currents in various resistances i.e.,

$I = I_1 + I_2 + I_3$ --- (1)

Since the voltage across each resistance is V, so by Ohm's Law

$I_1 = \frac{V}{R_1}$, $I_2 = \frac{V}{R_2}$ and $I_3 = \frac{V}{R_3}$

So eq. (1) becomes.

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \text{-----(3)}$$

We can replace the combination of resistors with a single resistor called the equivalent resistance R_e such that the same current passes through the circuit. From Ohm's Law

$I = V/R_e$ thus eq. (3) becomes.

$$\frac{V}{R_e} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Thus the equivalent resistance of parallel combination is the sum of the reciprocal of the individual resistances which is less than the resistance of any one of the combination. If resistances R_1, R_2, R_3, ----- R_n are connected in parallel then the equivalent resistance of the combination will be given by.

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots\ldots + \frac{1}{R_n}$$

Advantages of parallel circuit:

1) Each device in the circuit receives the full battery voltages.

2) Each device in the circuit may be turned off independently without stopping the current flowing to the other device in the circuit. This principle is used in house wiring.

Q.17 State and Explain the Joule's Law. 101114017

Or

Explain the energy dissipation in a resistance. What is Joule's Law?

Ans. Energy dissipation in a resistance

When a current flows in a resistor electrical energy is converted into other form of energy as light and heat energy. Loss of electrical energy in unit time is referred to as "power dissipation in resistor." The heat generated in the components of a circuit is dissipated into air.

Joule's law is used to find the power dissipated in a resistor. Joule is the unit of energy and power is the Joule per second.

Joule's Law:

The amount of heat generated in a resistance due to the flow of charges is equal to the product of square of current I resistance R and the time duration t.

Mathematically $W = I^2 R t$

Proof: Consider two points with a potential difference of V volts. If one coulomb of charge passes between these points the amount of energy delivered by the charge would be V Joule. Hence when Q coulomb of charge flows between these two points, then we will get QV Joule of energy. If we represent this energy by W then:

Electrical energy supplied by Q charge

$W = QV$ Joule --- (1)

Now current, when charges Q flow in time t is

$I = Q/t$

OR

$Q = I t$

So the energy supplied by Q Charge in t second

$W = V \times I \times t$ ---- (2)

This Electrical energy can be converted in to heat and other forms in the circuit.

From Ohm's Law we have

$V = IR$

So the energy supplied by Q Charge is: $W = I \times R \times I \times t$

$W = I^2Rt$

Or $W = \frac{V^2 t}{R}$

This equation is called Joule's Law.

This energy can be utilized for different useful purposes. For example bulb converts this energy into light and heat, heater and iron into heat and fans into mechanical energy. Usually, this energy appears as heat in the resistance. This is the reason that we get heat when current passes through a heater.

Q.18 Define Electric power. Write its formula and unit. 101114018

Ans. *The amount of energy supplied by electric current in unit time is known as electric power.*

$P = W/t$

Its unit is watt. This is equal to Joule per second (Js^{-1}).

As $P = W/t$

$\because$ $W = QV$

So $P = QV/t$

As $I = Q/t \Rightarrow Q = I \times t$

$P = VI$ and $V = IR$

$P = (I.R)I$

$P = I^2 R$

Appliance	Power (watts)
Electric stove	5,000
Electric heater	1,500
Hair dryer	1,000
Iron	800
Washing machine	750
Light bulb	100
Small fan	50
Clock radio	10

When current I is passing through a resistor R, the electric power that generates heat in the resistance is given by I^2R. Electric bulbs commonly used in houses consume 25W, 40W 60W, 75W and 100W of electric power.

Q.19 Define kilowatt-hour and prove that 1kWh = 3.6 MJ 101114019

Ans. *The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt– hour.*

It is the large unit of electrical energy.

Proof. One kilowatt – hour (1kWh)=1000 W× 1 hour

1 kilowatt-hours $= 1000\ W \times (3600s) = 36 \times 10^5 J = 3.6 \times 10^6\ J$

1 kilowatt-hours $= 3.6$ MJ

Q.20 How can we find the energy in kilowatt-hour. 101114020

Ans. The amount of energy in kilowatt-hour can be obtained by the formula.

$$\text{The energy in kilowatt-hours} = \frac{\text{Watt} \times \text{time of use in hours}}{1000}$$

Q.21 How can we calculate the amount of electricity bill? 101114021

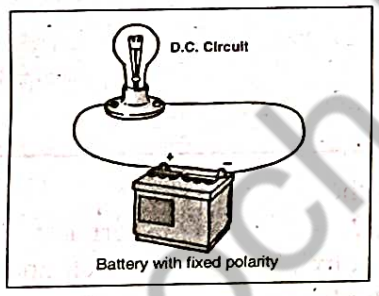
Ans. Cost of electricity = numbers of units consumed × cost of one unit.

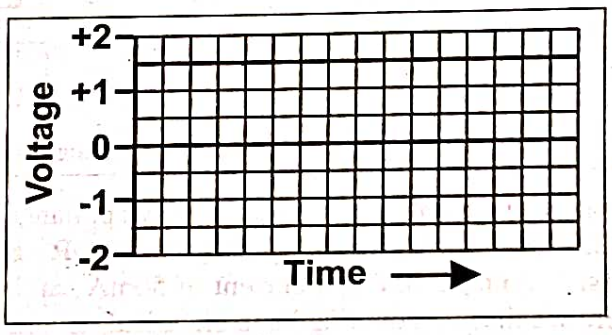
$$= \frac{\text{Watt} \times \text{time of use in hours}}{1000} \times \text{cost of one unit.}$$

Q.22 Differentiate between Direct current and Alternating current and explain it. 101114022

Ans. Direct current:

The current derived from a cell or a battery is direct current (d.c). It is unidirectional.





Alternating Current:

A current which changes its polarity again and again.

Such a current which changes direction after equal intervals of time is called alternating current or A.C This type of current is produced by AC generator.

Time Period:

Def: *The time interval after which the A.C voltage or a current repeats its value is known as its time period.*

The current that is used in our Houses is A.C. Its frequency is 50 Hz. Alternating current oscillates 50 times in every second.

101114023

Q.23 How is electric current supplied to a house?

Ans. The electric power enters our house through three wires. One is called **earth wire** or **ground wire (E)**. This carries no electricity. The earth wire is connected to a large metal plate buried deep in the ground near the house. The other wire is maintained at zero potential by connecting it to the earth at the power station itself and is called **neutral wire (N)**. This wire provides the return path for the current. The third wire is at a high potential and is called **live wire (L)**.

Effect of Electric Currents on the Body	
Current	**Effect**
0.001 A	Can be felt
0.005 A	Is painful
0.010 A	Causes involuntary muscle contractions (spasms)
0.015 A	Causes loss of muscle control
0.070 A	Goes through the heart; causes serious disruption; probably fatal if current lasts for more than 1 s.

The potential difference between the live wire and the neutral wire is 220 V.

Our body is a good conductor of electricity through which current can easily pass. Therefore, if a person holds live wire, current will start flowing to the ground while passing through his body which may prove fatal for the person. All electrical appliances are connected across the neutral and the live wires. The same potential difference is therefore applied to all of them and hence these are connected in parallel to the power source.

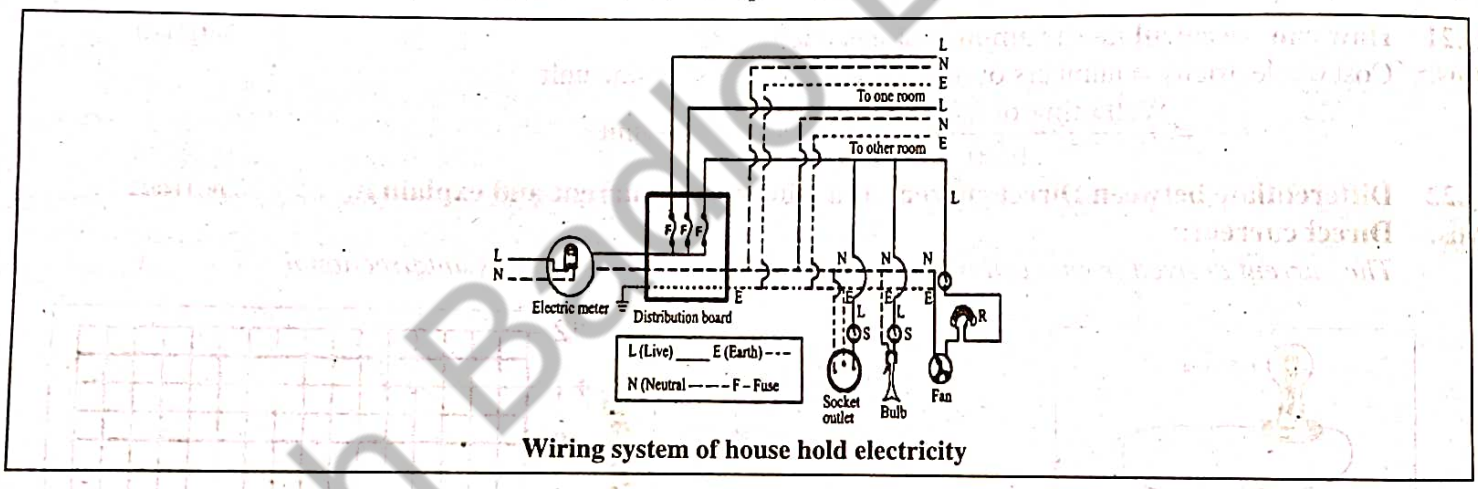
Q.24 Write a note on house wiring. **(F.B. 2016)** 101114024

Ans. Fig. shows the system of house wiring. The wires coming from power substation are connected to electricity meter installed in the house.

The output power from the electric meter has been installed in the house. The output power from the electric meter is taken to the main distribution board and then to domestic electric circuit.

The main box contains fuses of rating about 30 A. A separate connection is taken from the live wire of each appliance. The terminal of the appliance is connected to the live wire through a separate fuse and a switch. If the fuse of one appliance burns out it does not effect the other appliances.

In house wiring all appliances are connected in parallel with each other. This means they all get the full



Wiring system of house hold electricity

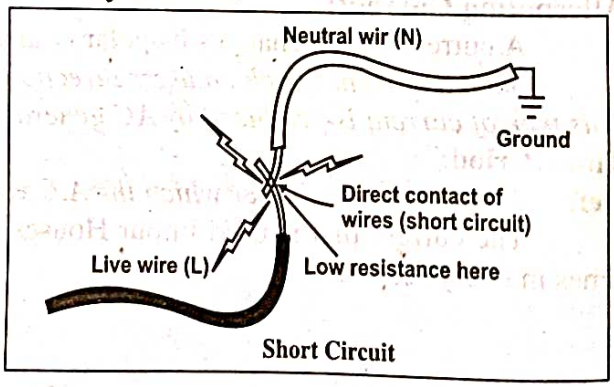
mains voltage and one can turn on any appliance without having to turn ON another.

Q.25 What are electricity Hazards? OR How a circuit is short circuited? 101114025

Ans. Voltage 50V and current of 50mA can be fatal. Major dangers of electricity are electric shock and fire. Here we discuss some faults in electrical circuits that may cause electricity Hazards.

1. Insulation Damage:

All electrical wires are well insulated with some plastic cover for the purpose of safety. But when electrical current exceeds the rated current carrying capacity of the conductor, it can produce excess current that can damage the insulation due to overheating of cables. This results in to a short circuit which can severely damage electrical devices or persons.



Short Circuit:

A short circuit occurs when a circuit with a very low resistance is formed. The low resistance causes the current to be very large when appliances are connected in parallel, each additional appliance placed in a circuit reduces the equivalent resistance in the circuit and increases the current through the wires.

This additional current might produce enough thermal energy to melt the wirings insulation which causes a short circuit or even starts a fire.

Short circuit can also occur when the live wire and the neutral wires come in direct contact.

Prevention from Short Circuit:

In order to avoid such situations, the wires carrying electricity should never be naked. Rather it should be covered with good insulator such an insulation covered wire is called cable. Constant friction may also remove the insulation from the wire whereas too much moisture also damages the insulation.

In such a situation, it is advisable to use a cable with two layers of insulation.

2. Damp Condition:

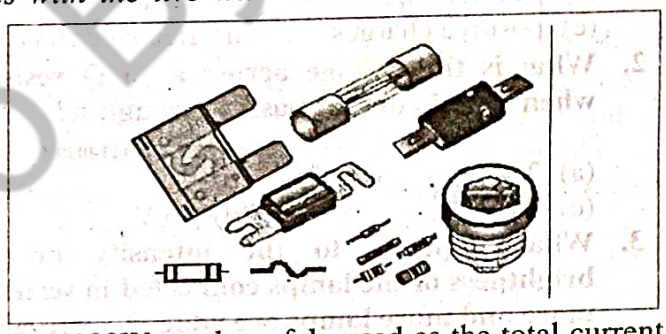
Dry human skin has a resistance of 100,000 ohm or more. But under damp conditions (wet environment) resistance of human skin is reduced drastically to few hundred ohms. Therefore never operate any electrical appliance with wet hand also keep switches, plugs sockets and wires dry.

Q.26 Write a note on safe use of electricity in homes? 101114026

Ans. Take much care to use fuse and circuit breakers in an electric circuit as safety devices. They prevent circuit over loads that can occur when too many appliances are turned on at the same time or when a short circuit occurs in one appliance.

Q.27 The following safety measures should be adopted in house hold circuits. 101114027

1-Fuse:*A fuse is a safety device that is connected in series with the live wire in the circuit to protect the equipments when excess current flows.*



Fuseare normally rated as 5A, 10A, 13A, 30A etc.

Different types of Fuse are shown in fig.

The following **safety measures** should be taken while using fuse in house holds electrical circuits.

i. Fuse to be used should have slightly more rating than the current which the electrical appliance will draw under normal conditions for example for a lightening circuit choose a 5A fuse as the current drawn by each lamp is very small (about 0.4A for a 100W Lamp). In such circuit 10 lamps a 100W can be safely used as the total current drawn is only 4A which can be calculated by the formula P=VI.

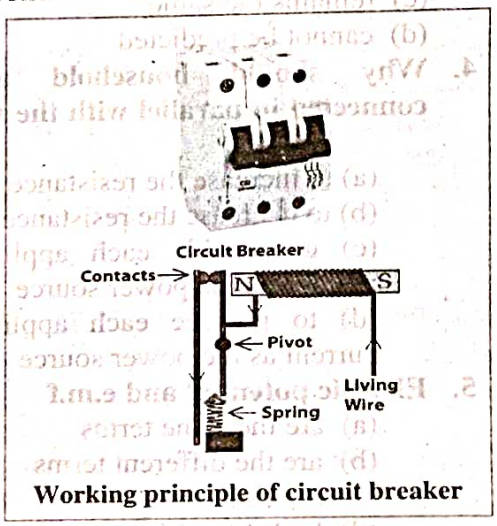
ii. Fuse should be connected to live wire so that the appliance will not become live after the fuse has blown.

iii. Switch off the main before changing any fuse.

2- Circuit Breaker:

The circuit breaker acts as a safety device in the same way as a fuse. It disconnects the supply automatically if the current exceeds the normal value. When the normal current passes through the live wire the electromagnet is not strong enough to separate the contacts. If some things go wrong with the appliances and large current flows through the live wire the electromagnet will attract the iron strip to separate the contacts and break the circuit.

The spring then keeps the contacts apart. After the fault is repaired the contacts can then be pushed back together by pressing a button on the outside of the circuit breaker box.

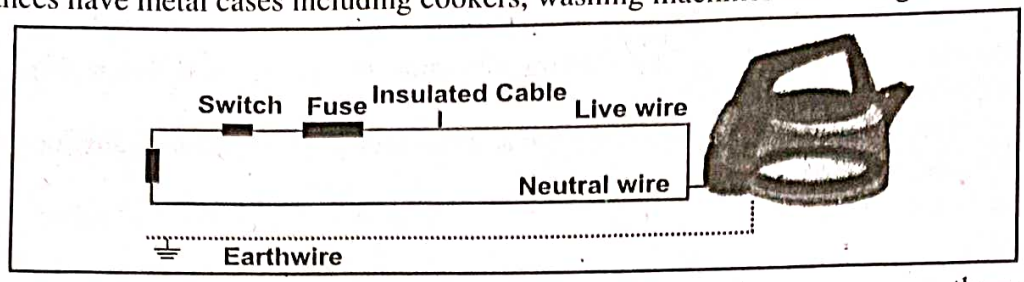


Working principle of circuit breaker

3- Earth Wire:

The additional wire used along with live and neutral wire with those appliances whose casing is made up of metal. If the live wire touches the casing, then earth wire provides the safe route for the flow of current. It save us from electric shock.

The earth wire provides a safe route for the current to flow through if the live wire touches the casing. We will get electric shock if the live wire inside an appliance comes loose and touches the metal casing. Many electrical appliances have metal cases including cookers, washing machines and refrigerators.



However the earth terminal is connected to the metal casing, so the current goes through the earth wire instead of passing through our body and causing an electric shock. A strong current passes through the Earth wire because it has a very low resistance.

This breaks the fuse and disconnects the appliance.

Multiple Choice Questions

Choose the correct answer from the following choices.

Exercise MCQs

1. An electric current in conductors is due to the flow of 101114028
(a) positive ions (b) negative ions
(c) positive charges (d) free electrons

2. What is the voltage across a 6 Ω resistor when 3 A of current passes through it? 101114029
(a) 2 V (b) 9 V
(c) 18 V (d) 36 V

3. What happens to the intensity or the brightness of the lamps connected in series as more and more lamps are added? 101114030
(a) increases
(b) decreases
(c) remains the same
(d) cannot be predicted

4. Why should household appliances be connected in parallel with the voltage source? 101114031
(a) to increase the resistance of the circuit
(b) to decrease the resistance of the circuit
(c) to provide each appliance the same voltage as the power source
(d) to provide each appliance the same current as the power source

5. Electric potential and e.m.f 101114032
(a) are the same terms
(b) are the different terms
(c) have different units
(d) both(b)and (c)

6. When we double the voltage in a simple electric circuit, we double the 101114033
(a) current (b) power
(c) resistance (d) both (a) and (b)

7. If we double both the current and the voltage in a circuit while keeping its resistance constant, the power 101114034
(a) remains unchanged (b) halves
(c) doubles (d) four times

8. What is the power rating of a lamp connected to a 12 V source when it carries 2.5 A? (F.B,2017) 101114035
(a) 4.8 W (b) 14.5 W
(c) 30 W (d) 60 W

9. The combined resistance of two identical resistors, connected in series is 8Ω. Their combine desistance in a parallel arrangement will be (F.B, 2017) 101114036
(a) 2 Ω (b) 4Ω
(c) 8 Ω (d) 12 Ω

Additional MCQs

10. The ampere is a unit of: (F.B, 2013) 101114037
(a) energy
(b) potential difference
(c) electric potential
(d) electric current

11. The rate of flow of charge through any cross-sectional area is called: 101114038
(a) Potential difference
(b) energy
(c) charge
(d) electric current

12. Battery converts chemical energy into which energy: 101114039
(a) Mechanical (b) Electrical
(c) Thermal (d) Sound

13. The resistance of conductors is due to: 101114040
(a) Protons (b) Fixed atoms
(c) Molecules (d) Neutrons

14. The unit of potential difference is: 101114041
(a) volt (b) coulomb
(c) ampere (d) joule

15. According to Ohm's law V = 101114042
(a) I^2R (b) IR^2
(c) IR (d) $\frac{I}{R}$

16. What type of graph is in between V and I, if metal obeys ohm's law? 101114043
(a) Curved (b) Parabola
(c) Straight line (d) Hyperbola

17. The unit of (ρ) in the formula $R = \frac{\rho L}{A}$ is: 101114044
(a) Ω (b) Ω-m
(c) $\Omega\text{-m}^2$ (d) $\Omega\text{-m}^{-2}$

18. SI unit of resistance is: 101114045
(a) Volt (b) Ampere
(c) Ohm (d) Joule

19. Resistance of conductor is directly proportional to: 101114046
(a) Length (b) Pressure
(c) Area (d) Volume

20. The equivalent resistance in parallel combination is: 101114047
(a) $R_e = R_1+R_2+R_3+\ldots\ldots+R_n$
(b) $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots + \frac{1}{R_n}$
(c) $R_1, R_2, R_3 \ldots R_n$
(d) $\frac{R_1}{2}, \frac{R_2}{1}, \ldots \frac{R_n}{n}$

21. Which instrument is used to detect current? 101114048
(a) Galvanometer (b) Voltmeter
(c) Ammeter (d) Electroscope

22. How is Galvanometer connected in circuit to detect current? 101114049
(a) In Series (b) In Parallel
(c) Fixed (d) Variable

23. Joule's law is W = 101114050
(a) $\frac{IR}{t}$ (b) IRt^2
(c) IR^2t (d) I^2Rt

24. The unit of electric power is 101114051
(a) volt (b) watt
(c) joule (d) coulomb

25. The A.C used in our houses has frequency 101114052
(a) 60Hz (b) 30Hz
(c) 50Hz (d) 130Hz

26. The current used in houses is: 101114053
(a) Alternating current
(b) Conventional current
(c) Direct current
(d) None of these

27. The current which changes its direction is called: 101114054
(a) Transient Current
(b) Conventional current
(c) A.C
(d) D.C

28. That period in which voltage repeats its value in equal intervals is called: 101114055
(a) Cycle (b) Time period
(c) Frequency (d) Amplitude

29. The current which does not change its direction is called: 101114056
(a) A.C (b) conventional
(c) D.C (d) Transient current

30. The resistance of voltmeter is: 101114057
(a) zero (b) low
(c) very high (d) 10 Ω

31. The colour of live wire is 101114058
(a) Black or blue (b) Green or yellow
(c) White or Grey (d) Red or Brown

32. Specific resistance of copper is: 101114059 (F.B. 2013)
(a) $1.62\times 10^{-8}\Omega\text{-m}$
(b) $1.69\times 10^{-8}\Omega\text{-m}$
(c) $5.25\times 10^{-8}\Omega\text{-m}$
(d) $2.75\times 10^{-8}\Omega\text{-m}$

33. Current is equal to: 101114060
(a) RV (b) QR
(c) $\frac{Q}{t}$ (d) $\frac{t}{Q}$

34. As the temperature of a conductor rises, its resistance 101114061
(a) Increases (b) Decreases
(c) Does not change (d) None of these

35. The property of substance, which opposes the flow of current through it is called: 101114062
(a) Resistance (b) Reactance
(c) Resistivity (d) Inductance

36. When resistances are connected in series the current passing through them is: 101114063
(a) different (b) zero
(c) the same (d) none of these

37. The equivalent resistance of a parallel combination is: 101114064
(a) equal to sum of all resistance
(b) is greater than the largest resistance of combination
(c) is smaller than the smallest resistance of combination
(d) all of these

38. A digital multimeter is used to measure: 101114065
(a) Current
(b) Resistance
(c) Potential difference
(d) All of above

39. A thermister is a _____ dependent resistors: 101114066
(a) Heat (b) Temperature
(c) Energy (d) Mass

40. Diamond does not conduct electricity, because it has no. 101114067
(a) free electrons
(b) free protons
(c) free neutrons
(d) free positive charge

41. The power of washing machine is: 101114068
(a) 700W (b) 750W
(c) 650W (d) 800W

42. The power of small fan is: 101114069
(a) 40W (b) 50W
(c) 60W (d) 80W

43. What is the amount of current passing through an electric heater, if it takes 1800C charge pass through it in 3 minute? 101114070
(a) 16 A (b) 10 A
(c) 100 A (d) 0.1 A

44. If 2 Joules of energy is required to transfer one coulomb of charge from one point to another, the potential difference between these points will be: 101114071
(a) 1 V (b) 2 V
(c) 4 V (d) 6 V

45. Watt is equal to: 101114072
(a) Coulomb per second
(b) Newton per second
(c) Volt per second
(d) Joule per second

46. The commercial unit of electrical energy is: 101114073
(a) Joule (b) Watt
(c) Kilowatt hour (d) Electron Volt

47. Circuit breaker works on the principle of 101114074
(a) Electric current
(b) Magnetism
(c) Electromagnetism
(d) Electrostatics

48. The galvanometer has been named after the scientist: 101114075
(a) Lewis
(b) Lowry Bronsted
(c) Luigi Galvano
(d) Galvano Einstein

49. Human skin, in dry conditions, has a resistance of: 101114076
(a) 20,000 ohm (b) 10,000 ohm
(c) 30,000 ohm (d) 2000 ohm

50. 100×10^{-3} A = 101114077
(a) 10^{-3}A (b) 10^{-2}A
(c) 10A (d) 10^{-1}A

51. If $R_1 = 6\Omega$ and $R_2 = 12\Omega$, then value of R_e in series combination is: 101114078
(a) 4Ω (b) 18Ω
(c) 12Ω (d) 6Ω

52. By keeping resistance constant if we double the voltage then current will be: 101114079
(a) Double (b) 4 times
(c) ¼ times (d) Half

53. V^2/R = 101114080
(a) Power (b) Energy
(c) Voltage (d) Resistance

54. When resistances are connected in parallel, the current passing through them is: 101114081
(a) Same (b) Zero
(c) Different (d) Infinite

55. When a potential of 10 volt is applied across a conductor, a current of 5 milliampere flows through it, the resistance of the conductor will be: 101114082
(a) 200 ohm (b) 2000 ohm
(c) 0.2 ohm (d) 0.002 ohm

56. The resistance of Ammeter is: 101114083
(a) Zero (b) Low
(c) Very high (d) None of these

57. Total energy supplied in driving one coulomb of charge around a complete circuit is called: 101114084
(a) Potential
(b) Potential difference
(c) Electromotive force
(d) Potential energy

58. The value of current I passing through a conductor is inversely proportional to: 101114085
(a) Temperature (b) Potential difference
(c) e.m.f. (d) Resistance

59. The range of galvanometer to measure current is: 101114086
(a) Few amperes
(b) Few micro amperes
(c) Few Milli amperes
(d) Mega amperes

60. By connecting suitable high resistance in series with galvanometer it will convert into: 101114087
(a) Voltmeter (b) Galvanometer
(c) Ammeter (d) Multimeter

61. In a dry cell, chemical energy changes into: 101114088
(a) Mechanical energy
(b) Electrical energy
(c) Potential energy
(d) Kinetic energy

62. Battery is one of the source of: 101114089
(a) Heat (b) Light
(c) Current (d) Sound

63. The colour of neutral wire is: 101114090
(a) Black or Blue (b) Green or Red
(c) Green or Blue (d) Red or White

64. The resistance of an ammeter should be: 101114091
(a) High (b) Very high
(c) Low (d) Constant

65. An ideal voltmeter is that which draws: 101114092
(a) Small voltage (b) No current
(c) High current (d) High voltage

66. An additional wire used along with live and neutral wire is: 101114093
(a) Cable wire (b) Earth wire
(c) Grip wire (d) Hot wire

67. A fuse is connected in series with: 101114094
(a) Neutral wire (b) Live wire
(c) Earth wire (d) Cable wire

68. Earth wire is connected with those appliances whose casing is made of: 101114095
(a) Metals (b) Wood
(c) Glass (d) Plastic

69. The resistance of conductor is inversely proportional to: 101114096
(a) Temperature
(b) Length
(c) Area of cross section
(d) Pressure

70. With the increase in temperature the resistance of pure metals: 101114097
(a) increases (b) decreases
(c) remains same (d) none of these

71. Who developed the 1st practical electric battery: 101114098
(a) Alessandro Volta (b) Faraday
(c) Newton (d) Coulomb

72. The rating of a fuse wire is always expressed in: 101114099
(a) ampere-hours (b) KWh
(c) volts (d) amperes

73. The filament of an electric bulb is made of: 101114100
(a) nickel (b) aluminium
(c) tungsten (d) carbon

74. A 3Ω resistor having 2A current will dissipate the power of: 101114101
(a) 12W (b) 4W
(c) 6W (d) 8W

75. The unit of electrical energy is: 101114102
(a) Joule (b) Watt
(c) Volt (d) electron volt(eV)

76. Nichrome wire is an alloy of: 101114103
(a) Lead and Zinc
(b) Silver and copper
(c) Nickel of and Chromium
(d) Iron and copper

77. Thermocouples convert: 101114104
(a) Heat energy into electrical energy
(b) Heat energy into light energy
(c) Heat energy into mechanical energy
(d) Chemical energy into electrical energy

78. Which is the best material for making connecting wires? 101114105
(a) iron (b) copper
(c) tungsten (d) nickel

79. In liquids and gases the current is due to the motion of: 101114106
(a) negative charges
(b) positive charges
(c) both positive and negative charges
(d) none of these

80. Which is not an e.m.f source? 101114107
(a) generator (b) solar cell
(c) battery (d) rheostat

81. A parallel circuit is also used as a divider for: 101114108
(a) power (b) resistance
(c) current (d) voltage

82. Specific resistance of silver is: 101114109
(a) $1.7\times10^{-8}\Omega.m$ (b) $2.63\times10^{-8}\Omega.m$
(c) $2.75\times10^{-8}\Omega.m$ (d) $7.0\times10^{-8}\Omega.m$

83. Specific resistance of Aluminium is: 101114110
(a) $1.7\times10^{-8}\Omega.m$ (b) $2.75\times10^{-8}\Omega.m$
(c) $5.25\times10^{-8}\Omega.m$ (d) $1.69\times10^{-8}\Omega.m$

84. Which of the following is an insulator? 101114111
(a) Copper (b) Iron
(c) Silk (d) Silver

85. Power of electric heater is: 101114112
(a) 1500 W (b) 750 W
(c) 100 W (d) 50 W

86. Power of hair dryer is: 101114113
(a) 1000 W (b) 750 W
(c) 10 W (d) 75 W

87. Alessandro Volta is a scientist: 101114114
(a) French (b) Italian
(c) American (d) Dutch

88. The symbol of earth in an electrical circuit is: (F.B 2018) 101114115
(a)  (b) 
(c)  (d) 

89. The electrical power is given by: (F.B 2018) 101114116
(a) $P = VI$ (b) $P = I^2R^2$
(c) $P = \frac{V^2}{R^2}$ (d) $P = VIT$

90. The amount of current that goes through the heart is: 101114117
(a) 0.070A (b) 0.1A
(c) 0.015 (d) 2A

91. The symbol used for ammeteris 101114118
(a)  (b) 
(c)  (d) 

92. The symbol is used for: 101114119
(a) Capacitor (b) Diode
(c) Voltmeter (d) Battery

93. In electric circuits the symbol used for fixed resistor : 101114120
(a) (b)
(c) (d)

94. Which instrument is used to measure current, resistance and potential difference. 101114121
(a) glavanometer (b) digital meter
(c) Voltmeter (d) Ammeter

95. Earth wire is connected to the: 101114122
(a) power house (b) transformer
(c) ground (d) generator

96. Simplest electrical circuits use: 101114123
(a) one wire (b) two wires
(c) four wires (d) five wires

97. What does a switch do? 101114124
(a) oppose the current
(b) open and close the circuit
(c) store energy
(d) provide voltage

98. If one of the resistors in a parallel circuit is removed, the total resistance will be: 101114125
(a) doubled (b) decreased
(c) increased (d) remain same

99. Which one is ohmic in nature? (F.B. 2017) 101114126
(a) thermister (b) filament lamp
(c) fixed resistor (d) variable resistor

100. Three resistors of 2Ω each connected in parallel are equivalent to a resistance of: (F.B. 2016) 101114127
(a) 3.33 Ω (b) 0.66 Ω
(c) 6 Ω (d) 12 Ω

101. House safety wiring is connected in. (F.B. 2017) 101114128
(a) parallel (b) series
(c) at random (d) gates

102. Number of switches used in a magnetic relay is / are: (F.B. 2017) 101114129
(a) 1 (b) 2
(c) 3 (d) 4

103. SI unit of electromotive force is: (F.B. 2015) 101114130
(a) Volt (b) Joule
(c) Newton (d) Dioptre

104. The unit of e.m.f in SI system is volt, which is equal to: (F.B. 2016) 101114131
(a) J (b) Jm^{-1}
(c) Js^{-1} (d) JC^{-1}

Answer Key

1.	d	2.	c	3.	b	4.	c	5.	b	6.	a	7.	d
8.	c	9.	a	10.	d	11.	d	12.	b	13.	b	14.	a
15.	c	16.	c	17.	b	18.	c	19.	a	20.	b	21.	a
22.	a	23.	d	24.	b	25.	c	26.	a	27.	c	28.	b
29.	c	30.	c	31.	d	32.	b	33.	c	34.	a	35.	a
36.	c	37.	c	38.	d	39.	b	40.	a	41.	b	42.	b
43.	b	44.	b	45.	d	46.	c	47.	c	48.	c	49.	b
50.	d	51.	b	52.	a	53.	a	54.	c	55.	b	56.	b
57.	c	58.	d	59.	c	60.	a	61.	b	62.	c	63.	a
64.	c	65.	b	66.	b	67.	b	68.	a	69	c	70	a
71	a	72	d	73	c	74	a	75	d	76	c	77	a
78	b	79	c	80	d	81	c	82	a	83	b	84	c
85	a	86	a	87	b	88	b	89	a	90	a	91	c
92	b	93	a	94	b	95	c	96	b	97	c	98	c
99	c	100	b	101	a	102	b	103	a	104	d		

Review Questions

Q.14.1 Define and explain the term electric current. 101114132

Ans. See Q#1 on Pg# 114

Q.14.2 What is the difference between electronic current and conventional current? 101114133

Ans.

Electronic Current	Conventional Current
The current that flows from negative terminal to positive terminal of the battery due to the flow of electrons is called electronic current.	Current flowing from positive to negative terminal of a battery due to the flow of positive charges is called conventional current.

Q.14.3 What do we mean by the term e.m.f? Is it realty a force? Explain. 101114134

Ans. See Q#5 on Pg#115

Q.14.4 How can we differentiate between e.m.f and potential difference? 101114135

Ans.

Electromotive force (e.m.f)	Potential Difference
(i) The energy converted from non-electrical form to electrical form when one coulomb of positive charge passed through the battery.	(i) Potential difference across the two ends of a conductor causes the dissipation of electrical energy into other forms of energy as the charges flow through the circuit.
(ii) Electromotive force is the potential difference between the two terminals of a cell.	(ii) The difference between electric potential between two points is measured in volts and is called potential difference.
(iii) Electromotive force can introduce energy to a system.	(iii) Potential difference cannot introduce energy to a system but it dissipates energy in a circuit.
(iv) Gain in energy per unit charge is e.m.f.	(iv) Loss in energy per unit charge is potential difference.
(v) Electromotive force is always greater than the potential difference.	(v) Potential difference is always less than the electromotive force.
(vi) Electromotive force does not depend on the resistance of the circuit.	(vi) Potential difference of two points depends on the resistance of those points.
(vii) Electromotive force remains constant.	(vii) Potential difference does not remain constant.
(viii) Work done on charge is e.m.f	(viii). Work done by charge is P.D

101114136

Q.14.5 Explain Ohm's law. What are its limitations?

Ans. See Q#9 on Pg# 118

101114137

Q.14.6 Define resistance and its units.

Ans. See Q#10 on Pg# 117

101114138

Q.14.7 What is the difference between conductors and insulators?

Ans.

Conductors	Insulators
(i) The substances through which electric current can pass easily are called conductors.	**(i)** The substances through which heat and electric current cannot pass easily are called insulators.
(ii) Metals like silver, copper etc are good conductor of electricity.	**(ii)** Plastic, fur, glass, wood, etc are non-conductors (or) insulators.
(iii) More free electrons are available for the conduction of electric current.	**(iii)** No free electrons are available for the conduction of current.
(iv) Conductors have very low value of resistance.	**(iv)** Insulators have very high value of resistance.
(v) In conductors, the valance shell is partially filled and have numerous empty levels for the free movement of electrons under the influence of an electric field.	**(v)** In insulators, the valance shell is completely filled and electrons cannot move under the influence of electric field.

101114139

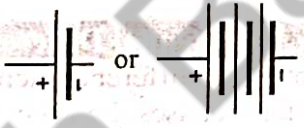
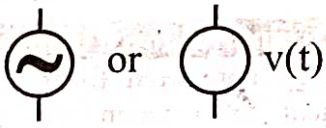
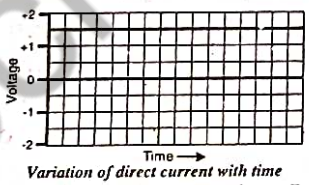
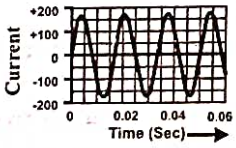
Q.14.8 Explain the energy dissipation in a resistance. What is Joule's Law?

Ans. See Q#14 on Pg# 120

101114140

Q.14.9 What is difference between D.C and A.?

Ans.

Direct Current (D.C)	Alternating Current (A.C)
(i) The current that does not change its direction of flow and is unidirectional is known as direct current.	**(i)** The current that changes its direction after equal intervals of time is called alternating current (or) A.C.
(ii) The current derived from a cell or a battery is direct current.	**(ii)** The current supplied to our home by the power companies is alternating current.
(iii) The symbol used for d.c supply is. 	**(iii)** The symbol used for A.C supply is. 
(iv) The variation of direct current with time is graphically represented as  *Variation of direct current with time*	**(iv)** The variation of alternating current with time is graphically represented as  *Variation of alternating current with time*
(v) Direct current has fix polarity. It means positive and negative terminals of d.c source are fixed.	**(v)** The Alternating Current sources, polarity changes in regular intervals of time.
(vi) Direct current cannot be transmitted to long distances.	**(vi)** Alternating Current can be transmitted to long distances with less power losses.

101114141

Q.14.10 Discuss the main features of parallel combination of resistors.

Ans. See Q#16 on Pg# 119

101114142

Q.14.11 Determine the equivalent resistance of series combination of resistors.

Ans. See Q#15 on Pg# 119

Q.14.12 Describe briefly the hazards of house hold electricity. 101114143

Ans. See Q#25 on Pg# 112

Q.14.13 Describe four safety measures that should be taken in connection with the household circ

(F.B. 2018) 101114144

Ans. Safety measures in household circuits.

(i) Fuse:

Always use Fuse for safety measures in household circuits because a fuse is a device which is used to limit the current in an electrical circuit. The Fuse is always connected to the live wire of the circuit in series before the appliance is connected. If a large, unsafe current passes through the circuit, the fuse melts and breaks the circuit before the wires become hot and cause fire.

(ii) Circuit Breaker:

Use circuit breaker as a safety device. It cuts off power to an electrical circuit if it becomes dangerously overloaded or if a short circuit occurs. Today most houses use circuit breakers to reduce the risk of overloading.

(iii) Earth Wire:

Always use Earth wire with those appliances whose casing is made up of metals. Earth wire protects the users from electric shock and provides the safe route for the flow of current if the live wire touches the casing of metal appliances.

(iv) When working with electricity always use insulated tools.

(v) Never use equipment with damaged insulation or broken plugs.

(vi) Never touch any electrical equipment or circuits with wet hands. It increases the conductivity of electric current.

(vii) Always disconnect the power source before servicing or repairing electrical equipment.

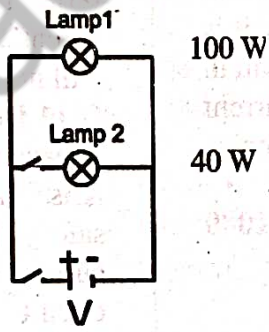
Q.12 Design a circuit diagram for a study room that needs the following equipment in parallel: 101114145

(a) One 100 W lamp operated by one switch.

(b) One reading lamp fitted with a 40 W bulb which can be switched on and off from two points.

(c) What is the advantage of connecting the equipments in parallel instead of series combination.

Ans. The circuit diagram of the part (a) and(b) will be



Parallel combination is better than series combination because in parallel combination each house hold appliances is provided equal voltage.

Conceptual Questions

Q.1 Why in conductors charge is transferred by free electrons rather than by positive charges? 101114146

Ans. As conductor carries a large number of free electrons so the charge in conductor is transferred by free electrons, also physical movement is possible only in case of electron. Positive charges are actually the deficiency of electrons which can't move.

Q.2 What is the difference between a cell and battery? 101114147

Ans. A cell is a energy or charge storing device that consists of a single set of plates while battery is a energy storing device which consists of a number of sets of plates connected in series. A cell is usually dry while in battery electrolyte is used. Battery stores larger energy as compared to single cell.

Q.3 Can current flow in a circuit without potential difference? (F.B. 2018) 101114148

Ans. No, current in any circuit can't flow without potential difference. According to Ohm's Law (V=IR) current passing through the conductor is directly proportional to potential difference. If potential difference is zero then no current will flow through the circuit.

Q.4 Two points on an object are at different electric potentials. Does charge necessarily flows between them? 101114149

Ans. When two points on an object are at different electrical potential then charges will flow. It means if one point is at higher potential and other point is at lower potential then charge flows due to the potential difference. If there is no potential difference then charge will not flow.

Q.5 In order to measure current in a circuit why ammeter is always connected in series? (F.B. 2015) 101114150

Ans. The resistance of an ammeter is very small due to which it does not affect the circuit current. Also in series combination current across each component of circuit is same so the scale reading of ammeter shows the current across each component.

Q.6 In order to measure voltage in a circuit why voltmeter is always connected in parallel? 101114151

Ans. If voltmeter is connected in parallel then due to high resistance it will notaffect the current in circuit due to which voltage of circuit will be different across different resistance. That's why it is always connected in parallel to measure potential. Due to high resistance of volt meter, no current passes through it and circuit voltage remains unaffected.

Q.7 How many watt-hours are there in 1000 joules? (F.B. 2016, 17) 101114152

Ans.

$$1\ \text{KWh} = 3.6\ \text{MJ}$$

$$3.6\times10^{3}\times10^{3}\ \text{J} = 1\ \text{kWh}$$

$$10^{6} = 10^{3}\times10^{3}$$

$$1000\ \text{J} = \frac{1}{3.6\times10^{3}}\ \text{kWh}$$

$$= \frac{1\ \text{kWh}}{3{,}6\times\text{k}}$$

$$= \frac{1}{3.6}\ \text{Wh}$$

$$1000\ \text{J} = 0.28\ \text{Wh}$$

Result: 0.28 volte-hours are in 1000 Joules.

Q.8 From your experience in watching cars on the roads at night, are automobile headlamps connected in series or in parallel? 101114153

Ans. Head light of automobiles are always connected in parallel, because due to technical fault, if one lamp does not work, the other will work properly.

Q.9 A certain flash-light can use a 10-Ohm bulb or a 5-Ohm bulb. Which bulb should be used to get the brighter light? Which bulb will discharge the battery first? 101114154

Ans. According to the relation (V=IR) or $I = \frac{V}{R}$ we can conclude that current and resistance have inverse relation. A flash light with 5Ω bulb gives brighter light and will discharge the battery first as compared to the 10Ω bulb.

Q.10 It is impracticable to connect an electric bulb and an electric heater in series, Why? 101114155

Ans. If both heater and bulb are connected in series then equivalent resistance will increase and potential will drop, also if one appliance fuses other will not run.

Q.11 Does a fuse in a circuit control the potential difference or the current? 101114156

Ans. A fuse controls the current in a circuitupto safety limit not potential difference.When the current exceeds the limit, it burns and breaks the circuit.

Additional Short Questions

Q.13 What do you mean by alternating current (A.(C) ? 101114157

Ans. The current which changes its direction of flow again and again with time is called alternating current or A.C.

Q.14 What do you mean by direct current or D.C? 101114158

Ans. The current which does not change its direction of flow is known as direct current or D.C. It has fixed polarity.

Q.15 Sate Joule's Law. Write down its formula. 101114159

Ans. "The amount of heat energy generated in a resistance is due to flow of electric current is equal to product of square of current 'I', resistance 'R' and time duration 't' i.e. $W = I^2Rt$. This is called Joule's Law".

Q.16 What is kilowatt hour (kWh)? 101114160

Ans. It is the amount of energy obtained from a power of one kilowatt in one hour. It is equal to 3.6 Mega joule.

Q.17 In metals, how electric current is produced? 101114161

Ans. In metals the current is produced only due to the flow of free electrons or negative charges.

Q.18 What do you mean by resistance? 101114162

Ans. The property of a substance which opposes the flow of current through it is called resistance. Its unit is ohm. $R = \frac{V}{I}$

Q.19 What do you mean by specific resistance? 101114163

Ans. The resistance of one-meter cube of a substance is called specific Resistance. $R = \rho\frac{L}{A}$ if $L = 1m$ & $A = 1m^2$ then $R = \rho$

Q.20 Define unit of Resistance
(OR) Define Ohm. 101114164

Ans. A material has a resistance of one Ohm (1 ohm) if there is a current of one ampere flowing through it when the potential difference across it is 1 volt.

Q.21 What is Electromotive force? Write it unit. 101114165

Ans. The energy supplied by the battery to a unit charge when it flows through the closed circuit is called electromotive force or (emf). It's unit is JC^{-1} or volt.

Q.22 What is the net result in the absence of electric field? Why current cannot pass through conductor in normal state? 101114166

Ans. In the absence of electric field, the rate at which the free electrons cross any section of the wire from right to left is equal to left to right; hence net rate is zero, so in spite of the fact that electrons are in motion no current flows through any section of the conductor.

Q.23 What is parallel combination of resistance? 101114167

Ans. If a number of resistors are connected side by side with their ends joined together at common point, then it is called parallel combination.

Q.24 What is equivalent resistance? Or Write the formulae for equivalent resistance for series and parallel combination. 101114168

Ans. A single resistance obtained by replacing a number of resistances in a combination giving similar effects is called equivalent resistance.

For Parallel Combination:

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots\ldots\ldots + \frac{1}{R_n}$$

For series combination:

$$R_e = R_1 + R_2 + R_3 + \ldots\ldots\ldots\ldots + R_n$$

Q.25 What is series combination of resistance? 101114169

Ans. If the resistances are connected end to end such that the same current passes through all of them, then it is called series combination of resistances.

Q. Define the following terms. 101114170
i. Galvanometer ii. Ammeter
iii. Voltmeter

Ans.

Galvanometer

It is a sensitive instrument which is used to detect the presence of current in circuit.

Ammeter

Ammeter is an instrument used to measure electric current.

Voltmeter

Ans. It is an instrument used to measure potential difference between two points.

Q.26 What is electric power? 101114171

Ans. The amount of energy supplied by current in unit time is called electric power. Mathematically,

$$P = \frac{W}{t}$$

Q.27 Prove that: 1 kWh = 3.6×10^6 J 101114172

Ans. 1 kWh = 1000 watt × 1 hour

$$1\text{ kWh} = 1000\,\frac{J}{sec} \times 3600\text{ sec}$$
$$= 10^3 \times 36 \times 10^2\text{ J}$$
$$= 36 \times 10^5\text{ J}$$
$$= 3.6 \times 10 \times 10^5$$
$$= 3.6 \times 10^6\text{J}$$
$$1\text{ kWh} = 3.6 \times 10^6\text{ J}$$

Q.28 What is circuit breaker? Write its working principle. 101114173

Ans. A safety device used in place of fuse is called circuit breaker. It breaks the electric circuit if current increases beyond the given rating. It works on the principle of electromagnetism.

Q.29 How Ammeter is connected in circuit? 101114174

Ans. In order to measure current in a circuit, the ammeter is connected in series, so the current passing in circuit also passes through the ammeter.

Q.30 Is there any effect on current, when ammeter is connected in a circuit? 101114175

Ans. There is no effect upon the current of the circuit, as the resistance of ammeter is very small.

Q.31 How galvanometer is converted into an ammeter? 101114176

Ans. Galvanometer is converted into an ammeter by connecting a suitable low resistance in parallel with the galvanometer which is called shunt.

Q.32 How Galvanometer is converted into Voltmeter? 101114177

Ans. Galvanometer is converted into voltmeter by connecting a suitable high resistance in series with the Galvanometer.

Q.33 What is difference between earth wire and live wire? 101114178

Ans.

Earth Wire	Live Wire
1. The wire carrying no electricity is called earth wire or ground wire.	1. The wire which is at high potential having voltages 220V is called live wire.
2. Its colour is green or yellow.	2. Its colour is red or brown.

Q.34 Why resistance of conductors increase by increasing temperature? 101114179

Ans. When we increase the temperature of a conductor the kinetic energy of the free electrons increases. Due to which the collision of electron with fixed atom increase, which increases the resistance of the conductor.

Q.35 Define Ohm's law and write its formula? 101114180

Ans.Ohm's law:

The amount of current I passing through a conductor is directly proportional to the potential difference V applied across its end provided the temperature and physical state of the conductor does not change.

Formula: $V = IR$

Q.36 What is the difference between fuse and circuit breaker? 101114181

Ans.

Fuse	Circuit Breaker
A fuse is safety device that is connected in series with the live wire in the circuit to protect the equipments when excess current flows.	The circuit breaker acts as a safety device in the same way as a fuse. It disconnects the supply automatically, when the value of current exceeds from the normal value.

Q.37 What is the difference between electric power and kilo watt hour? 101114182

Ans.

Electric Power	KiloWatt hour
The amount of energy supplied by electric current in unit time is known as electric power.	The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt hour.
$P = W/t$	1 KWh = 3.6 MJ

Q.38 Prove that : $P=I^2R$ 101114183

Ans. We know that

$$P = \frac{W}{t} \text{ ----- (i)}$$

as $W = QV$

putting value of 'W' in equation

$$P = \frac{Qv}{t}$$

as $I = \frac{Q}{t}$

so $P = IV$

as $V=IR$

so $P = I^2R$

Q.39 What is the difference between live wire and neutral wire? 101114184

Ans.

Live Wire	Neutral Wire
i. The wire which is at high potential having voltages 220 V is called live wire.	i. The wire which is maintained at zero potential by connecting it to the earth at the power station it self is called neutral wire.
ii. Its Colour is red or brown.	ii. Its colour is black or blue.

Q.40 Which devices are used to measure current? Write names. 101114185

Ans.
Following devices are used to measure current.
(i) Galvanometer
(ii) Ammeter

Q.41 What are the sources of emf? Write names. 101114186

Ans. Following are the sources of emf.

i. Batteries
ii. Thermocouples
iii. Generators

Q.42 Write down the power of electric heater and washing machine? 101114187

Ans. Electric heater : 1500 watt
Washing machine : 750 watt

Q.43 What is meant by potential difference? 101114188

Ans. Potential difference across the two ends of a conductor causes the dissipation of electrical energy into the other forms of energy as charges flow through the circuit.

Q.44 Give any two uses of fuses. 101114189

Ans. 1.It is used to control excess amount of current.

2.It is a safety device which protects electric appliance and person from fatal accidents.

Q.45 Describe two reasons of cables insulation damage. 101114190

Ans. Following are the reasons of cable insulation damage:

1. Constant friction removes the insulation from the wire. Too much moisture also damages the insulation. So it is advisable to use a cable with two layers of insulation.
2. When the electric current in the wire exceeds its limits, the insulation damages due to over heating.
3. When live wire come in contact with neutral wire, short circuit occur which damages the insulation cable.

Q.46 Define electric current and write its mathematical form? 101114191

Ans. *The rate of flow of electric charge through any cross-sectional area is called current.* If charge Q is passing through any area in time then current I flowing through it will be given by

Formula:

$$\text{Current} = \frac{Charge}{Time}$$

$$I = Q/t$$

Unit:

In SI the unit of current is Ampere

Q.47 What is SI unit of electric power. Define it. 101114192

Ans. The unit of electric power is watt (w) when 1 joule of energy is supplied to a resistor in 1 second then the power dissipated by the resistor is 1 watt.

$$1W = 1Js^{-1}$$

Q.48 What do you mean by electrical energy. 101114193

Ans. When a charge moves from a higher electric potential to a lower potential, it delivers electric current. Thus the process during which charges continuously move from a higher potential to a lower potential, becomes a continuous source of electrical energy.

Q.49 Why does the resistance of conductor increases with the increase of its temperature? (F.B. 2013) 101114194

Ans. When the temperature of conductor increases, the vibration of atoms about their mean position also increases which resists the motion of free electrons, for the conduction of electric current. Thus with the increase in temperature resistance of conductor also increases.

Side Information

Q.50 How Voltmeter is connected in circuit? 101114195

Ans. Voltmeter is always connected in parallel with resistance across which the potential difference is to be measured.

Q.51 How current flows in the electrolytes? 101114196

Ans. In electrolysis, current is produced due to flow of both positive and negative charges. In the electrolyte, positive ions are attracted to the cathode and negative ions are attracted to the anode. This movement of ions within the electrolytes constitutes an electric current within the internal circuit.

Q.52 What will be the force between two wires when one ampere current passes through them? 101114197

Ans. One ampere is the current through two parallel thin conducting wires of length 1 m, placed 1 m apart in a vacuum, that exerts a force of 2×10^{-7} N on each other.

Q.53 What is digital multimeter? 101114198

Ans. A digital multimeter can be used to measure currents, resistance and potential difference. For its multipurpose it is named as multimeter.

Q.54 Write down the function of a thermister. (F.B. 2017) 101114199

Ans. A thermister is a temperature dependent resistor and its resistance decreases as temperature rises.

Use: Thermister is used in a circuit that senses temperature change.

Q.55 Why is diamond used as a conductor for heat and insulator for electricity? (OR) How do the jewelersidentify diamond is real or a fake one? (F.B. 2017) 101114200

Ans. Diamond does not conduct electricity, because it has no free electrons. However, it is very good at conducting heat because its particles are very firmly bonded together. Jewellers can tell if a diamond is a real diamond or a fake one made from glass, by holding it to their lips. A real diamond feels very cold due to good ability of transferring heat four or five times better than copper.

Q.56 Write the heating effect of electric current for different purposes. 101114201

Ans. We use heating effect of an electric current for different purposes. For example, when a current flows through the filament of bulb, it glows white hot and gives out light. Electric heater have very thin wires that glow red hot when a current flows.

Q.57 Why energy saver is better source of light? 101114202

Ans. Energy-saver light bulbs transform much more of the electrical energy into light and much less into wasted heat energy. And energy-saver light bulb that uses 11 J of electrical energy each second gives the same amount of light as an "ordinary" incandescent bulb that uses 60 J of electrical energy each second.

Q.58 How is total energy found in appliances when switch on? 101114203

Ans. All electrical appliances have power rating, given in watts or kilowatts. An appliance with a power rating of 1 W transfers 1 joule of electrical energy each second. So a 60 W light bulb converts 60 J of electrical energy each second into light energy and heat energy. To find out the total energy an appliance transfer from the mains, we need to know the number of joules transferred each second and the number of seconds for which the appliance is ON.

Q.59 What is electrical grounding? 101114204

Ans. The Earth is a fairly good electrical conductor. Hence if a charged object is connected with the Earth by a piece of metal, the charge is conducted away from the object to the Earth. This convenient method of removing the charge from an object is called grounding the object. As a safety measure, the metal shells of electrical appliances are grounded through special wires that give electric charges in the shells paths to the Earth. The round post in the familiar three-prong electric plug in the ground connection.

Q.60 Why unit of potential difference is named so? 101114205

Ans. The volt is named after the Italian physicist *AlessondraVolta (1745-1827),* who developed the first practical electric battery, known as *voltaic pile.* Because potential difference is measured in units of volts, it is sometimes referred to as voltage.

Q.61 Why galvanometer is named so? 101114206

Ans. The galvanometer has been named after the physicist *LuigiGalvano (1737-1798),* who invented it.

Q.62 What is the history of the discovery of chemical cell and battery? 101114207

Ans. LuigiGalvano while dissecting a frog's leg, discovered that dissimilar metals touching the legs caused it to twitch. This chance discovery, led to the invention of the chemical cell and battery.

Q.63 In a dry cell chemical energy changes into which form of energy? 101114208

Ans. In a dry cell chemical energy changes into electrical energy.

Q.64 What is the importance of switches in an electric circuit? 101114209

Ans. Switches are used to turn electricity ON and OFF. Turning the switch OFF creates an open circuit by making a break in the wire. The break stops the flow of current because electricity cannot normally travel through air.

Q.65 How long does it take a current of 10mA to deliver 30 C of charge? 101114210

Ans. Given:

$I = 10mA$

$= 10 \times 10^{-3}$ A

$Q = 30$ C

$t = ?$

Solution:

$I = Q/t$

$t = Q/I$

$t = 30/10 \times 10^{-3}$

$t = 3 \times 10^{-3}$ sec.

Q.66 Which metal is used as the filament of an electric bulb? Explain with reason. 101114211

Ans. Tungsten metal is used as the filament because it offers a high resistance to the current. Due to large resistance filament gets heated and starts glowing.

Q.67 A bird can sit harmlessly on high tension wire. But it must not reach and grab neighboring wire. Do you know why? 101114212

Ans. A bird can sitharmlessly on high tension wire because there is no potential difference in the wire so no current will pass through its body. However if the bird grabs the neighboring wire, a potential difference occurs, due to which current will flow through the body of the bird and it will be dangerous.

Q.68 What is circuit diagram? 101114213

Ans. A circuit diagram is a symbolic method of describing a real circuit. The electric symbols used in circuit diagrams are standard, so anyone familiar with electricity can interpret a circuit diagram.

Q.69 Which formula can be used to determine resistance, if the values of all the resistors in a parallel circuit are the same? 101114214

Ans. If the values of all the resistors in a parallel circuit are the same, the overall resistance can be determined by

$$\frac{1}{R_e} = \frac{N}{R}$$

$$R_e = \frac{R}{N}$$

where N is the total number of resistors and R is the resistance of each individual resistor.

Q.70 A light bulb is switched on for 40 s. If the electrical energy consumed by the bulb during this time is 2400 J, find the power of the bulb. 101114215

Ans. **Given:** t= 40 sec
W = 2400 J
P = ?

Solution:

P = W/t
P=2400/40
P = 60 Js^{-1} or
= 60 W

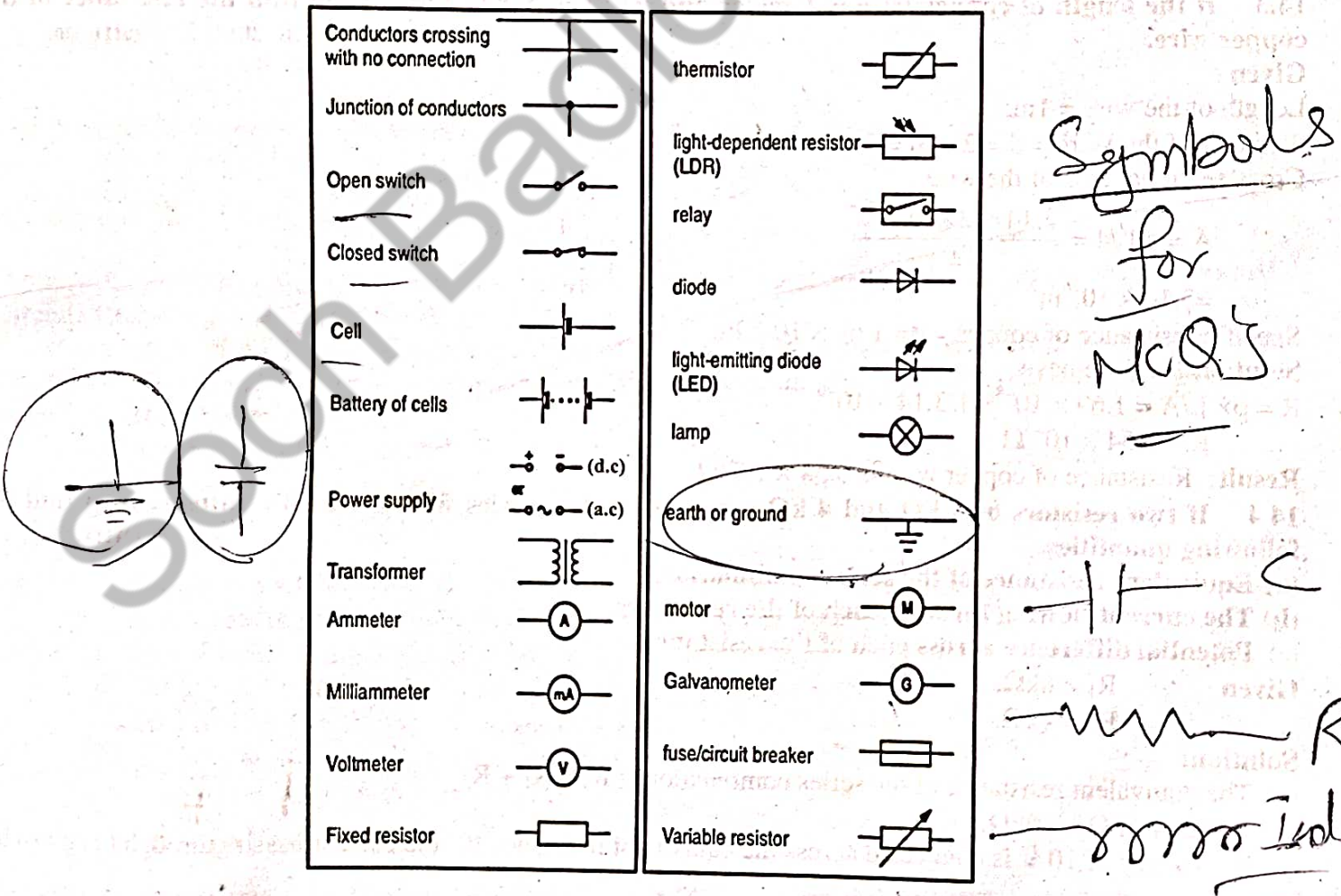
Q.71 What are the colours of live wire, neutral wire and earth wire? 101114216

Ans. Colours for the wires are:

i) Live wire: Red or Brown
ii) Neutral wire: Black or blue
iii) Earth wire: Green or Yellow

Q.72 What are the symbols of the components of the circuits? 101114217

Ans.



Solved Examples

14.1 If 0.5C charge passes through a wire in 10s, then what will be the value of current flowing through the wire? (F.B. 2013) 101114218

Given data:

Q = 0.5C
t = 10s

To find:

Current = I= ?

Solution:

I = Q/t
= 0.5 / 10
=0.05 A
I = 50 mA.

Result: Thus 50 mA current will be flowing though the wire.

14.2 Reading on voltmeter connected across a heating element is 60V. The amount of current passing through the heating element measured by an ammeter is 2A.What is the resistance of the heating coil of the element? 101114219

Given V = 60V,
I =2A.

To find: Resistant R = ?

Solution: Using Ohm's Law

V= IR

We get $I = \frac{V}{R} = \frac{60}{2} = 30\Omega$

Result: The resistance of wire is 30Ω.

14.3 If the length of copper wire is 1 meter and its diameter is 2mm. Then find the resistance of this copper wire. (F.B. 2014) 101114220

Given

Length of the wire = 1m,

diameter of the Wire = d = 2 mm = 2×10^{-3} m.

Cross-sectional area of the wire

$$A = \pi d^2/4 = \frac{3.14\times(2\times10^{-3})^2}{4}$$

$=3.14 \times 10^{-6} m^2$

Specific resistance of copper = ρ= $1.69 \times 10^{-8}\Omega$m.

Solution: Now we have

$R = \rho \times L/A = 1.69 \times 10^{-8} \times 1/3.14 \times 10^{-6}$

$R = 0.54 \times 10^{-2}\Omega$

Result: Resistance of copper wire is $0.54 \times 10^{-2}\Omega$.

14.4 If two resistors of 6 kΩ and 4 kΩ are connected in series with the a 10V battery, then find the following quantities. 101114221

(a) Equivalent resistance of the series combination.

(b) The current flowing through each of the resistance.

(c) Potential difference across each of the resistances.

Given $R_1 = 6k\Omega$,
$R_2 = 4k\Omega$.

Solution:

(a) The equivalent resistance of the series combination is $R_e = R_1 + R_2$
$= 6k\Omega + 4k\Omega = 10k\Omega$.

(b) If a battery of 10 V is connected across the equivalent resistance R_e, the current passingthroughit is given by

$$I = \frac{V}{R_e} = \frac{10}{10\times10^3} = 1.0\times10^{-3}\ A$$

In the case of series combination same current would pass through each resistance.

Hence current through R_1 and R_2 would be equal to 1.0×10^{-3} A.

(c) Potential difference across R_1 =

$$V_1 = IR_1 = 1.0 \times 10^{-3}\times6\times10^3 = 6V$$

Potential difference across R_2 =

$$V_2 = 1.0 \times 10^{-3}\times 4\times10^3 = 4V.$$

14.5 If in the circuit $R_1 = 2\Omega$, $R_2 = 3\Omega$, $R_3 = 6\Omega$, and V = 6V, then find the following quantities: 101114222

(a) Equivalent resistance of the circuit.

(b) Current passing through each of the resistances.

(c) The total current of the circuit.

Solution:

(a) As the resistors are connected in parallel, equivalent resistance of the combination R_e is given by

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_e} = \frac{6}{6} = 1\Omega$$

Therefore, $R_e = 1\Omega$. This value is smaller than the lowest value of the resistance in the combination which is always the case in parallel circuits.

(b) In parallel combination, the potential difference across each of the resistance is same and is equal to the potential of the battery, which is 6V here. Therefore.

Currentthrough $R_1 = I_1 = \frac{V}{R_1} = \frac{6}{2} = 3A.$

Current through $R_2 = I_2 = \frac{V}{R_2} = \frac{6}{3} = 2A.$

Current through $R_3 = I_3 = \frac{V}{R_3} = \frac{V}{R_3} = \frac{6}{6} = 1A.$

(c) Sum of the currents passing through the resistances in parallel combination is equal to the total current of the circuit. Therefore, total current is 6 A.

14.6 If a current of 0.5 A passes through a bulb connected across a battery of 6 V for 20seconds, then find the rate of energy transferred to the bulb. Also find the resistance of the bulb. (F.B. 2018) 101114223

Given: I = 0.5 A,
V = 6 V,
t = 20 s.

Solution: Now using the formula
Energy = W = VIt,
Energy = $6 \times 0.5 \times 20 = 60$ J.
So the rate of energy transferred must be 60 J in 20 s or 3 J per second or 3 watt.
Now Energy = W = I^2Rt,
We get resistance as
$60 = (0.5)^2\times R \times 20$

$$R = \frac{60}{20\times0.25} = 12\Omega$$

Result: Resistance of bulb is 12Ω.

14.7 The resistance of an electric bulb is 500Ω. Find the power consumed by the bulb when a potential difference of 250 V is applied across its ends. 101114224

Given:

R = 500Ω

V = 250 V

Solution: Using the formula, I = V/R.

We get, current I = 250 /500 = 0.5 A.

And Power = P = $I^2R = (0.5)^2 \times 500 =$ 125 W.

Result: Thus the power of the bulb is 125 W.

14.8 Calculate the one month cost of using 50 W energy saver for 8 hours daily in your study room. Assume that the price of a unit is Rs. 12. 101114225

Solution: Given Power = 50 W = 0.05 kW,

Time = 8 hours.

Or Energy consumed in KWH $= \frac{\text{watt} \times \text{time(h)} \times \text{No.of days}}{1000}$

$= \frac{50 \times 8}{10\cancel{0}\cancel{0}} \times 3\cancel{0} = \frac{12\cancel{0}}{1\cancel{0}}$

= 12KWH

= 12 unit

Number of units consumed = 8 ×30 × 0.05 = 12 units.

Therefore, total cost = 12 × 12 = Rs. 144.

Result: 12 units will be consumed in a study room. The cost of electricity is Rs. 144.

Numerical Problems

14.1 A current of 3mA is flowing through wire for 1 minute. What is the charge flowing through the wire? 101114226

Given data:

I=3mA

$=3 \times 10^{-3}$A

t=1min=60 sec

To Find

Q=?

Calculation:

Q=It

$=3 \times 10^{-3} \times 60$

$Q = 180 \times 10^{-3}$ C

Result: The charge flowing through the wire is 180×10^{-3} coulomb.

14.2 At 100,000Ω, how much current flows through your body if you touch the terminals of a 12V battery? If your skin is wet, so that your resistance is only 1000Ω, how much current would you receive from the same battery? 101114227

Given data:

Resistance of dry skin $=R_1$ $=100000\ \Omega$

Voltage $V_1=12$ V

Resistance of wet skin $=R_2=1000\ \Omega$

To Find

Current for dry skin

I_1 = ?

Current for wet skin

I_2 = ?

Calculation:

$I_1 = \frac{V}{R_1}$

$= \frac{12}{100000}$

$= \frac{12}{1 \times 10^5}$

$= 12 \times 10^{-5}$

$I_1 = 1.2 \times 10^{-4}$ A

Current for wet skin = $I_2 = \frac{V}{R_2} = \frac{12}{1 \times 10^3}$

$=12 \times 10^{-3}$ $=1.2 \times 10^{-2}$ A

Result: Hence, 1.2×10^{-4} A current would received by dry skin and 1.2×10^{-2} A current would be received by wet skin.

14.3 The resistance of a conductor wire is 10MΩ. If a potential difference of 100 volt is applied across its ends, then find the value of current passing through it in mA. 101114228

Given data: R = 10M Ω

= $10 \times 10^6 \Omega$

$V = 100V$

To Find

Current in mA = I = ?

Calculation:

We know that $V = IR$

$$I = \frac{V}{R}$$

$$= \frac{100}{10\times10^{6}}$$

$$= \frac{10}{10^{3}\times10^{+3}}$$

$$= \frac{10\times10^{-3}}{1000}$$

$$= 0.01\times10^{-3}\,A$$

$$I = 0.01\ mA$$

Result: Thus, 0.01 mA current is passing through the conductor.

14.4 By applying a potential difference of 10V across a conductor a current of 1.5 A passes through it. How much energy would be obtained from the current in 2 minutes?

(F.B. 2018) 101114229

Given data

$V = 10V$

$I = 1.5\ A$

$t = 2min = 2\times60 = 120\ sec$

To find

$W = ?$

We know that

$W = QV$

As $Q = I\times t$

Then

Calculation:

$$W = I\times t\times V$$

$$= 1.5\times120\times10$$

$$= 1800$$

$$= 1800\ J$$

Result: Thus, 1800J energy would be obtained from the current.

14.5 Two resistances of 2kΩ and 8kΩ are joined in series, if a 10V battery is connected across the ends of this combination, find following quantities. 101114230

(a) Equivalent resistance of the parallel combination.

(b) Current passing through each of the resistances.

(c) Potential difference across of their resistance.

Given data

$R_1 = 2\ k\Omega = 2\times10^{3}\Omega$

$R_2 = 8\ k\Omega = 8\times10^{3}\Omega$

$V = 10\ V$

To find

$R_e = ?$

$I = ?$

$V_1 = ?$

$V_2 = ?$

Calculation:

$$R_e = R_1 + R_2$$

$$= 2 + 8$$

$$= 10\ k\Omega$$

$$V = IR_e$$

$$I = \frac{V}{R_e}$$

$$= \frac{10}{10\times10^{3}}$$

$$= 1\times10^{-3}\ A$$

$$= 1\ mA$$

$$V_1 = IR_1$$

$$= 1\times10^{-3}\times2\times10^{3}$$

$$= 2V$$

$$V_2 = IR_2$$

$$= 1\times10^{-3}\times8\times10^{3} = 8V$$

14.6 Two resistance of 6kΩ and 12kΩ are connected in parallel. A 6V battery is connected across its ends, find the values of the following quantities. 101114231

(a) Equivalent resistance of the parallel combination.

(b) Current passing through each of the resistances.

(c) Potential difference across each of the resistance.

Given data

$R_1 = 6\ k\Omega = 6\times10^{3}\Omega$

$R_2 = 12\ k\Omega = 12\times10^{3}\Omega$

$V = 6\ V$

To find

$R_e = ?$

$I_1 = ?$

$I_2 = ?$

V_1 = ?

V_2 = ?

Calculation:

$$\frac{1}{R_e} = \frac{1}{R_1}+\frac{1}{R_2}$$

$$= \frac{1}{6}+\frac{1}{12}$$

$$= \left(\frac{1}{6}+\frac{1}{12}\right)$$

$$= \left(\frac{2+1}{12}\right)$$

$$= \frac{3}{12}$$

$$\frac{1}{R_e} = \frac{1}{4}$$

$R_e = 4\ k\Omega$

$$I_1 = \frac{V}{R_1}$$

$$= \frac{6}{6\times10^3}$$

$= 1 \times 10^{-3}$ A

= 1 m A

$$I_2 = \frac{V}{R_2}$$

$$= \frac{6}{12\times10^3}$$

$= 0.5\times 10^{-3}$A

= 0.5 m A

Because the resistances are connected in parallel so the value of voltage across each resistance is same which is equal to the value of voltage provided by the battery.

$V = V_1 = V_2$

V_1 = 6 V

and V_2 = 6 V

14.7 An electric bulb is marked with 220V, 100W. Find the resistance of the filament of the bulb. If the bulb is used 5 hours daily, find the energy in Kilowatt hour consumed by the bulb in one month (30-days). 101114232

Given data

V = 220 V

P = 100 W

t = 5 × 30 = 150 hours

To find

Energy in KWh = ?

Resistance = R = ?

Calculation:

We know that

$P = VI$

As $I = \frac{V}{R}$

Then $P = \frac{V^2}{R}$

$R = \frac{V^2}{P}$

$$= \frac{(220)^2}{100}$$

$$R = \frac{22\cancel{0}\times22\cancel{0}}{\cancel{100}}$$

R = 484 Ω

$$\text{Energy in KWh} = \frac{\text{Watt}}{1000}\times\text{Time(hrs)}$$

$$\text{Time(hrs)} = \frac{\cancel{100}}{1000}\times15\cancel{0}$$

5 × 30 = 150 hrs

= 15 KWh

Result: Resistance of bulb is 484Ω which consumes 15 KWh in a month.

14.8 An incandescent light bulb with an operating resistance of 95Ω is labelled "150 W" is this bulb designed for used in a 120V circuit or a 220V circuit? 101114233

Given data: R = 95 Ω

P = 150 W

To find

V = ?

Calculation:

$P = \frac{V^2}{R}$

$V^2 = PR$

$V = \sqrt{PR}$

$= \sqrt{95\times150}$

=119.37= 120 V

Result: So this bulb is designed for use in a 120 V, circuit

14.9 A house is installed with 101114234

(a) 10 bulbs of 60W each of which are used 5 hours daily.

(b) 4 fans of 75 W each of which runs 10 hours daily.

(c) One TV of 250 W which is used 2 hours

daily.

(d) **One electric iron of 1000W which is used for 2 hours daily.**
If the Cost of one unit of electricity is Rs.4.Find the monthly expenditure of electricity.
(One month = 30 days)

Given
For Bulbs
No. of bulbs =10
Power of bulb = 60 Watt
Time =5× 30=150 hrs

$$\text{Unit consumed by bulb} = \frac{\text{Watt}}{1000} \times \text{Time(hrs)}$$

$$= \frac{10 \times 60}{1000} \times 150$$

= 90 units

For Fan
No. of fans =4
Power of fan =75 W
Time =10 × 30 =300 hrs

$$\text{No. of unit} = \frac{\text{Watt}}{1000} \times \text{Time(hrs)}$$

$$= \frac{75 \times 4}{1000} \times 300$$

$$= \frac{300 \times 3}{10} = 90 \text{ units}$$

For T.V.
No. of T.V =1
Power of T.V =250 W
Time =2 × 30=60 hrs

$$\text{No. of units} = \frac{\text{Watt}}{1000} \times \text{Time(hrs)}$$

$$= \frac{250}{1000} \times 60$$

=15 units

No. of iron =1
Power of iron =1000 W
Time =2 × 30= 60hrs

$$\text{No. of unit} = \frac{\text{Watt}}{1000} \times \text{Time(hrs)}$$

$$= \frac{1000}{1000} \times 60$$

=60 Unit

Total units =90 + 90 + 15 + 60
=255 Unit

Cost of one unit =Rs 4

TO FIND
Cost of electricity =?
SOLUTION
Cost of electricity = Total unit× Cost of one unit

=255 × 4
=Rs. 1020

14.10 A 100 W lamp bulb and a 4 kW water heater are connected to a 250 V supply. Calculate (a) the current which flows in each appliance and (b) the resistance of each appliance when in use. 10111423035

Given data
Power of bulb P_1=100 W
Power of heater P_2=4 kW
=4 × 10^3 W
V = 250 V

To find
Current flow across bulb I_1=?
Current flow across heater I_2=?
Resistance of bulb R_1= ?
Resistance of heater R_2=?

Calculation:

$$P_1 = I_1 V$$

$$I_1 = \frac{P_1}{V} = \frac{100}{250}$$

= 0.4 A

$$I_2 = \frac{P_2}{V} = \frac{4 \times 10^3}{250}$$

$$= \frac{4000}{250}$$

I_2 = 16A

$$P_1 = \frac{V^2}{R_1}$$

Resistance of bulb

$$R_1 = \frac{V^2}{P_1} = \frac{(250)^2}{100}$$

$$= \frac{250 \times 250}{100}$$

$R_1 = 625\Omega$

= 625 Ω

$$P_2 = \frac{V^2}{R_2}$$

Resistance of heater $R_2 = \frac{V^2}{P_2} = \frac{(250)^2}{4000}$

$= \frac{250 \times 250}{4000}$

$= \frac{625}{4}$

$R_2 = 15.625\Omega$

Result: Current and resistance of bulb is 0.4A and 625Ω and current and resistance of heater is 16 A and 15.625Ω.

14.11 A resistor of resistance 5.6 Ω is connected across a battery of 3.0 V by means of wire of negligible resistance. A current of 0.5 ampere passes through the resistor. Calculate the (a) power dissipated in the resistor (b) total power produced by the battery. (c) Give the reason of difference between these two quantities.

(F.B. 2015) 101114236

Given data

R = 5.6 Ω

V = 3V

I = 0.5 A

To Find

Power dissipation in the resistor = P =?

Power dissipation in battery = P' =?

Calculation:

$P_{dis} = I^2R$

$= (0.5)^2 \times 5.6$

$= 1.4$ W

$P' = IV$

$= 0.5 \times 3$

$= 1.5$ W

$P' - P = 1.5 - 1.4$

$= 0.1$ W

Result: The difference arises to overcome the internal resistance of battery. Some power is lost by the internal resistance of the battery.

$P = IV$

$P = IV$ Only for Battery

$P = I^2R$, $P = \frac{V^2}{R}$ for Circuit

(actual Power) separately Battery

UNIT 15

Electromagnetism

Q.1 Define Electromagnetism. Write its uses. 101115001

Ans. Electromagnetism

It is the study of magnetic effect of current.

Uses: The uses of electromagnetism in different fields of science and technology are very wide.

1. Motors and electric meters are based on the effect of magnetism.
2. Generators produced electric current due to the movement of wires near very large magnets.

Q.2 What are the magnetic effects of steady current? 101115002

Ans. Magnetic effects of electric current

"When current passes through a conductor, a magnetic field is produced in the space around it."

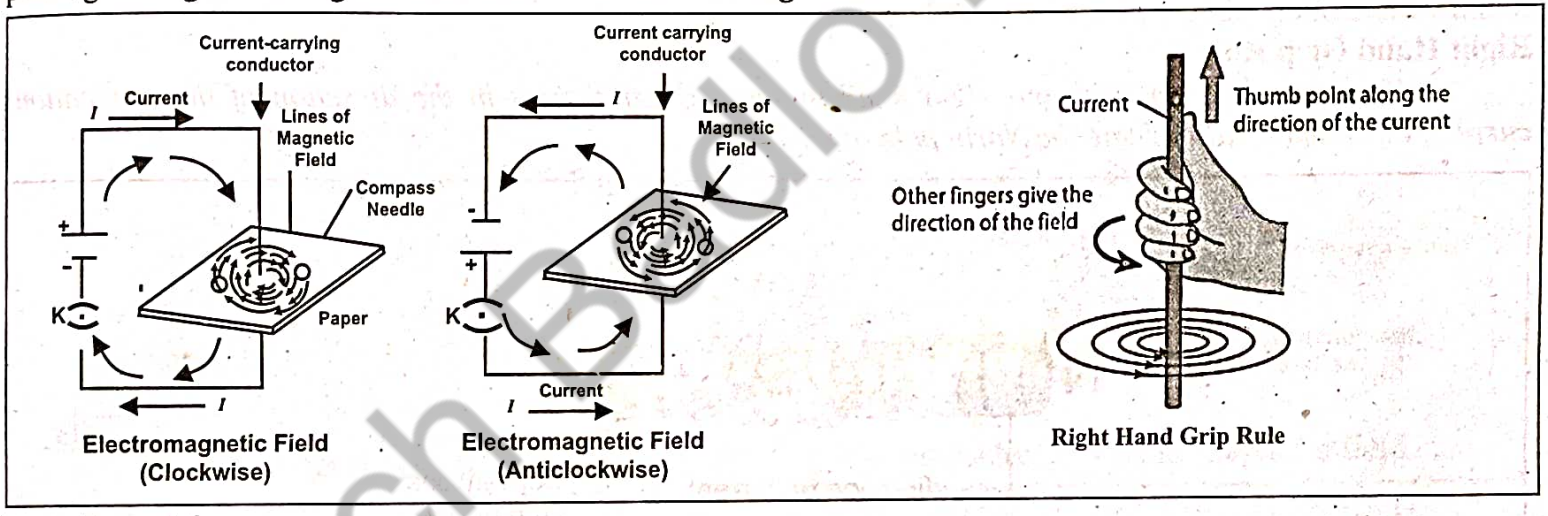
Straight Wire

If current passes through straight wire then lines of force of this magnetic field would be in the form of concentric circles. The lines of force can be traced on cardboard with the compass needle. The direction of lines of force can be determined by Right Hand Rule.

Right Hand Grip Rule

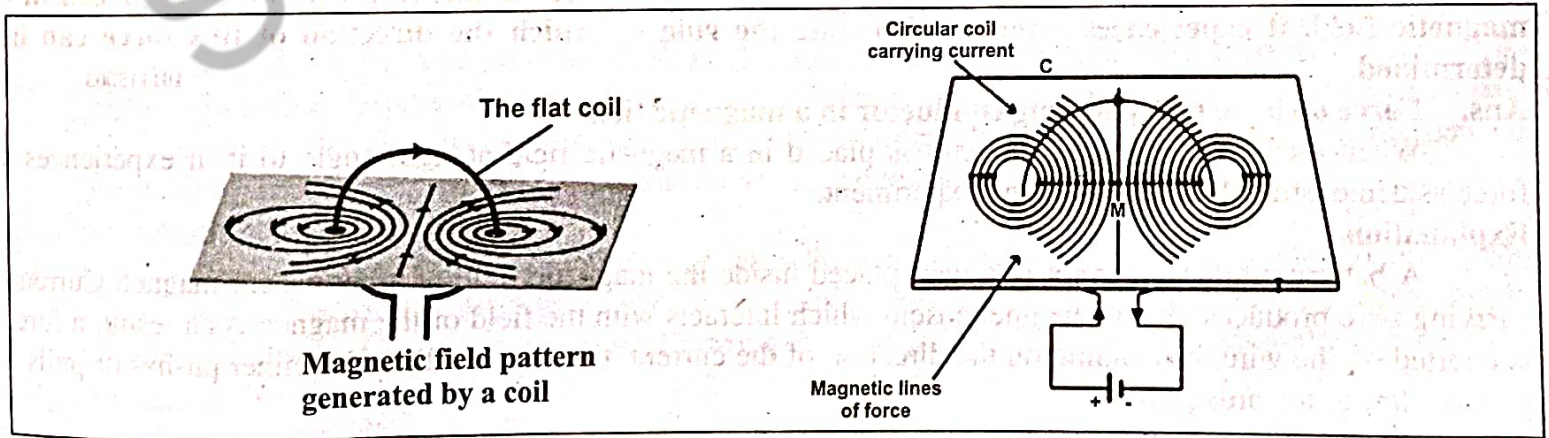
According to Right Hand Grip Rule ***"Grasp the current carrying conductor in right hand with the thumb being stretched in the direction of conventional current. The curl of fingers will point in the direction of magnetic lines of force"***. This rule shows that if the current is flowing through wire from bottom end to top then the direction of lines of force would be anti-clockwise. On the other hand, if the current is flowing from top towards the bottom, it would be clockwise.

Coil: A coil of few turns of wire is shown in fig. Its two ends are connected with a battery so that a current is passing through it. In fig, vertical cross section of a single turn of this coil has been shown by a small circle.



Direction of Current

The direction of current has been indicated by placing a dot (.) or a sign of multiplication (×) in these circles. A dot indicates that the current is directed out of the plane of the paper, i.e., it is flowing towards us where as a sign of cross (×) would mean that the current is directed into the paper i.e. it is flowing away from us.



Lines of Force of Coil

These lines are straight and parallel in a small region near the centre of the coil and are directed perpendicular to its plane. They are approximately circular near the wire. Thus, the field is uniform in a small area surrounding the centre of the coil. In the remaining portion it is non-uniform.

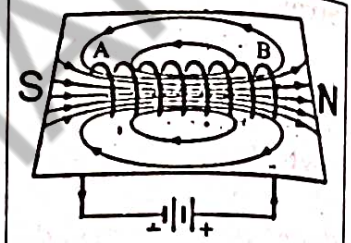
Solenoid

A long coil of wire consisting of many loops is called a Solenoid.

Solenoid

Magnetic field of a Solenoid

The field from each loop in a solenoid adds to the fields of the loops and creates greater total field strength. Electric current in the coil of wire produces magnetic field which is similar to the magnetic field of a permanent magnet. When this current-carrying coil is brought close to a suspended bar magnet, one end of the coil repels the north pole of the magnet bar menu. Thus, the current-carrying coil has a North and a South pole and is itself a magnet.



Magnetic field due to coil

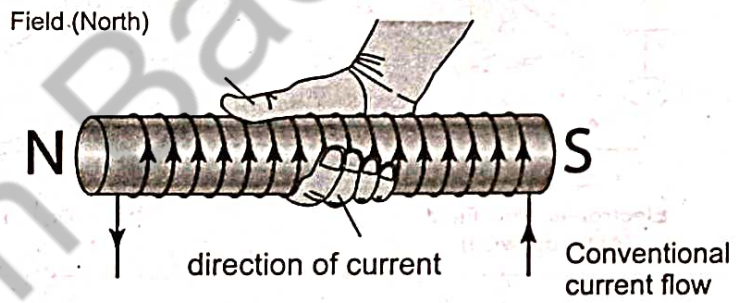
Electromagnet

"The type of temporary magnet, which is created when current flows through a coil, is called an Electromagnet".

The direction of the magnetic field produced by a coil due to the flow of conventional current can be found with the help of Right Hand Grip Rule stated as

Right Hand Grip Rule

"If we grip the coil with our right hand by curling our fingers in the direction of the conventional current, our thumb will indicate the North pole of the coil".



Right hand grip rule for a coil

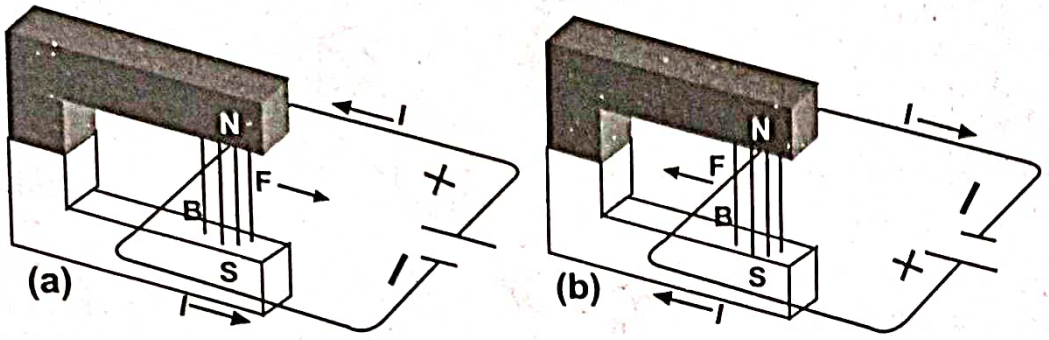
Q.3 Describe an experiment to show that when a straight current carrying conductor is placed in a magnetic field, it experiences a force. Also state the rule by which the direction of this force can be determined. 101115003

Ans. Force on a current carrying conductor in a magnetic field

When a current carrying conductor is placed in a magnetic field at right angle to it, it experiences a force as demonstrated by the following experiment.

Explanation

A battery produces current in a wire placed inside the magnetic field of a permanent magnet. Current-carrying wire produces its own magnetic field which interacts with the field of the magnet. As a result, a force is exerted on the wire. Depending on the direction of the current, the force on the wire either pushes or pulls it towards left or towards right.



Force on a current carrying wire in magnetic field

Dependence of Force

Michael Faraday discovered that the force on the wire is at right angles to both the direction of the magnetic field and the direction of the current. The force is increased if

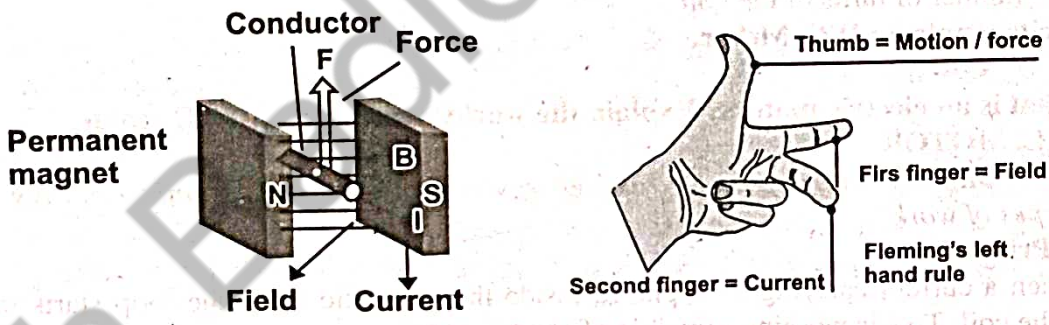
- The current in the wire is increased
- Strength of magnetic field is increased
- The length of the wire inside the magnetic field is increased

Direction of Force

The direction of the force on a current-carrying wire in a magnetic field can be found by using Fleming's Left Hand Rule stated as:

Fleming's Left Hand Rule

"Stretch the thumb, forefinger and the middle finger of the left hand mutually perpendicular to each other. If the forefinger points in the direction of the magnetic field, the middle finger in the direction of the current, then the thumb would indicate the direction of the force acting on the conductor".



Direction of force on a current carrying conductor placed in magnetic field

Note:

The force acting on the conductor is at right angle to both the directions of current and magnetic field according to the Fleming's Left Hand Rule.

Q.4 How current carrying coil rotates in a magnetic field? 101115004

OR

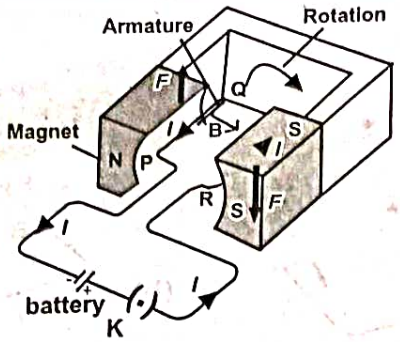
State that a current carrying coil placed in magnetic field experience a torque.

Ans. *"When a current carrying rectangular coil is placed in magnetic field then it rotates about its axis".*

If instead of a straight conductor, we place a current-carrying loop inside the magnetic field, the loop will rotate due to the torque acting on the coil. This is also the working principles of electric motors.

Explanation

Consider a rectangular coil of wire with sides PQ and RS, lying perpendicular to the field, placed between the two poles of a permanent magnet. Now if the ends of the coil are connected with the positive and negative terminals of a battery, a current would start flowing through the coil. The current passing through the loop enters from one end of the loop and leaves from the other end.



A current carrying coil in a magnetic field

Direction of Force

To find the direction of force on a coil we apply Fleming's Left Hand Rule to each side of the coil. We can see that on PQ side of the loop force acts upward, while on the RS side of the loop force acts downward. It is because the direction of the current through the two sides of the loop facing the two poles is at right angle to the field but opposite to each other. The two forces which are equal in magnitude but opposite in direction form a couple. The resulting torque due to this couple rotates the loop, and the magnitude of the torque acting on the loop is proportional to the magnitude of the current passing through the loop.

Dependence of Torque

If we increase the number of loops, the turning effect is greatly increased. This is the principle involved in electric motors. Torque or turning effect of force acting on a current carrying loop placed inside the magnetic field can be increased by increasing.

- Strength of magnetic field
- Area of loop
- Amount of current
- Number of turns of the coil

Q.5 Write a note on D.C. Motor. 101115005

OR

What is an electric motors? Explain the working principle of D.C motor.

Ans. D. C. MOTOR

"D.C. Motor converts the electrical energy of battery into mechanical energy, which is utilized for different types of work".

Working Principle:

When a current carrying loop placed inside the magnetic field, the loop starts to rotate due to torque acting on the coil. This is working principle of electric motor.

Construction

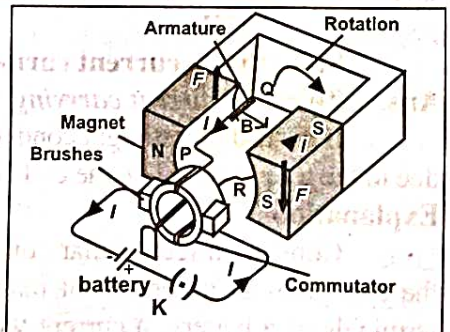
D. C. Motor consists of following parts:

1- Rectangular coil which is mounted on spindle. **2-** Permanent magnet.

3- Split ring commutator. **4-** Two carbon brushes.

Working

The simple coil placed in a magnet cannot rotate more than 90°. The forces push the PQ side of the coil up and the RS side of the loop down until the loop reaches the vertical position. In this situation, plane of the loop is perpendicular to the magnetic field and the net force on the coil is zero. So the loop will not continue to turn because the forces are still up and down and balanced. To rotate the coil continously direction of current must be reversed.



Working principle of D.C. Motor

To reverse direction of current, the connection to coil is made through an arrangement of brushes and a ring that is split into two halves, called a split ring commutator. Brushes, which are usually pieces of

graphite, make contact with the commutator and allow current to flow into the loop. As the loop rotates, so does the commutator. The split ring is arranged so that each half of the commutator changes brushes just as the coil reaches the vertical position. Changing brushes reverse the current in the loop. When coil reaches the vertical position, the brushes reach to vacant space between the split rings and their connection with the coil is cut off, the coil instead of becoming stationary, it continues to move beyond this vertical position because of its momentum and the connection of split ring with brushes is again established. As the direction of current is reversed which allow the coil to rotate continuously.

Result

As a result, the direction of the force on each side of the coil is reversed and it continues to rotate. This process repeats at each half-turn, causing coil to rotate in the magnetic field continuously. The result is an electric motor, which is an apparatus that converts electric energy into rotational kinetic energy.

Practical Electrical Motor

In a practical electric motor the coil, called the armature, is made of many loops mounted on a shaft or axle. The magnetic field is produced either by permanent magnet or by an electromagnet, called a field coil. The torque on the armature, and, as a result, the speed of the motor, is controlled by varying the current through the motor.

Dependence of Force

The total force acting on the armature can be increased by:

- Increasing the number of turns on the coil
- Increasing the strength of the magnetic field
- Increasing the current in the coil
- Increasing the area of the coil

Q.6 Explain the Electromagnetic Induction. 101115006

OR

Describe a simple experiment to demonstrate that a changing magnetic field can induce e.m.f in circuit.

OR

Define electromagnetic induction and explain with example.

Ans. Electromagnetic Induction

"The process of generating an induced current in a circuit by changing the number of magnetic lines of force passing through it is called Electromagnetic Induction."

Historical Background

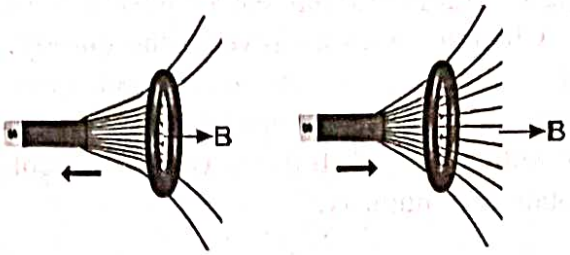
Hans Christian Oersted and Ampere discovered that an electric current through a conductor produces a magnetic field around it. Michael Faraday thought that the reverse must also be true: that a magnetic field must produce an electric current. Faraday found that he could induce electric current by moving a wire through a magnetic field. In the same year, Joseph Henry also showed that a changing magnetic field could produce electric current.

Strength of Magnetic Field

"The strength of magnetic field is defined as the number of magnetic lines of force passing through any surface.

- The number of lines of force is maximum when the surface is held perpendicular to the magnetic lines of force.
- It will be minimum when surface is held parallel to the magnetic lines of force.
- If we place a coil in the magnetic field of a bar magnet, some of the magnetic lines of force will pass through.
- If the coil is far away from the magnet, only a few lines of force will pass the coil.
- If the coil is close to the magnet, a large number of lines of force will pass through it.

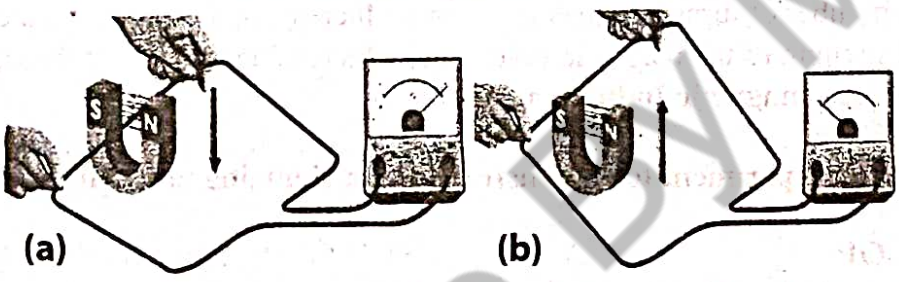
This means, we can change the number of magnetic lines of force through a coil by moving it in the magnetic field. This change in the number of magnetic field lines will induce an e.m.f in the coil. This is the basic principle of production of electricity and working of transformer.



Demonstration of electromagnetic induction by the movement of a wire loop in the magnetic field
Variation of magnetic field lines of force through a coil placed at different distances from the magnet

Experiment

Take a rectangular loop of wire and connect its two ends with a galvanometer. Now hold the wire stationary or move it parallel to the magnetic field of a strong u-shaped magnet. Galvanometer shows no deflection and hence there is no current. Now move the wire downward through the field, current is induced in one direction as shown by the deflection of the galvanometer. Now move the wire upward through the field, current is induced in the opposite direction.



Electromagnetic induction by the movement of wire loop in the magnetic field

Q.7. State and explain the Faraday's law of electromagnetic induction. 101115007

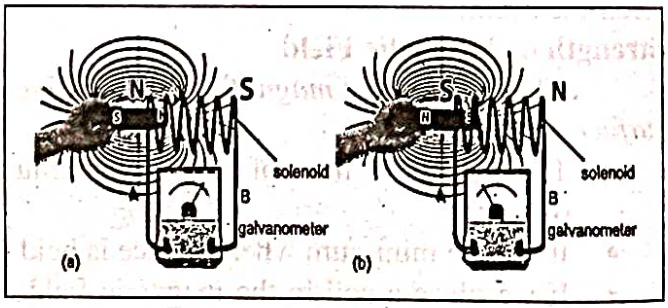
Faraday's law

Michael Faraday stated this law in 1831. According to this law,

"The value of induced e.m.f in a circuit is directly proportional to the rate of change of number of magnetic lines of force through it".

Experiment

Following experiment verify Faraday's Law of Electromagnetic Induction in which current is induced by moving a magnet into the solenoid or out of the solenoid. When the magnet is stationary, no current is induced. When the magnet is moved towards the solenoid, the needle of galvanometer deflects towards right, indicating that a current is being induced in the solenoid. When the magnet is pulled away from the solenoid, the galvanometer deflects towards left, indicating that the induced current in the solenoid is in the opposite direction.



Result:

From the above experiment, we conclude that an e.m.f is induced in the coil when there is a relative motion between the coil and the magnet. This phenomenon in which an e.m.f is induced due to the relative motion between the coil and the magnet is called Electromagnetic Induction.

Factors Affecting Induced e.m.f

The magnitude of induced e.m.f in a circuit depends on the following factors:

1. Speed of relative motion of the coil and the magnet.
2. Number of turns of the coil.
3. Amount of current passing through the coil.

Q.8 Define and explain Lenz's Law. OR How can we find out the direction of induced e.m.f.?
OR
Describe the direction of induced e.m.f in a circuit? How does this phenomenon relate to conservation of energy? 101115008

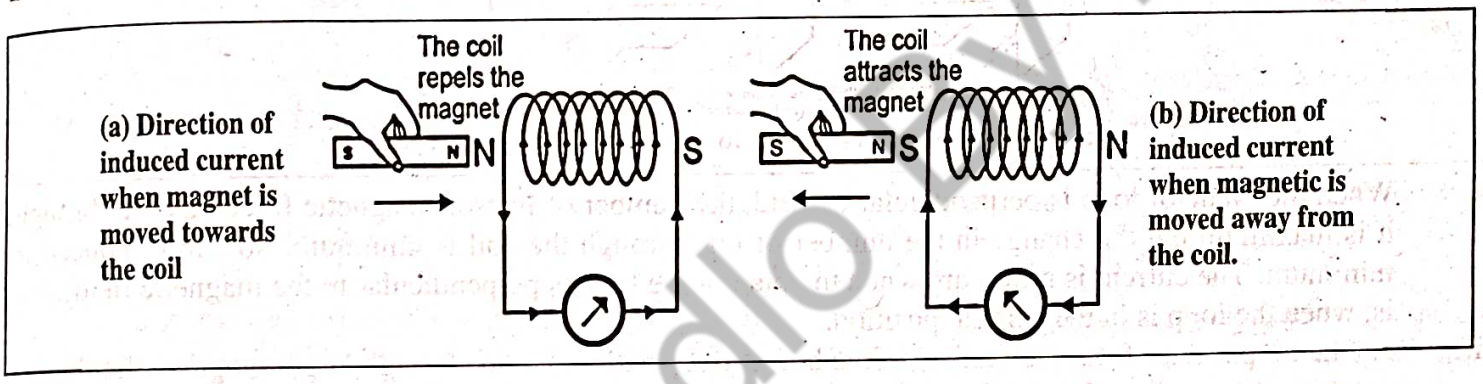
Ans. Lenz devised a rule to find out the direction of a current induced in a circuit and is defined as:
"The direction of an induced current in a circuit is always such that it opposes the cause that produces it".

Experiment:

If we bring a north pole of a bar magnet near a solenoid, e.m.f will be induced in the solenoid by electromagnetic induction. The direction of the induced current in the solenoid by the induced e.m.f will be such that it will repel the north pole of the magnet. This is only possible if the left end of the solenoid becomes a north pole. Hence, according to right hand grip rule, the direction of the induced current in the solenoid will be anticlockwise. Similarly, when we move the north pole of the magnet away from the solenoid, the direction of the induced current will be clockwise.

Lenz's Law and Law of Conservation of Energy

If we apply the law of conservation of energy to electromagnetic induction, we realize that the electrical energy induced in a conductor comes from the kinetic energy of the moving magnet. We do some work on the magnet to bring it close to the solenoid. This work done consequently appears as electrical energy in the conductor. Thus, mechanical energy of our hand used to push the magnet towards or away from the coil results into electrical energy. Hence, Lenz's law is a manifestation of the law of conservation of energy.



Q.9 What is A.C. Generator? Explain its construction and working. 101115009
OR **(F.B. 2018)**
Draw a labelled diagram to illustrate the structure and working of A.C generator.

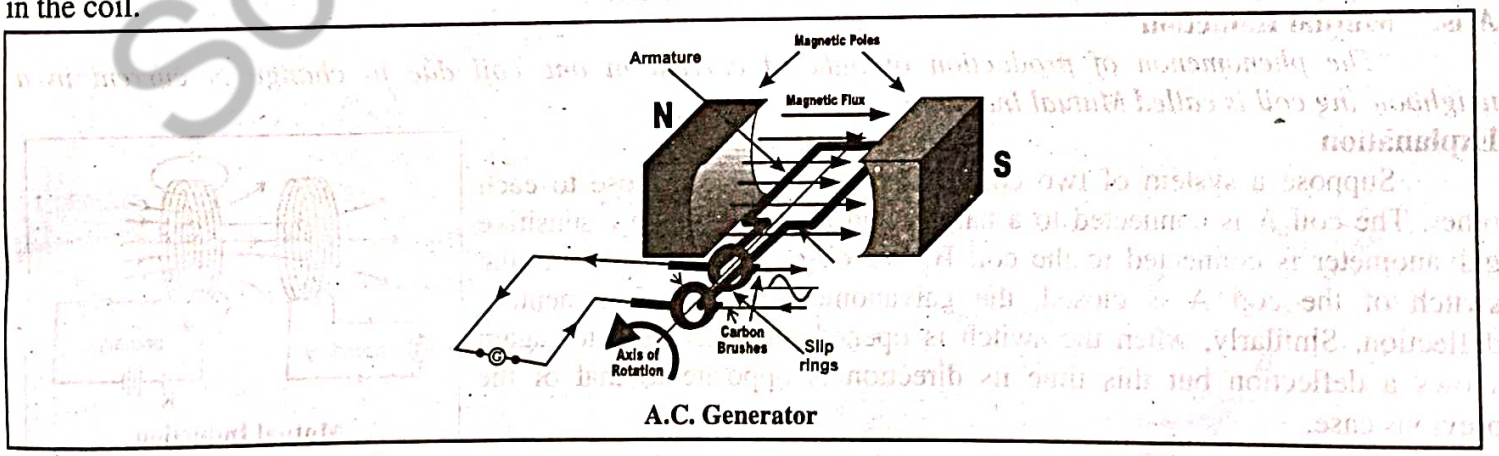
Ans. A.C. Generator

"It is a device which converts mechanical energy into electrical energy. This energy is in the form of alternating current".

Principle

A.C generator works on the principle of electromagnetic induction.

When a coil rotates in a magnetic field, the magnetic flux passing through it continuously changes from maximum to minimum and from minimum to maximum value and so on. This change of flux induces an e.m.f. in the coil.



A.C. Generator

Construction

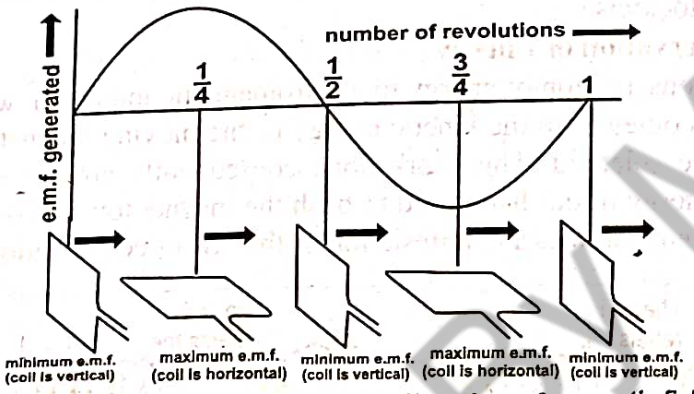
It consists of following parts:

1. Rectangular coil.
2. Permanent magnet
3. Slip rings
4. Two carbon brushes

A simple generator consists of a rectangular coil, which is rotated between the poles of a permanent magnet. Both the ends of the coil are soldered to the two slip rings fixed on the arm of the coil. Two carbon brushes are kept in contact with these slip rings with the help of two springs. Current is drawn from the coil through these brushes.

Current from a generator:

When a generator is connected in a closed circuit, the induced e.m.f. generates an electric current. As the loop rotates, the strength and the direction of the current changes as shown in Fig.



Position of coil with respect to direction of magnetic field

(i) When the plane of loop is perpendicular to field, the number of lines of magnetic force passing through it is maximum but the change in the number of line through the coil is minimum. So e.m.f. induced is minimum. The current is minimum when the plan of the loop is perpendicular to the magnetic field; that is, when the loop is in the vertical position.

(ii) As the loop rotates from the vertical to the horizontal position, it cuts through larger magnetic field lines per unit of time, thus the e.m.f and the current increase. When the current in loop reaches its maximum value.

(iii) As the loop continues to turn, the segment that was moving up begins to move down and reverses the direction of the e.m.f and the current in the loop.

(iv) This change in direction takes place each time the loop turns through 180°. Thus, the e.m.f. and the current changes smoothly from zero to some maximum values and back to zero during each half-turn of the loop.

Q.10 What is meant by mutual induction? Describe an experiment to explain this phenomenon.

101115010

OR

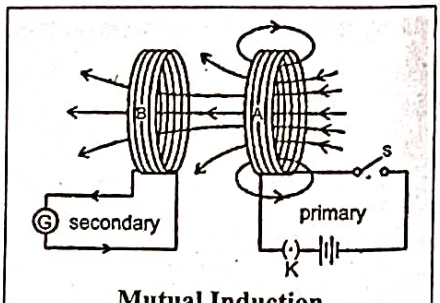
What do you understand by the term mutual induction?

Ans. Mutual Induction

"The phenomenon of production of induced current in one coil due to change of current in a neighbouring coil is called Mutual Induction".

Explanation

Suppose a system of two coils A and B are placed close to each other. The coil A is connected to a battery and a switch, while a sensitive galvanometer is connected to the coil B. We observe that as soon as ,the switch of the coil A is closed, the galvanometer shows a momentary deflection. Similarly, when the switch is opened, the galvanometer again shows a deflection but this time its direction is opposite to that of the previous case.



Mutual Induction

By Faraday's Law of Electromagnetic Induction

When the switch of coil A is closed, a current is induced in the coil due to which magnetic field is developed across the coil. Some of the magnetic lines of force of this field start passing through the coil B. Since current is changing in the coil A, hence number of magnetic lines of force across the coil B also change due to which a current is induced in the coil B in accordance with Faradays' law. When current in the coil A becomes steady, number of magnetic lines of force across the coil A also become constant. Therefore, there is no more change in number of magnetic lines of force through the coil B due to which induced current in coil B reduces to zero.

Similarly, when the switch of the coil A is opened, the flow of current through it stops and in few moments its magnetic field reaches to zero. The number of magnetic lines of force through the coil B decreases to zero due to which current is again induced in it but in opposite direction to that in the previous case.

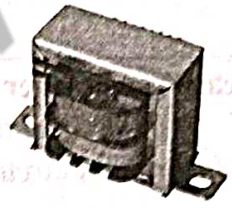
Q.11 What is Transformer? Explain its construction and working. **(F.B. 2017)** **101115011**

OR

What is a transformer explain the working of a transformer in connection with mutual induction.

Ans. Transformer

"Transformer is an electrical device which is used to increase or decrease the value of the alternating voltage".



A transformer

Uses: Use of transformers is common because they change voltages with relatively little loss of energy. In fact, many of the devices in our homes such as game systems, printers and stereos, have transformers inside their casings or as part of their connecting cords.

Construction

It consists of two coils which are wound on two different sides of a rectangular iron core. One coil is called primary coil and the second one is known as secondary coil.

Working Principle

Transformer works on the principle of mutual induction. Induced current is produced in one coil due to change of current in neighbouring coil.

Working

A transformer has two coils, electrically insulated from each other, but wound around the same iron core. One coil is called the primary coil. The other coil is called the secondary coil. Number of turns on the primary and the secondary coils are represented by N_p and N_s respectively. When the primary coil is connected to a source of A.C. voltage, the changing current creates a changing magnetic field, which is carried through the core to the secondary coil. In the secondary coil, the changing field induces a varying e.m.f. This effect is called mutual inductance. The e.m.f. induced in the secondary coil, called the secondary voltage V_s, is proportional to the primary voltage V_p. The secondary voltage also depends on the ratio of the number of turns on the secondary coil to the number of turns on the primary coil.

Mathematical form:

Suppose:

N_p = number of turns in the primary coil.

N_s = number of turns in the secondary coil.

V_p = voltage applied across the primary coil which is to be altered.

V_s = The required voltage generated across the secondary coil.

Then we can prove that:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Primary Coil

The coil in which the change in current produces induced current in another coil is known as Primary Coil.

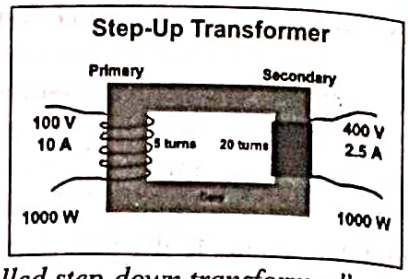
Secondary Coil

The second coil in which current is induced is known as Secondary Coil.

Types of Transformer

There are two types of Transformer:

1. Step-up Transformer 2. Step-down Transformer

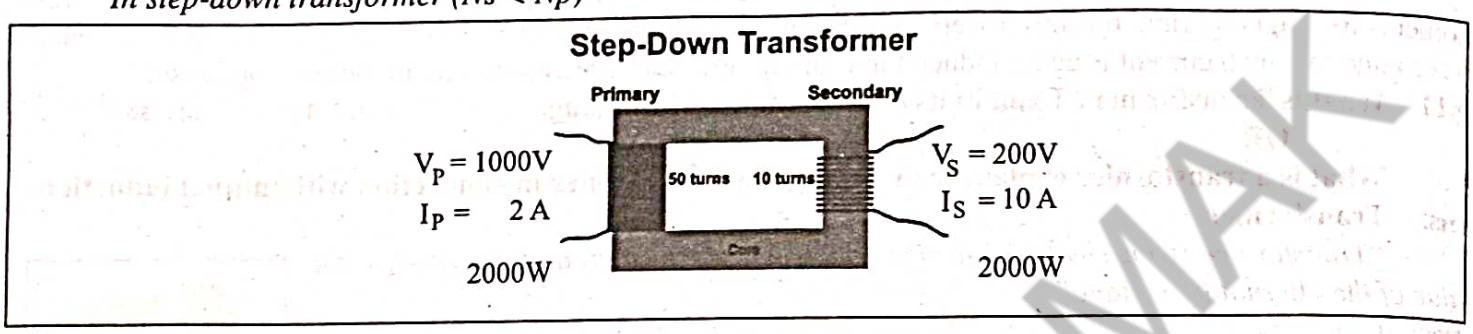


Step-up Transformer

"If the secondary voltage is larger than primary voltage, the transformer is called a step-up transformer". In step-up transformer (Ns > Np)

Step-down Transformer

"If the secondary voltage is smaller than the primary voltage, the transformer is called step-down transformer". In step-down transformer (Ns < Np)



Ideal Transformer

In an ideal transformer, the electric power delivered to the secondary circuit equals the power supplied to the primary circuit. An ideal transformer dissipates no power itself, and for such a transformer we can write:

$$P_P = P_S$$

$$V_P I_P = V_S I_S$$

Q.12 Describe the High Voltage Transmission. 101115012

Ans. Generation and Transmission of Electric Power

Electric power is usually generated at places which are far from the places where it is consumed. The power is transmitted over long distances at high voltage to minimize the loss of energy in the form of heat during transmission. As heat dissipated in the transmission cable of resistance R is I^2 Rt.

Role of Transformers

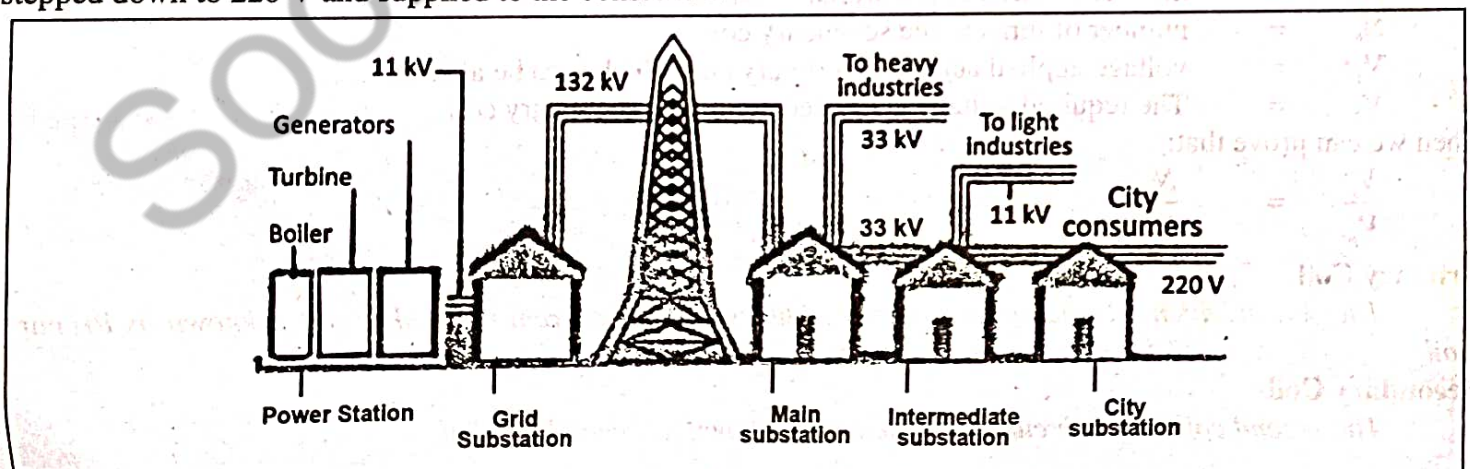
Transformers play an essential part in power distribution. Transformers work only with alternating current. This is one reason why main power is supplied as alternating current.

Role of Step-up Transformer

By reducing the current I through the cable, power loss in the form of heat dissipation can also be reduced. So the alternating voltage is stepped up by using step-up transformer at the generating station.

Role of Step-down Transformer

Generated voltage is then transmitted to the main sub-station. This voltage is stepped down and is transmitted to the switching transformer station or the city sub-station. At the city sub-station it is further stepped down to 220 V and supplied to the consumers.



A Schematic Diagram of High Voltage Transmission

Q.13 Define Electromagnet. Write one application of electromagnetic effect. 101115013

Ans. Electromagnet

"Magnetic effect of current is called Electromagnet". This effect is used in many devices like relay, electric bell etc. Soft iron, gains and loses magnetism easily in such devices.

Application of Electromagnetic Effect

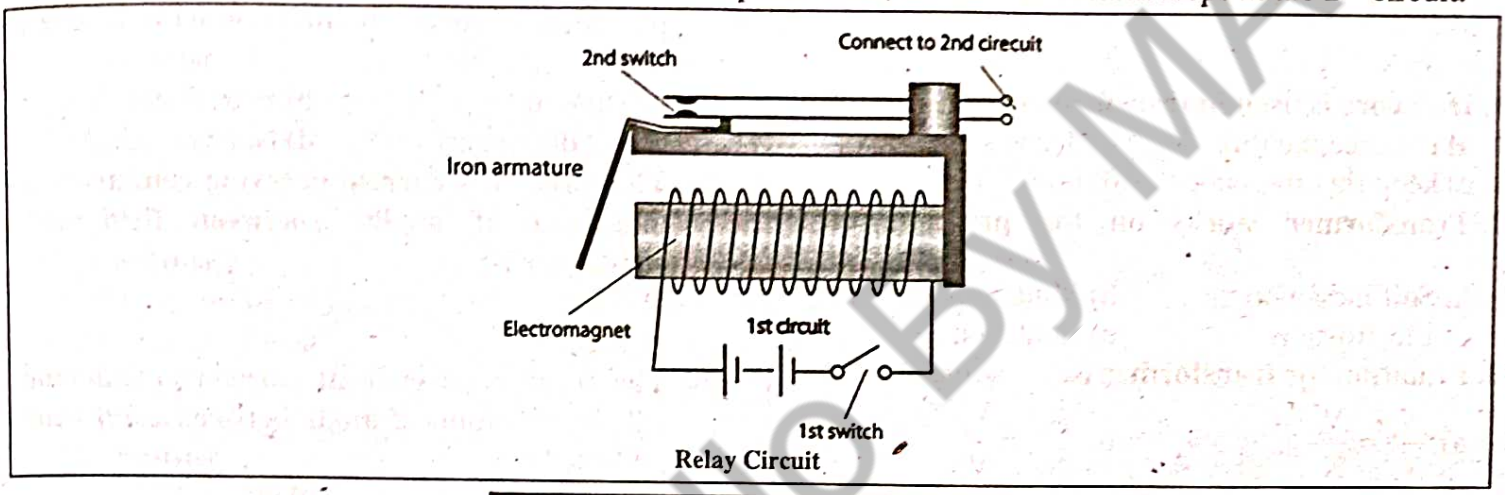
Electromagnetic effect is used in relay.

Relay

"The relay is an electrical switch which is used to control a large current with the help of small current, it opens and closes under the control of another electrical circuit".

Explanation

The 1st circuit (input circuit) supplies current to the electromagnet. The electromagnet is magnetized and attracts one end of the iron armature. The armature then closes the contacts (2nd switch) and allows current to flow in the second circuit. When 1st switch opens again, the current to the electromagnet stops. Now electromagnet loses its magnetism and the 2nd switch opens. Thus, the flow of current stops in the 2nd circuit.



Relay Circuit

Multiple Choice Questions

Choose the correct answer from the following choices.

Exercise MCQs

1. **Which statement is true about the magnetic poles?** 101115014
   a) unlike poles repel
   b) like poles attract
   c) magnetic poles do not effect each other
   d) a single magnetic pole does not exist
2. **What is the direction of the magnetic field lines inside a bar magnet?** 101115015
   a) from North pole to South pole
   b) from South pole to North pole
   c) from side to side
   d) there are no magnetic field lines
3. **The presence of a magnetic field can be detected by a:** (F.B. 2017) 101115016
   a) small mass
   b) stationary positive charge
   c) stationary negative charge
   d) magnetic compass
4. **If the current in a wire which is placed perpendicular to a magnetic field increases, the force on the wire** 101115017
   a) increases b) decreases
   c) remains the same d) will be zero
5. **D.C motor converts** 101115018
   a) mechanical energy into electrical energy
   b) mechanical energy into chemical energy
   c) electrical energy into mechanical energy
   d) electrical energy into chemical energy
6. **Which part of a D.C. motor reverses the direction of current through the coil every half-cycle?** 101115019
   a) the armature b) the commutator
   c) the brushes d) the slip rings
7. **The direction of induced e.m.f. in a circuit is in accordance with conservation of:** (F.B. 2017) 101115020
   a) mass b) charge
   c) momentum d) energy

8. **The step-up transformer;** (F.B. 2016)
a) increases the input current 101115021
b) increases the input voltage
c) has more turns in the primary
d) has less turns in the secondary coil

9. **The turn ratios of a transformer is 10. It means;** 101115022
a) $I_S = 10I_P$ b) $N_S = N_P/10$
c) $N_S = 10N_P$ d) $V_S = V_P/10$

Additional MCQs

10. **A transformer has $N_p = 100$ and $N_s = 500$, if 6 volt D.C is applied across its primary, the induced voltage is:** 101115023
a) 0 V b) 30 V
c) 45 V d) 60 V

11. **Iron core is used in transformer to:** 101115024
a) enhance the flux b) decrease the flux
c) keep flux the same d) both a and b

12. **Transformer works on the principle of:** 101115025
a) Self induction b) Mutual induction
c) Electrostatic d) Induction

13. **Equation for transformer is:** 101115026
a) $\frac{N_s}{V_p} = \frac{V_s}{N_s}$ b) $\frac{N_s}{N_p} = \frac{V_p}{V_s}$
c) $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ d) $\frac{V_p}{N_p} = \frac{N_s}{N_p}$

14. **The number of lines of force in a magnetic field depends upon:** 101115027
a) Shape of coil b) Size of coil
c) Magnet d) Strength of field

15. **If current is flowing from bottom end to the top end in a wire, according to right hand rule the direction of line of forces would be:** 101115028
a) Anti-clock wise b) Clock wise
c) Left to right d)Along the conductor

16. **The lines will be in the form of concentric circles, if conductor is:** 101115029
a) Circular b) Straight
c) Solenoid d) None of these

17. **The end of solenoid from which lines of force emerge out anti-clock wise is called:** 1011150230
a) North pole b) South pole
c) North and south pole d) None

18. **The end of solenoid from which line of forces enter clock wise is called:** 101115031
a) North pole b) South pole
c) North and south pole d) None

19. **The magnetic field of a solenoid resembles as:** 101115032
a) Iron wire b) U-shape magnet
c) Bar magnet d) Point charge

20. **A current carrying conductor produces a field around it is called:** 101115033
a) Electric field b) Magnetic field
c) Gravitational field d) None

21. **According to Fleming's left hand rule the direction of magnetic field is indicated by:** 101115034
a) Thumb b) Forefinger
c) Middle finger d) Right hand rule

22. **According to Fleming's left hand rule the direction of force on the conductor is given by:** 101115035
a) Thumb b) Fore finger
c) Middle finger d) None

23. **The force on a current carrying conductor is maximum if angle between field and conductor is:** 101115036
a) 0° b) 90°
c) 180° d) 45°

24. **The force on a current carrying conductor will be minimum if angle between conductor and field is:** 101115037
a) 0° b) 90°
c) 45° d) 60°

25. **In D.C. motor split rings are made of:** 101115038
a) Steel b) Carbon
c) Copper d) Iron

26. **Who discovered Electromagnetic Induction?** 101115039
a) Michael Faraday b) Fleming
c) Ohm d) Coulomb

27. **Michael Faraday belonged to.** 101115040
a) British b) U.S.A.
c) K.S.A d) Russia

28. **Which type of energy is converted into mechanical energy in the D.C. motor?** 101115041
a) Magnetic energy
b) Heat energy
c) Electrical energy
d) Chemical energy

29. **Which device has two coils, primary and secondary?** 101115042
a) D.C Motor b) Transformer
c) A.C. generator d) a and b

30. **The voltage is decreased by:** 101115043
a) Step-up transformer
b) Step-down transformer
c) A.C. generator
d) D.C. Motor

31. **Transformer which increases voltage is called:** 101115044
a) Step-up transformer
b) Step-down transformer
c) D.C. Motor
d) A.C. Generator

32. **In A.C generator flux will be zero if coil is to the field;** 101115045
a) 90° b) 45°
c) parallel d) inclined

33. **If the change of current in a circuit induces a current in another circuit, this phenomena is known as;** 101115046
a) Self induction
b) Mutual induction
c) Electromagnetic induction
d) Non-mutual induction

34. **The shape of magnetic lines of force in case of a straight current carrying conductor is:** 101115047
a) elliptical b) triangular
c) rectangular d) circular

35. **When a current carrying conductor is placed in magnetic field at right angle to it. The direction of force acting upon it is:** 101115048
a) the same as direction of field
b) opposite to the direction of the field
c) makes an angle of 45° with the current
d) at right angle to both the field and the current

36. **Bank credit cards have strip engraved on them is;** 101115049
a) Electric b) Electronic
c) Magnetic d) Mechanical

37. **Which thing works on the principle of electromagnetic induction in hydro electric power house?** 101115050
a) Motor b) Generator
c) Galvanic Cell d) Voltaic Cell

38. **Law of electromagnetic induction and electrolysis were presented by:** 101115051
a) Simon Ohm b) George Coulomb
c) Newton d) Michael Faraday

39. **A current carrying conductor produces a field around it is called:** 101115052
a) Electric field
b) Magnetic field
c) Gravitational field
d) Nuclear field

40. **An electrical device which is used to increase or decrease the value of alternating voltage is called:** 101115053
a) Transformer b) Electric Motor
c) Capacitor d) Generator

41. **If current is coming out from the plane surface of paper, we put the sign:** 101115054
a) cross (×) b) summation (+)
c) distribution (÷) d) dot (.)

42. **A step up transformer has turned ratio 1:20, When 100V are supplied to the primary coil, the secondary coil will give volt** 101115055
a) 3000 b) 4000
c) 2000 d) 1000

43. **Which rule shows the direction of lines of forces?** 101115056
a) Right hand rule b) Left hand rule
c) Fleming's rule d) Joule's law

44. **The simple coil in DC motor, placed in a magnet cannot rotate more than;** 101115057
a) 180° b) 90°
c) 360° d) 270°

45. **The rotating coil of electric motor is called;** 101115058
a) Solenoid b) Shaft
c) Armature d) Axle

46. **"Magnetic field must produce an electric current". This statement is proposed by:** 101115059
a) Ampere b) Coulumb
c) Ohm d) Faraday

47. **Which is used to control a large current with the help of small current?** 101115060
a) Relay b) Resistance
c) Capacitance d) Circuit

48. **A generator is a _____ if its input and output reversed.** 101115061
a) Transformer b) Capacitor
c) DC motor d) Solenoid

49. **If the current is flowing from top towards the bottom, then the direction of lines of force would be:** 101115062
a) Anti-clockwise b) Clockwise
c) Left to right d) Along the conductor

50. Which statement is true for step up transformer? 101115063
a) $I_s < I_p$ b) $V_s > V_p$
c) $V_s < V_p$ d) $N_p > N_s$

51. Which statement is true for step down transformer? 101115064
a) $I_p < I_s$ b) $V_s > V_p$
c) $V_s < V_p$ d) $N_s > N_p$

52. The type of temporary magnet, which is created whose current flows through the coil is called: 101115065
a) Coil b) Conductor
c) Electromagnet d) Magnet

53. The power is transmitted over a large distance at high to minimize loss of energy. 101115066
a) Current b) Power
c) Resistance d) Voltage

54. What is the working of split rings in DC motor? 101115067
a) To convert AC to DC
b) To convert DC to AC
c) Maintain current
d) To reverse the direction of current

55. Who discovered that when a current passes through a conductor it produces magnetic field around it? 101115068
a) Faraday b) Ampere
c) Henry d) Coulomb

56. The current carrying coil is itself a: 101115069
a) Resistance b) Magnet
c) Diode d) Capacitor

57. Lenz's law is the manifestation of the: 101115070
a) Law of conservation of energy
b) Law of conservation of momentum
c) Law of conservation of mass
d) Law of conservation of power

58. Metal detectors detect metal weapons using the principle of: 101115071
a) Electromagnetic induction
b) Self induction
c) Mutual induction
d) Electrolysis

59. _____ plays an important role in power distribution: 101115072
a) Capacitor b) Transformer
c) Generator d) DC Motor

60. For an ideal transformer we can write: 101115073
a) $P_p = P_s$ b) $P_p > P_s$
c) $P_p < P_s$ d) $P_p = 0$

61. Equation for an ideal transformer: 101115074
a) $V_sI_p = V_pI_s$ b) $V_pI_p = V_sI_s$
c) $V_pI_p > V_sI_s$ d) $V_pI_p < V_sI_s$

62. The step down transformer: 101115075
a) Decrease the input current
b) Decrease the input voltage
c) Has more turns in secondary coil
d) Has less turns in primary coil

63. Transformer is used to: 101115076
a) increase voltage
b) increase resistance
c) both (a) & (b)
d) none of these

64. According to right hand rule for a current carrying conductor, current will be in the direction of: (F. B. 2016) 101115077
a) curling fingers b) forefinger
c) thumb d) opposite to thumb

65. The number of magnetic lines of force passing through any surface is known as: (F.B. 2013) 101115078
a) electric flux
b) magnetic flux
c) electric flux density
d) magnetic flux density

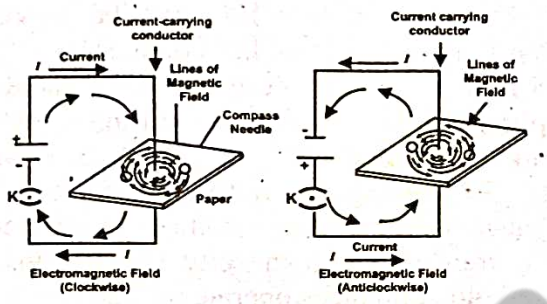
Answer Key

1.	d	2.	b	3.	d	4.	a	5.	c	6.	b	7.	d
8.	b	9.	c	10.	a	11.	a	12.	b	13.	c	14.	d
15.	a	16.	b	17.	a	18.	b	19.	c	20.	b	21.	b
22.	a	23.	b	24.	a	25.	c	26.	a	27.	a	28.	c
29.	b	30.	b	31.	a	32.	c	33.	b	34.	d	35.	d
36.	c	37.	b	38.	d	39.	b	40.	a	41.	d	42.	c
43.	a	44.	b	45.	c	46.	d	47.	a	48.	c	49.	b
50.	b	51.	c	52.	d	53.	d	54.	d	55.	b	56.	b
57.	a	58.	a	59.	b	60.	a	61.	b	62.	b	63.	a
64.	c	65.	b										

Review Questions

Q.15.1. Demonstrate by an experiment that a magnetic field is produced around a straight current carrying conductor. 101115079

Ans. Ampere discovered that when a current passes through a conductor, it produces a magnetic field around it. To demonstrate this, we take a straight conductor and pass it vertically through a cardboard. Now connect the two ends of the conductor wire with the terminals of the battery so, that current flows through the circuit in the clock wise direction. The lines of force of magnetic field produced around the wire would be in the form of concentric circles. If we place a compass needle at different points in the region of magnetic field, it will align along the direction of magnetic field. Also if we sprinkle some iron fillings on the cardboard around the wire, they will align themselves in the concentric circles in the clockwise direction.



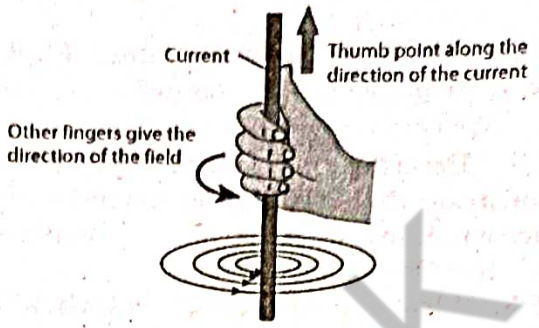
If we reverse the direction of the current by reversing the terminals of the battery, the compass needle also reverse its direction. Now the magnetic field lines will align in the clockwise direction. The magnetic field produced is stronger near the current carrying conductor and weaker farther away from it.

Q.15.2. State and explain the rule by which the direction of the lines of force of the magnetic field around a current- carrying conductor can be determined. 101115080

Ans. When current passes through a conductor, a magnetic field produced in the space around it. The direction of lines of force can be determined by Right Hand Rule.

Right Hand Rule:

According to this rule, "Grasp the current carrying conductor in right hand with the thumb being stretched in the direction of conventional current. The curl of fingers of your hand will point in the direction of magnetic lines of force."



Right Hand Grip Rule

Q.15.3 You are given an unmarked magnetized steel bar and a bar magnet, its north and south ends are marked N and S respectively. State how would you determine the polarity at each end of the unmarked bar? 101115081

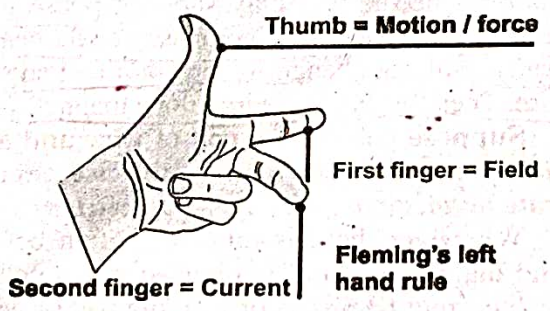
Ans. We will mark north and south pole of unmarked bar magnet by placing it close to the marked bar magnet. Suspend the unmarked bar magnet by a thread from its centre. Bring the north pole of marked bar near one end of suspended magnet. Repulsion will show that this end is north pole of unmarked bar magnet. Attraction will show that this end is the south pole.

Q.15.4. When a straight current carrying conductor is placed in a magnetic field, it experiences a force. State the rule by which the direction of this force can be found out. 101115082

Ans. The direction of force on a current carrying wire in a magnetic field can be found by using Fleming's left hand rule.

Fleming's left hand rule:

"Stretched the thumb, forefinger, and the middle finger of the left hand mutually perpendicular to each other. If the forefinger points in the direction of magnetic field the middle is in the direction of current, then the thumb would indicate the direction of force on a current carrying conductor.



Q.15.5 State that a current carrying coil in a magnetic field experiences a torque. 101115083

Ans. See Q#4 on Pg# 147

Q.15.6. What is an electric motor? Explain the working principle of D.C motor? 101115084

Ans. See Q#5 on Pg# 148

Q.15.7 Describe a simple experiment to demonstrate that a changing magnetic field can induce e.m.f. in a circuit. 101115085

Ans. See Q#6 on Pg# 149

Q.15.8. What are the factors which affect the magnitude of the e.m.f induced in a circuit by changing magnetic field. (F,B 2014) 101115086

Ans. The magnitude of induced e.m.f in a circuit depends on the following factors

(i) Speed of relative motion of the coil and magnet.

(ii) Number of turns of the coil.

(iii) Strength of magnetic field.

Q.15.9 Describe the direction of an induced e.m.f. in a circuit? How does this phenomenon relate to the conservation of energy? 101115087

Ans. See Q#8 on Pg# 151

Q.15.10 Draw a labeled diagram to illustrate the structure and working of A.C generator. 101115088

Ans. See Q#9 on Pg# 151

Q.15.11 What do you understand by the term mutual induction? 101115089

Ans. See Q#10 on Pg# 152

Q.15.12. What is a transformer? Explain the working of a transformer in connection with mutual induction. 101115090

Ans. See Q#11 on Pg# 153

Q.15.13. The voltage chosen for the transmission of electrical power over large distances is many times greater than the voltage of the domestic supply. Give two reasons why electrical power is transmitted at high voltage. 101115091

Ans. Electric power of transmission is the bulk movement of electrical energy from power station to electrical substation. Power is transmitted at higher voltage to reduce power losses during transmission. Power is the product of voltage and current.

$$P = VI$$

$$I = \frac{P}{V}$$

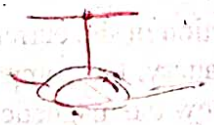
So when the same amount of power is transmitted at higher voltages, current in the conductor is lower. This leads to lesser power loss in the power lines. Since power loss is proportional to the square of current.

$$P = I^2R$$

So, for the same value of R Power losses is less if current is less this can be achieved by transmitting power at higher voltages.

Q.15.14 Why is the voltage used for the domestic supply much lower than the voltage at which the power is transmitted? 101115092

Ans. The voltage used for the domestic supply are much lower because voltage is stepped down and is transmitted to the city sub-station. All the house-hold appliances operate on 220V.



Conceptual Questions

Q.1 Suppose someone handed you three similar iron bars and told you one was not magnet but the other two were. How would you find the iron bar that was not magnet? 101115093

Ans. (i) We bring an iron strip close to each iron bar one by one. The iron bar from which the iron strip is not affected, is not a magnet.

(ii) If we bring a compass needle near three iron bars. The compass needle will only show response to the magnets. So, when we take compass needle near the iron bar, it will not change its direction and show no response. Then this bar is the iron not a magnet.

Q.2 Suppose you have a coil of wire and a bar magnet. Describe how you could use them to generate an electric current. 101115094

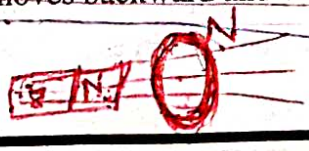
Ans. Whenever there is relative motion between coil and magnet an e.m.f is induced in the coil due to which current begins to flow in the coil of wire.

Q.3 Which device is used for converting electrical energy into mechanical energy? 101115095

Ans. D.C. motor is used to convert electrical energy into mechanical energy.

Q.4 Suppose we hang a loop of wire so that it can swing easily. If we now put a magnet into the coil, the coil will start swinging. Which way will it swing relative to the magnet and why? 101115096

Ans. According to the Lenz's Law: "The direction of an induced current in a circuit is always such that it opposes the cause that produced it". Hence, coils will move opposite to the direction of motion of magnet. If magnet moves forward, coil moves backward and vice versa.



Q.5 A conductor wire generates a voltage while moving through a magnetic field. In what direction should the wire be moved, relative to the field to generate the maximum voltage? 101115097

Ans. A conductor wire generates a voltage while moving through a magnetic field. To generate the maximum voltage a conductor wire should be move perpendicular to the magnetic field.

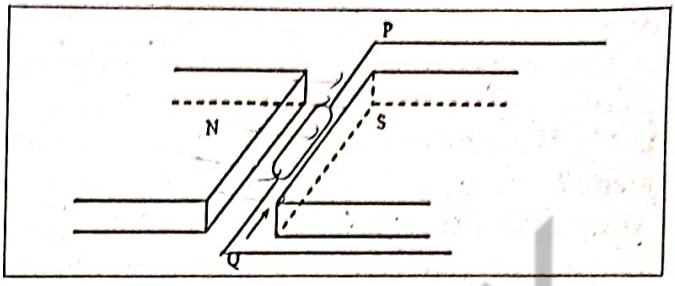
Q.6 What is the difference between a generator and a motor? (F. B. 2014, 16) 101115098

Ans. A generator converts mechanical energy into electrical energy while a motor converts electrical energy into mechanical energy. In generator the output energy is the electrical energy. In motor, the output energy is mechanical energy.

Q.7 What reverses the direction of electric current in the armature coil of D.C motor? 101115099

Ans. To reverse direction of current the connection to coil is made through an arrangement of brushes and a ring that is split into two halves called split rings. The split ring is arranged so that each half of the commutator changes brushes just as the coil reaches the vertical position. Changing brushes reverse the current in the loop.

Q.8 A wire lying perpendicular to an external magnetic field carries a current in the direction shown in the diagram below. In what direction will the wire move due to the resulting magnetic force? 101115100



Ans. By using Fleming's left hand rule the force on the conductor is in downward direction and the wire will move in anti clockwise direction.

Q.9 Can a transformer operate on direct current? (F. B. 2017) 101115101

Ans. No, transformer operate only on Alternating current. Transformer work on the phenomena of production of induced current in one coil due to change of current in a neighboring coil. Only in alternating current the value of current changes from minimum to maximum and from maximum to minimum value.

Additional Short Questions

Q.10 What do you understand by magnetic flux? 101115102

Ans. The number of magnetic lines of force passing through any surface is known as magnetic flux.

Q.11 On what factors the magnitude of induced e.m.f. depends? (F. B. 2016, 17) 101115103

Ans. The magnitude of induced e.m.f. depends upon the relative speed of magnet and the coil. Higher the speed, larger the induced e.m.f. It also depends upon the following factors:

1- Strength of the field.
2- Number of turns in the coil.

Q.12 What is an A.C. generator? Write its principle. 101115104

Ans. A.C. generator converts mechanical energy into electrical energy i.e. it produces alternating voltage. The principle on which it works is electromagnetic induction. i.e. when a coil rotates in a magnetic field the flux passing through it continuously changes. This change of magnetic flux produces an induced e.m.f.

Q.13 What is Mutual Induction? (F. B. 2013) 101115105

Ans. If a current is induced in a circuit due to change of current in another circuit. This phenomenon is known as mutual induction.

Q.14 What is a Transformer? On which principle it works? 101115106

Ans. A Transformer is an electrical device which is used to increase or decrease the value of alternating voltage. It cannot increase or decrease D.C. voltage. It works on the principle of mutual induction.

Q.15 What are two types of transformer and how they are made? / What do you mean by step up and step down transformers? (F. B. 2013) 101115107

Ans. The two types of transformer are step-up transformer and step-down transformer.

Step up transformer:

If number of turns in the secondary coil is more than the number of turns in the primary coil, then it is step-up transformer.

Step down transformer:

If the number of turns in primary are more

than the number of turns in the secondary then it is step--down transformer.

Q.16 What is meant by Primary and Secondary coils? (F. B. 2016) 101115108

Ans. The coil in which the change in current produces induced current in another coil is known as Primary coil and the coil in which current is induced is called Secondary coil.

Q.17 What is the function of split rings in D.C. motor? 101115109

Ans. Split rings connect the coil to the battery through carbon brushes. When coil rotates in between the pole pieces of a magnet, split rings keep the current in the coil and hence coil rotates in the field.

Q.18 What is a D.C. motor? On which principle it works? 101115110

Ans. D.C. Motor is a device which converts electrical energy into mechanical energy. It works on the principle that when current passes through a coil placed in magnetic field, it experiences a force due to which coil rotates in the field.

Q.19 State Fleming's Left Hand Rule. (F. B. 2013) 101115111

Ans. The direction of force on a current carrying conductor is given by Fleming's Left Hand Rule. It states as "Stretch the thumb, fore finger and the middle finger of the left hand mutually at right angles to each other. If the fore finger points in the direction of the magnetic field, the middle finger in the direction of current, then thumb will indicate the direction of force on the conductor".

Q.20 State the rule to find north and south poles of a current carrying solenoid. (F. B. 2016) 101115112

Ans. Hold the solenoid in your right hand by curling the fingers in the direction of current. The stretched thumb will indicate the north pole. **OR**

Hold down the end of current carrying solenoid in front of you, if the direction of flow of current to this end is anti-clockwise, it will be the north pole, otherwise it will be a south pole.

Q.21 What is the principle to find the direction of magnetic field? State it. 101115113

Ans. The principle to find the direction of magnetic field is "Right Hand Rule".

It states, "hold the current carrying straight conductor in right hand in such a way that thumb shows the direction of current then curling of right hand fingers will give the direction of magnetic field, which will be in the form of concentric circles."

Q.22 What is a Solenoid. And what type of magnetic field it possesses? 101115114

Ans. A solenoid is a closely wound cylindrical coil of insulated wire. The magnetic field pattern of solenoid is just like the magnetic field resembling to the bar magnet.

Q.23 When the force on a current carrying conductor in a magnetic field maximum and when it is minimum? 101115115

Ans. When a current carrying conductor makes an angle of 90^{o} with the magnetic field i.e. when it is perpendicular to the field, the force will be maximum. If the conductor is placed along or parallel to the magnetic field, no force acts on the conductor.

Q.24 What is relay? How it works? 101115116

Relay

"The relay is an electrical switch which is used to control a large current with the help of small current, it opens and closes under the control of another electrical circuit".

Explanation

The 1^{st} circuit (input circuit) supplies current to the electromagnet. The electromagnet is magnetized and attract one end of the iron armature. The armature then closes the contacts (2^{nd} switch) and allows current to flow in the second circuit. When 1^{st} switch opens again, the current to the electromagnet stops. Now electromagnet loses its magnetism and the 2^{nd} switch opens. Thus, the flow of current stops in the 2^{nd} circuit.

Q.25 Define Lenz's law. 101115117

Ans. Lenz devised a rule to find out the direction of a current induced in a circuit and is defined as:

"The direction of an induced current in a circuit is always such that it opposes the cause that produces it".

Q.26 How many coils are used in transformers write their names? 101115118

Ans. These are two coils used in transformer:

There names are:

i. Primary Coil ii. Secondary Coil

Q.27 What is meant by intensity of magnetic field? 101115119

Ans. The strength / intensity of magnetic field is defined as "the number of magnetic lines of force passing through any surface".

Q.28 Define electromagnetic induction 101115120

Ans. *"The process of generating an induced current in a circuit by changing the number of*

magnetic lines of force passing through it is called Electromagnetic Induction."

Q.29 Define Faraday's law of electromagnetic induction. On which factors does the induced e.m.f depend? (F. B. 2015) 101115121 (a)

Ans. According to Micheal Faraday's law "The value of induced e.m.f in a circuit is directly proportional to the rate of change of number of magnetic lines of force through it".

The magnitude of induced e.m.f. in a circuit depends on the following factors:

(i) Speed of relative motion of the coil and the magnet.
(ii) Number of turns of the coil.
(iii) Amount of current passing through the coil.

Side Information

Q.30 What is the fundamental difference between magnetism and electricity? 101115122

Ans. Electric charges can be separated into a single type. For example, you can have a single negative charge or a single positive charge. Magnetic poles cannot be separated. It is not possible to have a magnetic north pole without a magnetic south pole. This is a fundamental difference between magnetism and electricity.

Q.31 What do you mean by MRI? Write its uses. 101115123

Ans. Weak ionic current in our body that travels along the nerve can produce the magnetic effect. This forms the basis of obtaining images of different parts of body. This is done using the technique called Magnetic Resonance Imaging (MRI). Heart and brain are two main organs where significant magnetic fields can be produced. Using MRI doctors can diagnose the disorders of brain and heart etc.

Q.32 How the account information of the user stored in bank credit cards? 101115124

Ans. Bank credit cards have a magnet strips engraved on them. On this strip account information of the user is stored and then is read by the ATM machine.

Q.33 How do magnetic field lines help us? 101115125

Ans. Magnetic field lines help us to visualize the magnitude and direction of the magnetic field vectors, just as electric field lines do for the magnitude and direction of E.

Q.34 Who was Michael Faraday and what did he discover? 101115126

Ans. Michael Faraday was a British chemist and physicist. At the early stage of his age he had to work as a book binder to meet his financial needs. There he learnt a lot from the book that helped him to become an expert. Although Faraday received little formal education. He was one of the most influential scientists in history, and was one of the best experimentalist in the history of science. He discovered the principle of electromagnetic induction and the laws of electrolysis etc.

Q.35 Who had observed an induced current before Faraday? 101115127

Ans. It is said Joseph Henry (1797-1878) observed an induced current before Faraday, but Faraday published his results first and investigated the subject in more detail.

Q.36 What is a connection between a generator and a DC motor? 101115128

Ans. A generator is a DC motor with its input and output reversed.

Q.37 What are walk- through gates? Also write their working principle. 101115129

Ans. Walk-through metal detectors are installed at air ports and other places for security purpose. These detectors detect metal weapons etc. using the principle of electromagnetic induction.

Q.38 Which field resembles with the magnetic field of a coil? 101115130

Ans. The magnetic field of a coil is identical to the field of a disk shaped permanent magnet.

Q.39 How electromagnet works? 101115131

Ans. When electric current passes through the soft iron core, it produces magnetic flux. If insulated wire is wrapped around an iron or steel object, a powerful magnetic field is produced. When electricity is passed through a coiled wire, a stronger magnetic field is generated.

Q.40 Can a high power transformer reduces the voltage keeping the power constant. 101115132

Ans. Yes, a high power transformer can reduce the voltage keeping the power constant.

Q.41 In what way generator produces electricity on hydroelectric dam? 101115133

Ans. A generator inside a hydroelectric dam uses electromagnetic induction to convert mechanical energy of a spinning turbine into electrical energy.

Solved Examples

15.1 If a transformer is used to supply voltage to a 12 V model train which draws current 0.8 A. Calculate the current in the primary if the voltage of the A.C source is 240 V. 101115134

Given data.

$V_p = 240$ V
$V_s = 12$ V
$I_s = 0.8$ A

To Find: $= I_p = ?$

Solution:

By law of conservation of energy, input power of the primary = output power of secondary

Therefore, $I_p = \frac{V_s I_s}{V_p}$

$$I_p = \frac{(12)(0.8)}{240}$$

$I_p = 0.04$ Amp.

Result:

Current across primary coil is 0.04 A.

Numerical Problems

15.1 A transformer is needed to convert a main 240 V supply into a 12 V supply. If there are 2000 turns on the primary coil, then find the number of turns on the secondary coil. 101115135

Given data:

$V_p = 240V$
$V_s = 12V$
$N_p = 2000$

To find

$N_s = ?$

Calculation:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$N_s = \frac{N_p \cdot V_s}{V_p}$$

$$= \frac{2000 \times 12}{240}$$

$= 100$ turns

Result:

Thus the 100 turns will be in secondary coil.

15.2 A step-up transformer has a turn ratio of 1: 100. An alternating supply of 20 V is connected across the primary coil. What is the secondary voltage?

(F. B. 2015) 101115136

Given data:

$\frac{N_s}{N_p} = \frac{100}{1}$

$V_p = 20V$

$V_s = ?$

To find

Calculation:

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\frac{100}{1} = \frac{V_s}{20}$$

$V_s = 20 \times 100$

$V_s = 2000V$

Result:

Voltage across the primary coil is 2000 volt.

15.3 A step-down transformer has a turn ratio of 1: 100. An ac voltage of amplitude 170 V is applied to the primary. If the current in the primary is 1.0 mA, what is the current in the secondary? 101115137

Given data:

$\frac{N_s}{N_p} = \frac{1}{100}$

$V_p = 170V$

$I_p = 1mA$

$= 1 \times 10^{-3} A$

To find:

$I_s = ?$

Calculation:

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$V_s = \frac{N_s}{N_p} \times V_p$$

$$= \frac{1}{100} \times 170$$

$= 1.7$ V

$V_p I_p = V_s I_s$

$$170 \times 10^{-3} = 1.7 \times I_s$$

$$I_s = \frac{170 \times 10^{-3}}{1.7}$$

$$= 100 \times 10^{-3}$$

$$I_p = 0.1 \text{ A}$$

Result:

The current in the primary coil is 0.1 A.

15.4 A transformer, designed to convert the voltage from 240 V a.c main to 12 V, has 4000 turns on the primary coil. How many turns should be on the secondary coil? If the transformer were 100% efficient, what current would flow through the primary coil when the current in the secondary coil was 0.4A? 101115138

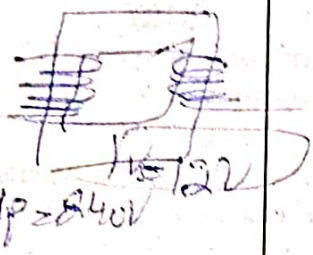
Given data:

$V_p = 240$ V

$V_s = 12$V

$N_p = 4000$

$I_s = 0.4$A



To find:

$N_s = ?$

$I_p = ?$

Calculation:

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$N_s = \frac{V_s}{V_p} \times N_p$$

$$= \frac{12}{240} \times 4000$$

$$= 200 \text{ turns}$$

$$V_s I_s = I_p V_p$$

$$I_p = \frac{V_s I_s}{V_p}$$

$$= \frac{12 \times 0.4}{240}$$

$$= \frac{0.4}{20}$$

$$I_p = 0.02 \text{ A}$$

Result:

Number of turns across the secondary coil is 200 turns and current across the primary coil is 0.02 A.

15.5 A power station generates 500 MW of electrical power which is fed to a transmission line. What current would flow in the transmission line if the input voltage is 250 kV? 101115139

Given data:

$P = 500$ MW

$P = 500 \times 10^6$W

$V = 250$kV

$= 250 \times 10^3$V

To Find:

$I = ?$

Calculation:

$$P = IV$$

$$I = \frac{P}{V}$$

$$= \frac{500 \times 10^6}{250 \times 10^3}$$

$$I = 2 \times 10^3 \text{A}$$

Result:

The current flow in the transmission line is 2×10^3 A.

UNIT 16

Basic Electronics

Q.1 What is meant by Electronics? (F. B. 2017) 101116001

Ans. *"Electronics is that branch of applied physics which deals with behaviour of electrons by using different devices for various useful purposes".*

Q.2 What is Thermionic Emission? Explain. (F. B. 2016) 101116002

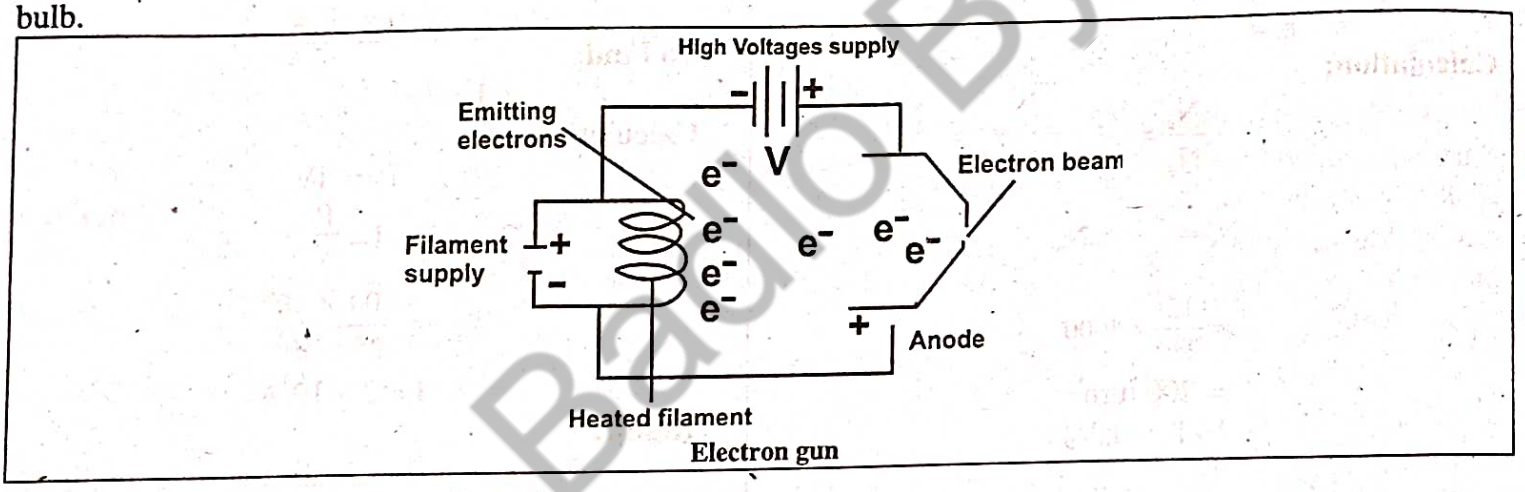
Ans. *"The process of emission of electrons from the hot metal surfaces is called Thermionic Emission".*

Metals contain a large number of free electrons. At room temperature electrons cannot escape the metal surface due to attractive forces of the atomic nucleus. If the metal is heated to a high temperature, some of the free electrons may gain sufficient energy to escape the metal surface.

Thermionic emission can also be produced by electrically heating a fine tungsten filament. The typical values of the voltage and current used are 6V and 0.3A.

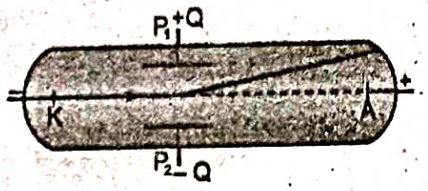
Q.3 What are the properties of the electrons? (OR)
Explain the deflection of electron by electric and magnetic field. 101116003

Ans. Electron gun is used to investigate the properties of electron beam. The electrons are produced by thermionic emission from a tungsten filament heated by 6 V supply. A high positive potential (several thousands) is applied to a cylindrical anode (+). The electrons are accelerated to a high speed and pass through the hole of the anode in the form of a fine beam of electrons. The whole set up is fitted in an evacuated glass bulb.



Deflection of electrons by electric field

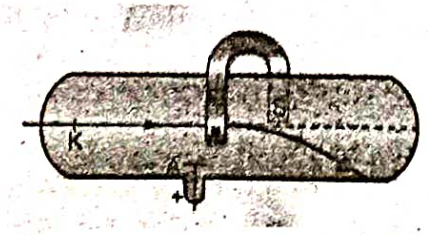
We can set up electric field by applying a potential difference across two parallel metal plates placed horizontally separated with some distance. When an electron beam passes between the two plates, it can be seen that the electrons are deflected towards the positive plate. The reason for this is that electrons are attracted by the positive charges and repelled by the negative charges due to force F=qE, where q is the electron charge and E is the electric field due to plates. The degree of deflection of electrons from their original direction is proportional to the strength of the electric field applied.



Deflection of electrons by electric field

Deflection of Electrons by magnetic field

Now we apply magnetic field at right angle to the beam of electrons by using a horse shoe magnet. We will see that the spot of the electrons beam on screen is getting deflected from its original direction. Now change the direction of the horseshoe magnet. We will see that spot on the fluorescent screen getting deflected in the opposite direction.



Deflection of electrons by magnetic field

Q.4 What is Cathode-Ray Oscilloscope (C.R.O)? Write its two uses.

OR

Explain the working of different parts of Oscilloscope.

OR

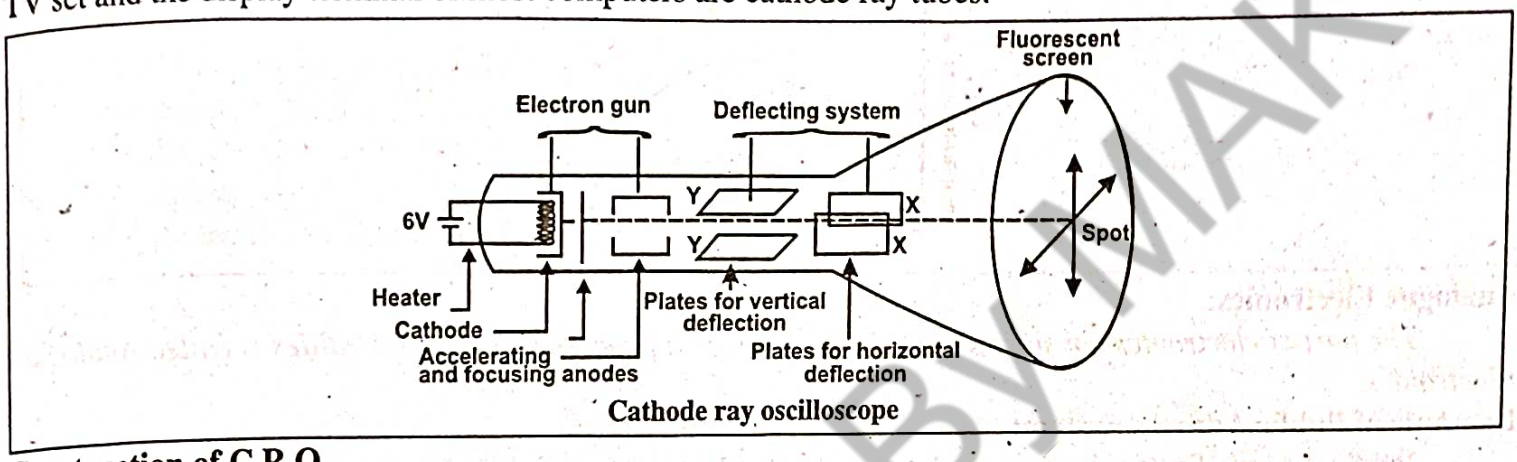
Explain the construction of C.R.O.

OR

What is cathode ray oscilloscope? Write a brief note on its component.

Ans. *"The Cathode-Ray Oscilloscope is an instrument which is used to display the magnitudes of changing electric currents or potentials".*

The information is displayed on the screen of a cathode-ray tube. This screen appears as a circular or rectangular window usually with a centimeter graph superimposed on it. For example the picture tube in our TV set and the display terminal of most computers are cathode ray tubes.



Cathode ray oscilloscope

Construction of C.R.O.

The Cathode-Ray Oscilloscope (C.R.O) consists of the following components.

- The electron gun
- The deflecting plates
- A fluorescent screen.

(i) The Electron Gun

The cathode-ray oscilloscope consists of an "electron gun" for producing a beam of fast moving electrons called cathode rays.

- The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons. Electron gun also has an electrode called **grid** G for controlling the flow of electrons in the beam. The grid is connected to a negative potential. The more negative this potential, the more electrons will be repelled from the grid and hence fewer electrons will reach the anode and the screen.
- The number of electrons reaching the screen determines the brightness on the screen light. Hence, the negative potential of the grid can be used as a brightness control. The anode is connected to positive potential and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

(ii) The Deflecting Plates.

After leaving the electron gun, the electron beam passes between a pair of horizontal plates. A potential difference applied between these plates deflects the beam in a vertical plane. This pair of plates provides the Y-axis or vertical movement of the spot on the screen. A pair of vertical plates provides the X-axis or horizontal movement of the spot on the screen.

(iii) The Fluorescent Screen

The screen of a cathode-ray tube consists of a thin layer of phosphors, which is a material that gives light as a result of bombardment by fast moving electrons.

Uses:

1. The CRO is used in many fields of science; displaying waveforms, measuring voltages, range-finding (as in radar), echo-sounding (to find the depth of sea-beds).
2. The CRO is also used to display heart beats.

Q.5 Write a note on analogue quantities and digital electronics. 101116005

Ans. We can divide electronics into two main branches, one is Analogue electronics and other is Digital electronics.

(i) Analogue Quantities

Definition

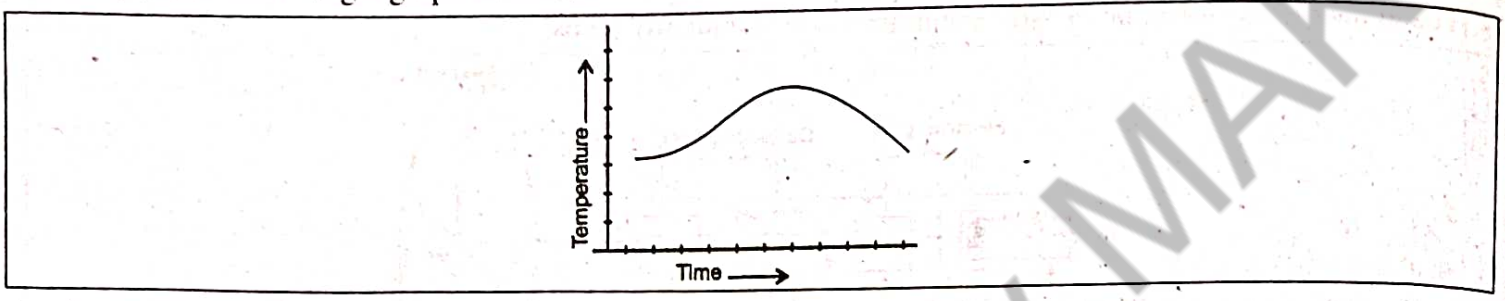
Analogue quantities are those quantities whose values increase or decrease continuously with time or remains constant are known as analogue quantities.

Example:

Temperature, Time, Pressure, Distance etc.

Temperature-Time graph

Temperature of air varies continuously during 24 hours of a day. If we plot temperature, time graph, for different values then we get graph as shown.

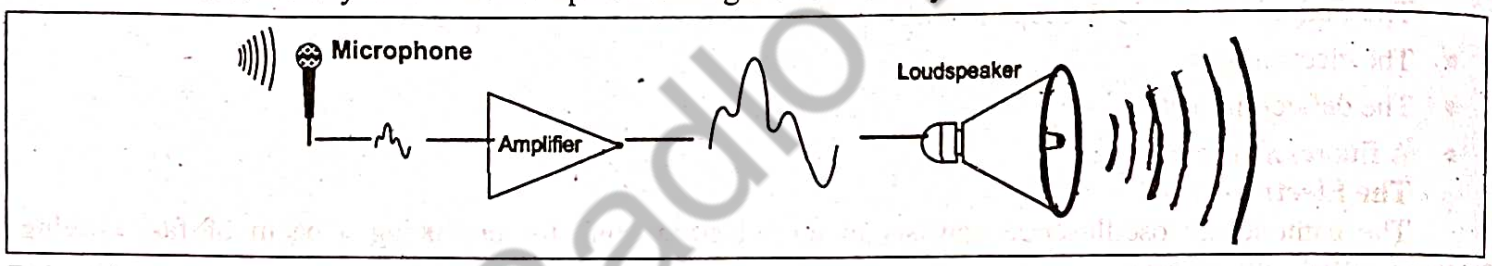


Analogue Electronics:

The part of electronics consisting of such circuits which process analogue quantities is called Analogue Electronics.

Example of Public Address System:

Public Address System is an example of analogue electronic system is shown below.

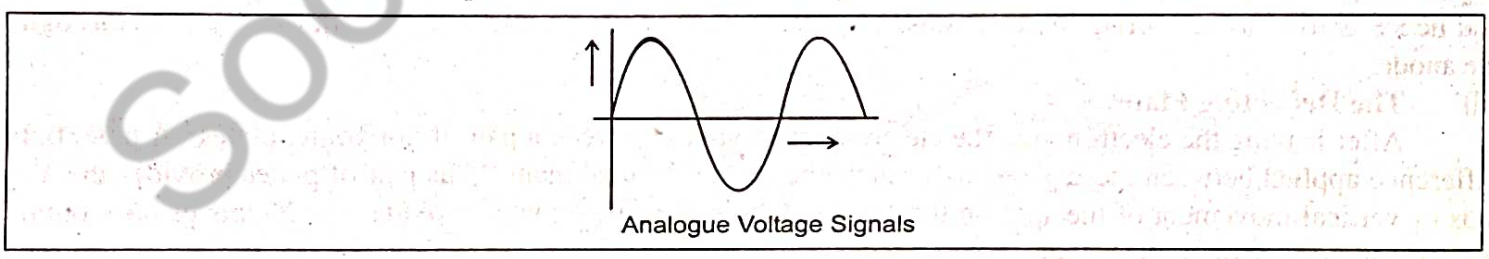


Principle:

The microphone converts sound energy into continuously varying electric potential. This potential is an analogue signal. This signal is applied to an electric amplifier which is also analogue circuit, which amplifies the signal without changing its shape to such an extent that it can operate the loud speaker. In this way loud sound is produced out of the speaker.

Note:

Radios, television and telephones are a few common devices that transfer analogue signals.



Q.6 Define and explain digital quantities and digital electronics. 101116006

Ans: Digital Quantities

"The quantities whose values vary in non-continuous manner are called digital quantities". Digital quantities are expressed in the form of digits or numbers.

Digital Electronics

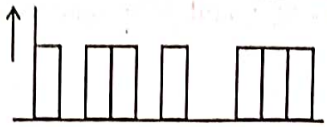
"That branch of electronics which provide the data in the form of maximum and minimum voltage signal is known as digital electronics". **OR**

"The branch of electronics which deals with the digital quantities is called digital electronics".

The digits used by digital electronics are '0' and '1' and the whole data is provided in Binary system due to which processing of data becomes easy. It can be seen that digital signals provide the data by maximum and minimum voltage level.

Example:

Modern telephone system, radar system, naval and other systems of military importance, devices to control the operation of industrial machines, medical equipments and many household appliances work on digital electronics.



Digital Voltage Signals

Q.7 What do you know about ADC and DAC? 101116007

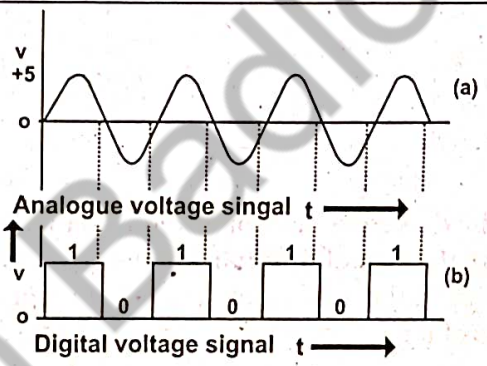
Ans: Analogue to Digital Convertor (ADC):

"A circuit which converts the analogue signal into a digital one in the form of digits is known as analogue to digital converter (ADC)".

Digital to Analogue Convertor (DAC):

"The circuit which converts the digital signal into analogue signal is called digital to analogue convertor (DAC).

A continuously varying signal is called an **analogue signal**. For example, an alternating voltage varying between the maximum value of +5V and the minimum value of -5V is an analogue signal. A signal that can have only two discrete values is called a **digital signal**. For example, a voltage with square wave form is a digital signal. This signal has only two values i.e. +5V and 0V. The high voltage is +5V and the low voltage is 0V.



Q.8 What are basic operations of digital electronics? 101116008

Ans. Basic operations of digital electronics

A circuit can either be on or off. It cannot have a third state. A given statement would be either true or it would be false. A switch would be either open or closed.

Binary Variables

Such things which can have only two possible states are known as Binary variables. The two states of binary variables are usually represented by the digits "0" and "1".

Example:

A closed switch is represented by "1" and an open one by "0". If there are two switches and one says that they are in state 1 then it would mean that both of them are closed.

Output Current

Suppose we form a circuit by connecting some resistors, two switches and a battery. As a result of this connection, some current may pass through the circuit. In this case the output also has only two states. Depending upon the states of the switches, the current either would pass or it would not pass. Thus, the output current is also a Binary variable.

Input Current

In case the current is passing, we can say the value of output is "1" and it is zero when no current is passing. Whether the value of the output would be "1" or "0", it depends upon the values of Boolean variables which specify the state of the switches.

In this example, the switches form the input Binary variable because the value of output depends upon the state of these variables.

The question arises that if the values of input variables of a circuit or a system are known, then how can the value of the output be determined? In order to solve this problem, digital electronics require three basic operations known as AND operation, OR operation and NOT operation.

Logic Operations

The various operations of Boolean variables are called logic operations because the various variables used in the subject of logic also possess two values. The word "truth" has also been borrowed from this subject.

In digital electronics, the 0 and 1 values of the variables are simulated by two different levels of the potential.

Usually low voltage is represented as 0 or ground potential and high voltage by 1 or by any other suitable voltage.

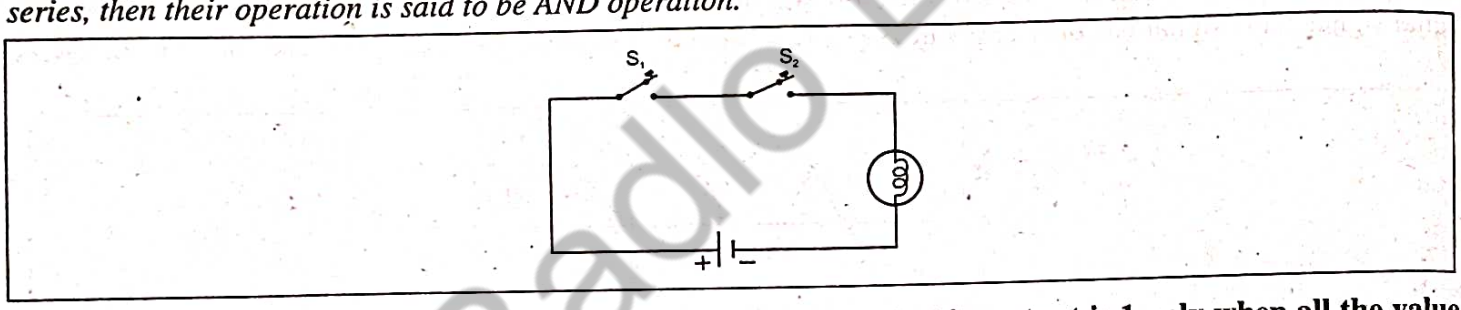
Logic Gates

Such circuits have been designed which implement the various logic operations. These circuits are known as logic gates.

Q.9 Explain AND operation. (OR) Draw circuit diagram of AND gate and write its truth table?

101116009

Ans. Definition: *Whenever two Boolean variables operate in such a way as two switches are connected in series, then their operation is said to be AND operation.*



"AND operation can be defined as such logic operation that its output is 1 only when all the value of its inputs is 1. It is represented by the sign of multiplication or by a dot".

In order to understand AND operation, the input variables S_1 and S_2 are considered as two switches. Suppose there are four possible states of these two switches which are given below.

i- Both S_1 and S_2 are open — i.e. $S_1 = 0, S_2 = 0$ — Lamp is OFF

ii- The switch S_1 is closed and S_2 is open — i.e. $S_1 = 1, S_2 = 0$ — Lamp is OFF

iii- The switch S_1 is open and S_2 is closed — i.e. $S_1 = 0, S_2 = 1$ — Lamp is OFF

iv- Both switches S_1 and S_2 are closed — i.e. $S_1 = 1, S_2 = 1$ — Lamp is ON

S_1	S_2	X=A.B
OPEN	OPEN	OFF
CLOSED	OPEN	OFF
OPEN	CLOSED	OFF
CLOSED	CLOSED	ON

The table shows the four possible states of the switches S_1 and S_2, circuit is formed by connecting these two switches in series. Whether a current would pass through the circuit or not, it depends upon the state of the switches.

Symbol of AND Operation:

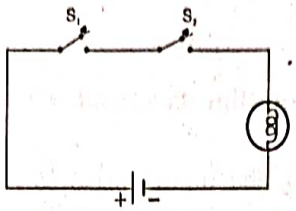
AND operation is represented by dot (.).

Boolean expression for AND Operation:

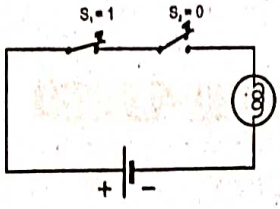
Its Boolean expression is: X = A.B and is read as "X equals A AND B".

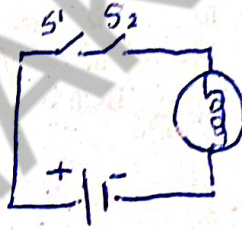
The output X obtained as a result of AND operation shown in the table is written as X=A.B. The table is called the truth table of AND operation. Truth table shows all the values of the output for each set of the values of the inputs. By using the sign of AND operation, the various lines of the truth table can be written as in the following table.

(i) In the first line of the table $S_1 = 0$, $S_2 = 0$, i.e. both the switches are open. In this condition, no current would pass through the circuit so, the value of X would be 0.

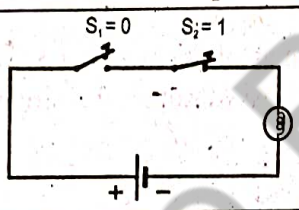


(ii) In the second line of the table, $S_1 = 1$, $S_2 = 0$, i.e. switch S_1 is closed and S_2 is open as shown in the figure. In this condition no current would also pass through the circuit and X = 0.



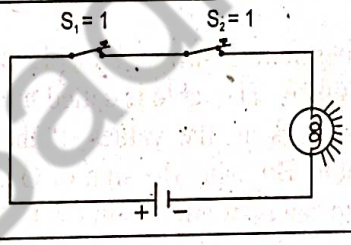


(iii) In the third line of the table $S_1 = 0$, $S_2 = 1$ i.e. switch S_1 is open and S_2 is closed as the figure shows.



No current would pass through the circuit i.e. X = 0

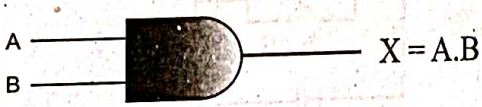
(iv) In the fourth line of the table $S_1 = 1$, $S_2 = 1$ i.e. both the switches are closed.



Now the current would pass through the circuit and the bulb will glow. Thus, X would be 1 in this case

AND Gate

The circuit which implement the AND operation is known as AND gate. Its symbol is shown in the figure.



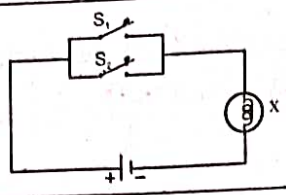
It has two or more than two inputs and only one output. It operates in such a fashion that the value of its output is always in accordance with the truth table of AND operation, i.e. the value of its output is only 1(5 volts) when all of its inputs are at 1 (5.volts). For all other values of the inputs the output would be zero.

Truth Table

A	B	X = A.B
0	0	0
1	0	0
0	1	0
1	1	1

Q.10 Explain OR operation.

Ans. Definition: *When ever two Boolean variables operate in such a way as two switches are connected in parallel, then their operation is said to be OR operation.*



"OR operation is such logic operation that its output is 1 when at least one of its inputs is at 1. The output is 0 only when all the inputs are 0".

In order to understand OR operation, the input variables S_1 and S_2 are considered as two switches. Suppose there are four possible states of these two switches which are given below.

i-	Both S_1 and S_2 are open	i.e. $S_1 = 0, S_2 = 0$	Lamp is OFF
ii-	The switch S_1 is closed and S_2 is open	i.e. $S_1 = 1, S_2 = 0$	Lamp is ON
iii-	The switch S_1 is open and S_2 is closed	i.e. $S_1 = 0, S_2 = 1$	Lamp is ON
iv-	Both switches S_1 and S_2 are closed	i.e. $S_1 = 1, S_2 = 1$	Lamp is ON

S_1	S_2	X=A+B
OPEN	OPEN	OFF
CLOSED	OPEN	ON
OPEN	CLOSED	ON
CLOSED	CLOSED	ON

The table shows the four possible states of the switches S_1 and S_2, circuit is formed by connecting two switches in parallel. Whether a current will pass through the circuit or not, it depends upon the state of the switches.

Symbol of OR Operation:

OR operation is represented by the symbol of plus (+).

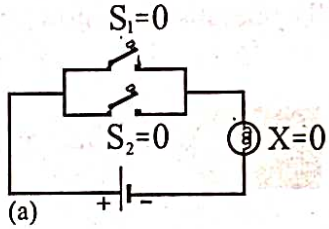
Boolean expression for OR Operation:

Its Boolean expression is: X = A+B and is read as "X equals A OR B".

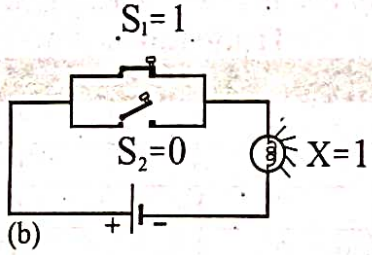
The output X obtained as a result of OR operation shown in the table is written as X=A+B. It is read as X equal A OR B. The table is called the truth table of OR operation. Truth table shows all the values of the output for each set of the values of the inputs. By using the sign of OR operation, the various lines of the truth table can be written as in the following table.

Note that although the symbol of OR operation is the same as the plus sign, yet its operation is quite different from the action of plus sign. For example, we will write the fourth line of the truth table of the OR operation as 1 + 1 = 1

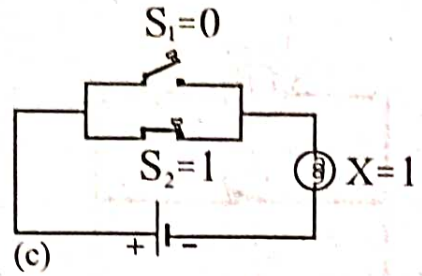
(i) In the first line of the table $S_1 = 0$, $S_2 = 0$, i.e. both the switches are open. In this condition, no current will pass through the circuit so, the value of X would be 0.



(ii) In the second line of the table, $S_1 = 1$, $S_2 = 0$, i.e. switch S_1 is closed and S_2 is open as shown in the figure. In this condition current will also pass through the circuit and X = 1.

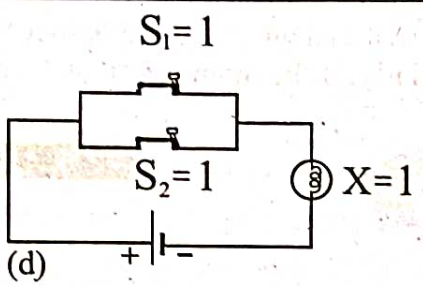


(iii) In the third line of the table $S_1 = 0$, $S_2 = 1$ i.e. switch S_1 is open and S_2 is closed as the figure shows:-



Current will pass through the circuit i.e. X = 1

(iv) In the fourth line of the table $S_1 = 1$, $S_2 = 1$ i.e. both the switches are closed.



Current will pass through the circuit and the bulb would glow. Thus, X would be 1 in this case.

OR

Gate

"The electronic circuit which implements the truth table of OR operation is known as OR gate". It is symbolically shown in fig.

OR Gate

It has two or more than two inputs and has only one output. It operates in such a fashion that its output is at 1 (5 volts) even when one of its output is at 1 (5 volts). The value of its output will be 0 only when all of its inputs are at 0. In other words the value of its output is in accordance with the truth table of OR operation.

Truth Table

A	B	X = A+B
0	0	0
1	0	1
0	1	1
1	1	1

Q.11 Explain NOT operation. 101116011

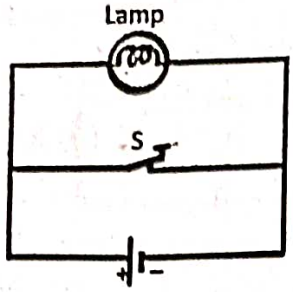
Ans. NOT operation inverts the value of Boolean variable. *A Boolean variable, after NOT operation changes its state and acquires the second possible state.* For example, if the value of a Boolean variable is 0, then after NOT operation it will change to 1. Similarly if its value is 1, then after NOT operation, it will be 0. Thus, NOT operation inverts the value of Boolean variable.

Table

S	Lamp
OPEN	ON
CLOSED	OFF

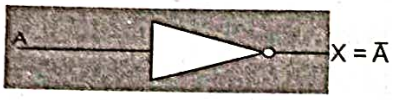
If the value of a Boolean variable, after NOT operation becomes X, then it is symbolically written as: $X = \overline{A}$

NOT operation is represented by a sign of bar and it is read as X equals A NOT. Above table is the truth table of NOT operation.



NOT Gate

"The electronic circuit which implements NOT operation is known as NOT gate". It is symbolically represented in Fig. It has only one input terminal and only one output terminal. It operates in such a fashion that if its input is 0, its output will be 1. Similarly, if the input is 1, then its output will be 0.



NOT Gate

Table

A	X = Ā
0	1
1	0

(Board 2014)

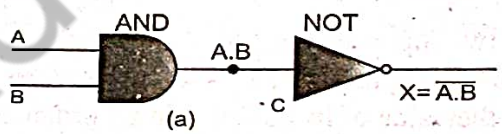
Q.12 Explain NAND Gate. **101116012**

Ans. *"A NAND gate is formed by coupling a NOT gate with the output terminal of the AND gate.* The NOT gate inverts the output of the AND gate. The output of the NAND gate equals to $\overline{A.B}$ and is written as $X = \overline{A.B}$."

It is read as X equals A AND B NOT. The NAND gate has been symbolically shown in fig.(b). In this figure, the NOT gate has been replaced with a small circle. In the symbol of NAND gate, this small circle attached at the output of AND gate shows NOT operation. Table given is the truth table of NAND gate. In each line of this table, the value of the output has been obtained by inverting the value of the output of the AND gate corresponding to that line.

Truth Table

A	B	$X = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0



(a)

(b) NAND Gate

Q.13 What is NOR gate? Draw its truth table and symbol. OR Explain NOR Gate. **(F. B. 2017)** **101116013**

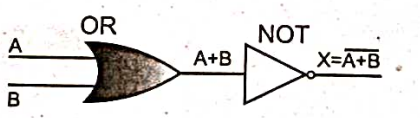
Ans. *In this gate the output of OR gate is coupled with a NOT gate* as shown in fig. (a). This NOT gate inverts the output A+B of the OR gate i.e. the output of the NOR gate $\overline{A + B}$ which is expressed by the following equation $X = \overline{A + B}$.

It is read as X equals A OR B NOT. The symbol of NOR gate is shown in fig. (b). Table given is the truth table of NOR gate. In this table, the value of output has been written by inverting the output of OR Gate.

Truth Table

A	B	$X = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

(a)



(b) NOR gate

Q.14 Explain the uses of the Logic Gate. 101116014

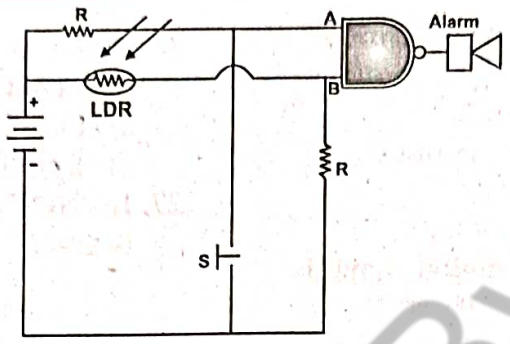
Ans. Uses of Logic Gate

Logic gates are used to perform different types of jobs in digital electronics. Here, we will describe one of its uses.

These circuits usually use Light Depending Resistors (LDRs) to keep inputs Low. An LDR can act as a switch that is closed when illuminated by light and open in the dark.

House Safety Alarm

We can use single NAND gate to make burglar alarm. This can be done by using NAND gate, an LDR, a push-button switch S and an alarm. Connect LDR between NAND gate input B and the positive terminal of the battery. The LDR will cause a HIGH level input (1) at B when in light because of its low resistance. The LDR will cause a low level input (0) at B when light is interrupted and causes high resistance in LDR. A LOW level signal is also caused at A when burglar steps on switch S. So this burglar alarm sounds when either burglar interrupts light falling on LDR or steps on switch S.



(Burglar alarm schematic circuit)

Multiple Choice Questions

Choose the correct answer from the following choices.

1. **The process by which electrons are emitted by a hot metal surface is known as:** 101116015
   a) boiling b) evaporation
   c) conduction d) thermionic emission
2. **The particles emitted from a hot cathode surface are:** (F. B. 2015) 101116016
   a) positive ions b) negative ions
   c) protons d) electrons
3. **The logical operation performed by this gate is:** 101116017

   a) AND b) NOR
   c) NAND d) OR
4. **AND gate can be formed by using two:** 101116018
   a) NOT gates b) OR gates
   c) NOR gates d) NAND gates
5. **The output of a two input NOR gate is 1 when:** 101116019
   a) A is 1 and B is 0
   b) A is 0 and B is 1
   c) both A and B are 0
   d) both A and B are 1
6. **If X = A.B, then X is 1 when:** (F. B. 2017) 101116020
   a) A and B are 1
   b) A or B is 0
   c) A is 0 and B is 1
   d) A is 1 and B is 0
7. **The output of a NAND gate is 0 when:** (F. B. 2016) 101116021
   a) both of its inputs are 0
   b) both of its inputs are 1
   c) any of its inputs is 0
   d) any of its inputs is 1

Additional MCQs

8. **Electronics is a branch of:** 101116022
   a) Atomic Physics
   b) Applied Physics
   c) Mechanics
   d) Nuclear Physics
9. **Electronics is the study of principles by means of which we control the:** 101116023
   a) flow of electrons
   b) nuclear fission
   c) fusion reaction
   d) radiations

10. **The quantities, whose values remain constant or vary continuously are called:** 101116024
a) analogue quantities
b) digital quantities
c) maximum quantities
d) minimum quantities

11. **Analogue quantity is:** 101116025
a) time b) pressure
c) distance d) all of these

12. **Public address system is the example of:**
a) analogue electronics 101116026
b) digital electronics
c) binary system
d) none of these

13. **The digits used in electronics are:** 101116027
a) 1 b) 0
c) 0 and 1 d) 1 and 2

14. **Digital technology is used in:** 101116028
a) Bulb b) radar
c) electric motor d) all of these

15. **The converter of analogue to digital signal is:** 101116029
a) ADC b) DAC
c) ATDC d) none of these

16. **The converter of digital to analogue signal is:** 101116030
a) ADC b) DAC
c) DATC d) DTC

17. **A closed switch in Boolean expression is represented by:** 101116031
a) 0 b) 1
c) 10 d) 2

18. **An open switch in Boolean expression is represented by:** 101116032
a) 0 b) 1
c) 10 d) 2

19. **AND operation can be expressed by:** 101116033
a) $X = A + B$ b) $X = A.B$
c) $X = \overline{A.B}$ d) $X = \overline{A + B}$

20. **NAND gate is symbolically written as:** 101116034
a) $X = \overline{A + B}$ b) $X = \overline{A.B}$
c) $X = A.B$ d) $X = A - B$

21. **If A input is 1, and B is zero, then in AND operation output will be:** 101116035
a) 0 b) 0, 1
c) 1 d) None

22. **The output of OR gate would be '0' when:** 101116036
a) Both of its inputs are zero
b) one of its two inputs is zero
c) Both of its inputs are 1
d) Anyone of its inputs is 1

23. **The output of an AND gate is 1, when:** 101116037
a) Both of its inputs are zero
b) Anyone of the two inputs is zero.
c) Both of its inputs are 1
d) Anyone of the two inputs is 1

24. **The two inputs of a NAND gate are A and B. Its output would be zero when:** 101116038
a) A = 0 , B = 0 b) A = 1 , B = 0
c) A = 1 , B = 1 d) A = 0 , B = 1

25. **A and B are the two inputs of a NOR gate. Its output would be 1 when:** 101116039
a) A = 1 , B = 1 b) A = 0 , B = 1
c) A = 1 , B = 0 d) A = 0 , B = 0

26. **When we heat the metal at high temperature they emit:** (F. B. 2013) 101116040
a) Holes b) Protons
c) Neutrons d) Electrons

27. **In NOT gate number of input terminals is/are:** 101116041
a) 1 b) 2
c) 3 d) 4

28. **The cathode ray oscilloscope consists of main parts:** 101116042
a) Two b) Three
c) Four d) Five

29. **George Boole invented:** (Board 2015)
a) Boolean algebra 101116043
b) Arithmetic algebra
c) Mean algebra
d) Geometry

30. **The standard group of bits in digital electronics is:** 101116044
a) 5 bits b) 6 bits
c) 7 bits d) 8 bits

31. **Eight bits combine to form:** 101116045
a) A byte b) Megabyte
c) Kilobyte d) Gigabyte

32. **In C.R.O grid is always connected with potential** 101116046
a) Negative b) Positive
c) High Positive d) Zero Positive

33. **The instrument which is used to display the magnitude of changing electric current is called:** 101116047
a) Evacuated tube
b) Cathode rays Oscilloscope
c) Television tube
d) Picture tube

34. Electron gun has an electrode called for controlling the flow of electrons in the beam. 101116048
a) Plate b) Grid
c) Screen d) Filament

35. The more negative potential of grid, the more electrons will be ___ 101116049
a) Attracted
b) Repelled
c) Attracted as well as repelled
d) Neither attracted nor repelled

36. In medical field, C.R.O is used to display 101116050
a) Heart beats
b) Pictures of organs
c) Pictures of bones
d) Blood pressure

37. LDR can acts as; 101116051
a) Diode b) Switch
c) Transistor d) Rectifier

38. Which gate is used for safety alarm? 101116052
a) AND b) NAND
c) OR d) NOR

39. AND operation is represented by: 101116053
a) Dot (.) b) Addition (+)
c) Division (÷) d) Minus (–)

40. In OR operation inputs are connected as: 101116054
a) Series
b) Parallel
c) both series or parallel
d) None of these

41. OR operation is represented by: 101116055
a) (×) sign b) ÷ sign
c) + sign d) – sign

42. Which combination forms NAND gate? 101116056
a) AND & OR b) AND & NOT
c) NOT & OR d) NAND & NOR

43. J.J Thomson observed deflection of cathode rays in: 101116057
a) 1895 b) 1896
c) 1897 d) 1898

44. The screen of a cathode ray tube consists of a thin layer of: 101116058
a) Sodium b) Nitrogen
c) Oxygen d) Phosphorus

45. NOT gate is also called: (F. B. 2014) 101116059
a) Converter b) Inverter
c) Transmitter d) Receiver

46. At room temperature, electrons cannot escape the metal surface due to ____ of atomic nucleus: 101116060
a) Repulsive Forces
b) Attractive Forces
c) Gravitational Forces
d) Electromagnetic Force

47. Which is used to investigate the properties of electron beam? 101116061
a) LDR b) Electroscope
c) Proton Gun d) Electron Gun

48. The equation of NOT operation is: 101116062
a) $X = A.B$ b) $X = A + B$
c) $X = A - B$ d) $X = \overline{A}$

49. $X = A.B$. This equation is used for which operation? 101116063
a) AND b) OR
c) NOT d) NAND

50. There are _____ tubes or electron guns in a colour television set 101116064
a) Two b) Four
c) Five d) Three

51. In case of OR and AND operation, if switches S_1 and S_2 both are open then lamp is (F.b 2016) 101116065
a) On
b) Off
c) Sometimes on and sometimes off
d) neither on nor off

52. Universal gates are: (F.b 2016) 101116066
a) Not gate b) NAND & NOR
c) AND gate d) Not & AND

53. In burglar alarm, the Light Dependent Resistance (LDR) acts as a/an: (F.B 2018) 101116067
a) OFF Switch b) ON Switch
c) AND Gate d) OR Gate

54. LDR stand for: 101116068
a) Light Dependent Resistance
b) Light Diode Resistor
c) Low Dimension Ray
d) Less diffracted Ray

55. Cathode rays are actually: (F. B. 2014) 101116069
a) x rays b) electron bean
c) magnetic field d) proton bean

Answer Key

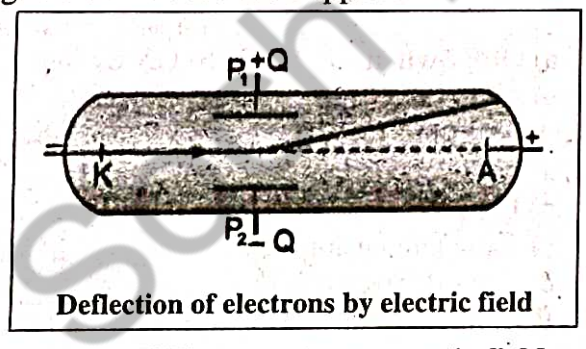
1.	d	2.	d	3.	c	4.	d	5.	c	6.	a	7.	b
8.	b	9.	a	10.	a	11.	d	12.	a	13.	c	14.	b
15.	a	16.	b	17.	b	18.	a	19.	b	20.	b	21.	a
22.	a	23.	c	24.	c	25.	d	26.	d	27.	a	28.	b
29.	a	30.	d	31.	a	32.	a	33.	b	34.	b	35.	b
36.	a	37.	b	38.	b	39.	a	40.	b	41.	c	42.	b
43.	c	44.	d	45.	b	46.	b	47.	d	48.	d	49.	a
50.	d	51.	b	52.	b	53.	b	54.	a	55.	a		

Review Questions

Q.16.1. Describe, using one simple diagram in each case, what happens when a narrow beam of electrons is passed through
(a) A uniform electric field
(b)Uniform magnetic field.
What do these results indicate about the charge on electron? 101116070

Ans. (a) Deflection of electrons by electric field

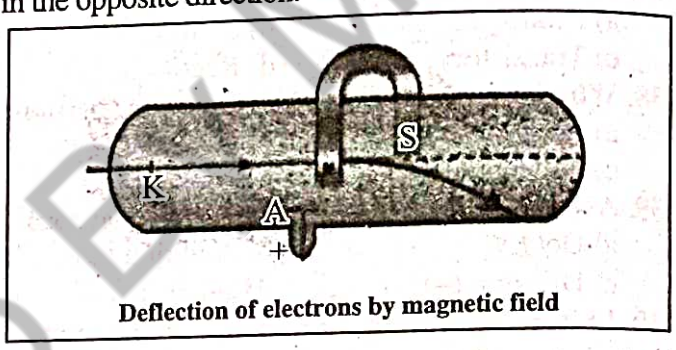
We can set up electric field by applying a potential difference across two parallel metal plates placed horizontally separated with some distance. When an electron beam passes between the two plates, it can be seen that the electrons are deflected towards the positive plate. The reason for this is that electrons are attracted by the positive charges and repelled by the negative charges due to force F=qE, where q is the electron charge and E is the electric field due to plates. The degree of deflection of electrons from their original direction is proportional to the strength of the electric field applied.



Deflection of electrons by electric field

(b) Deflection of Electrons by magnetic field

If we apply magnetic field at right angle to the beam of electrons by using a horse shoe magnet. We will see that the spot of the electrons beam on screen is getting deflected from its original direction. Now change the direction of the horseshoe magnet. We will see that spot on the fluorescent screen getting deflected in the opposite direction.



Deflection of electrons by magnetic field

Q.16.2. Explain the working of different parts of oscilloscope. 101116071

Ans. See Q#4 on Pg# 167

Q.16.3. Name some uses of oscilloscope. 101116072

Ans. The Oscilloscope is used in many fields of science, some uses are given below:

i. Displaying wave forms.
ii. Measuring voltages.
iii. Range finding (as in radar)
iv. Echo-sounding (to find the depth of sea beds)
v. To display heart beats.

Q.16.4. Considering an oscilloscope explains: 101116073

(i) How the filament is heated?

Ans. Filament is heated electrically by a battery 6V Supply.

(ii) Why the filament is heated?

Ans. The filament is heated to get a fine beam of electrons.

(iii) Why the anode potential is positive with respect to the cathode potential?

Ans. The electron emitted from heated filament are accelerated due to positive potential.

(iv) Why a large potential is applied between anode and cathode? 10116075

Ans. A large potential is applied between anode and cathode due to which electrons are directed in specific direction.

(v) Why the tube is evacuated? 10116076

Ans. In the presence of gas or air in the tube ionization is produced, electrons may be scattered and absorbed before reaching the screen. So vacuum is created inside the tube, so that electrons could easily reach the screen.

Q.16.5. What is electron gun? Describe the process of thermionic emission. 101116074

The Electron Gun:

An electron gun is used to investigate the properties of electron beam and make a narrow beam of electron.

The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons. Electron gun also has an electrode called grid G for controlling the flow of electrons in the beam. The grid is connected to a negative potential. The more negative this potential, the more electrons will be repelled from the grid and hence fewer electrons will reach the anode and the screen.

The number of electrons reaching the screen determines the brightness on the screen light. Hence, the negative potential of the grid can be used as a brightness control. The anode is connected to positive potential and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

Thermionic Emission:

"The process of emission of electrons from the hot metal surfaces is called Thermionic Emission".

Metals contain a large number of free electrons. At room temperature electrons cannot escape the metal surface due to attractive forces of the atomic nucleus. If the metal is heated to a high temperature, some of the free electrons may gain sufficient energy to escape the metal surface.

Thermionic emission can also be produced by electrically heating a fine tungsten filament. The typical values of the voltage and current used are 6V and 0.3A.

Q.16.6. What do you understand by digital and analogue quantities? 101116075

Ans. Analogue quantities:

Analogue quantities are those quantities whose value increases or decreases continuously with time or remains constant.

Example:

Temperature, Time, Pressure, Distance etc.

Digital quantities:

The quantities whose values vary in non-continuous manner are called digital quantities. Digital quantities are expressed in the form of digits or numbers..i.e '0' and "1'

Example:

Modern telephone system, radar system, naval and other systems of military importance.

Q.16.7. Differentiate between analogue electronics and digital electronics. Write down names of five analogue and five digital devices that are commonly used in everyday life. 101116076

Analogue Electronics:

The branchtof electronics consisting of such circuits which process analogue quantities is called Analogue Electronics.

Analogue devices:

Radio, Electric fan, Electric motor, Mechanical watch, Washing machine, Electric bulb

Digital Electronics:

"The branch of electronics which provides the data in the form of maximum and minimum voltage signal is known as digital electronics".

OR

"The branch of electronics which deals with the digital quantities is called digital electronics".

The digits used by digital electronics are '0' and '1' and the whole data is provided in Binary system due to which processing of data becomes easy. It can be seen that digital signals provide the data by maximum and minimum voltage level.

Digital devices:

Computer, Radar System, Calculator, Mobile Phone, CD player

Q.16.8 State and explain for each case whether the information given by the following devices is in analogue or in a digital form. 101116077

(i) A moving-coil voltmeter measuring the e.m.f of a cell.

(ii) Microphone generating an electric current

(iii) A central heating thermostat controlling the water pump

(iv) Automatic traffic lights controlling the flow of traffic.

Ans.

(i)Moving coil voltmeter measures the e.m.f of the cell so it provides information in analogue form.

(ii) A microphone generating electric current is also in analogue form.
(iii) Central heating thermostat controlling the water pump is also in analogue form.
(iv) Automatic traffic lights controlling full of traffic are on the basis of digital quantities.

Q.16.9 Write down some benefits of using digital electronics over analogue electronics. 101116078

Ans. There are many benefits of using digital electronics over analogue electronics.

i. There is no interfering or loss of signals.
ii. Digital technology in television gives excellent picture.
iii. A lot of data could be held digitally in the tiny chip.
iv. It enables multi directional transmission simultaneously.
v. The digital system is more accurate than the analogue.
vi. Transmission is transmitted at a higher rate and with a wider broadband width.
vii. It is more secure.
viii. It is also easier to translate human audio and video signals and other messages into machine language.
ix. Digital circuits require less power to operate as compared to analogue circuits.
x. Digital information can easily be manipulated and processed

Q.16.10. What are the three basic Logic gates? Give their symbols and truth tables? 101116079

Ans. There are three basic logic gates;

AND Gate

The circuit which implement the AND operation is known as AND gate. Its symbol is shown in the figure.

It has two or more than two inputs and only one output. It operates in such a fashion that the value of its output is always in accordance with the truth table of AND operation, i.e. the value of its output is only 1(5 volts) when all of its inputs are at 1 (5 volts). For all other values of the inputs the output would be zero.

Truth Table

A	B	X = A.B
0	0	0
1	0	0
0	1	0
1	1	1

OR Gate

"The electronic circuit which implements the truth table of OR operation is known as OR gate". It is symbolically shown in fig.

OR Gate

It has two or more than two inputs and has only one output. It operates in such a fashion that its output is at 1 (5 volts) even when one of its output is at 1 (5 volts). The value of its output will be 0 only when all of its inputs are at 0. In other words the value of its output is in accordance with the truth table of OR operation.

Truth Table

A	B	X = A+B
0	0	0
1	0	1
0	1	1
1	1	1

NOT Gate

"The electronic circuit which implements NOT operation is known as NOT gate". It is symbolically represented in Fig. It has only one input terminal and only one output terminal. It operates in such a fashion that if its input is 0, its output will be 1. Similarly, if the input is 1, then its output will be 0.

NOT Gate

Table

A	X = Ā
0	1
1	0

Conceptual Questions

Q.1 Name two factors which can enhance thermionic emission. (F. B. 2017, 18) 101116080

Ans. The process of emission of electrons from the hot metal surface is called thermionic emission.
Factors which enhance the thermionic emission.
i- If we increase the temperature of metal surface, rate of emission of electron will increase.
ii- By increasing the surface area of metal plate, thermionic emission can be enhanced.

Q.2 Give three reasons to support the evidence that cathode rays are negatively charged electrons. (F. B. 2014) 101116081

Ans.
(i) By applying the electric field, we observe that cathode rays are deflected towards positive charge plate. So they carry negative charge because opposite charges attract each other.
(ii) We apply magnetic field at right angle to the beam of electrons by using a horse shoe magnet, we will notice that spot of electrons beam on screen is getting deflected from its original direction.
(iii) By using the electroscope we can also find that electrons are negatively charged particles.

Q.3 When electrons pass through two parallel plates having opposite charges they are deflected towards the positively charged plate. What important characteristics of the electron can be inferred from this? 101116082

Ans. When electrons pass through two parallel plates having opposite charges. They are deflected towards the positively charged plate, it show that electrons carry negative charge and are attracted towards positively charged plate.

Q.4 When a moving electron enters the magnetic field, it is deflected from its straight path. Name two factors which can enhance electron deflection. 101116083

Ans. Electrons can be deflected from its path by applying magnetic field.
(i) If strength of field increases, electron deflection will also increase.
(ii) By applying high (negative potential) voltage, electron deflection will increase.

Q.5 How can you compare the logic operation X = A.B with usual operation of multiplication? 101116084

Ans.

Logic Operation	Usual Multiplication
X = A.B	X = A.B
X = 0.0 = 0	X = 0.0 = 0
X = 1.1 = 1	X = 1.1 = 1
X = 2.1 = 1	X = 2.1 = 2
In logic operation output is only in the form of 0 and 1.	In usual multiplication if we multiply any number to 1 result will be in that number.

Q.6 NAND gate is the reciprocal of AND gate. Discuss. 101116085

Ans. NAND Gate is the reciprocal of AND gate because the output of AND gate is reciprocal to the output of NAND gate.

AND gate

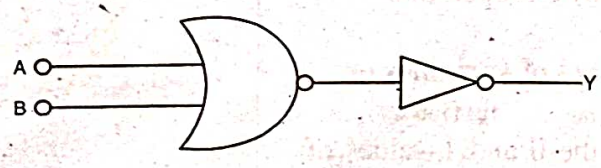
A	B	X = A.B
0	0	0
0	1	0
1	0	0
1	1	1

NAND gate

A	B	$X = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Q.7 Show that the circuit given as below acts as OR gate. 101116086

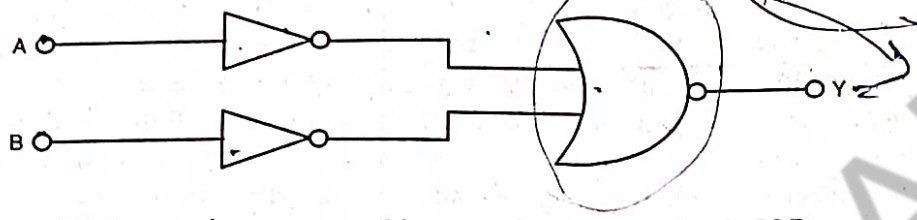
Ans. This circuit act as OR gate, because output terminal of NOR gate is coupled with NOT operation. The value of NOR gate is inverted by NOT operation.



A	B	X = A + B	$X = \overline{A+B}$	$X = \overline{\overline{A+B}}$
0	0	0	1	0
0	1	1	0	1
1	0	1	0	1
1	1	1	0	1

This is the output of OR gate so this circuit acts as OR gate.

Q.8 Show that the circuit given as below acts as AND gate. 101116087



Ans. This shows that two NOT operations are working as input terminal of NOR gate, so that this circuit given below act as AND gate.

A	B	$\overline{A}$	$\overline{B}$	$Y = \overline{A+B}$
0	0	1	1	0
1	0	0	1	0
0	1	1	0	0
1	1	0	0	1

This truth table proof that this circuit act as AND gate.

Additional Short Questions

Q.9 What do you mean by analogue quantities? 101116088

Ans. Those quantities whose value vary continuously or remain constant are known as analogue quantities.

Q.10 What is analogue Electronics? 101116089

Ans. The part of electronics consisting of such circuits which process analogue quantities is called analogue Electronics.

Q.11 What do you understand by analogue to digital converter? 101116090

Ans. Since analogue quantities in digital circuit can not be processed. Therefore, circuit has been made which convert analogue signal to digital one in the form of digits. Such circuits are known as an analogue to digital converter (ADC).

Q.12 Write down the names of three basic operations of digital Electronics. 101116091

Ans. The three basic operations are

i) AND operation ii) OR operation

iii) NOT operation

Q.13 What are the two values of variables in digital electronics? 101116092

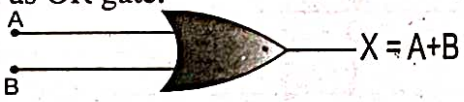
Ans. In digital Electronics the 0 and 1 values of variables are stimulated by two different levels of potentials i.e. 0 for ground level and 1 by 5 volts or any other voltage.

Q.14 Define AND gate? (OR) Draw the diagram of AND gate. 101116093

Ans. The circuit which implements the AND operation is known as AND gate.

Q.15 Define OR gate. Draw diagram of OR gate. 101116094

Ans. The circuit which implements OR operation is known as OR gate.



Q.16 Define NOT gate. Draw diagram of NOT gate. 101116095

Ans. The circuit which implements the NOT operation is known as NOT gate.

Q.17 Describe the role of deflecting plates in cathode ray oscilloscope? 101116096

Ans. The Deflecting Plates:

After leaving the electron gun, the electron beam passes between a pair of horizontal plates. A potential difference applied between these plates deflects the beam in a vertical plane. This pair of plates provides the Y-axis or vertical movement of the spot on the screen. A pair of vertical plates provides the X-axis or horizontal movement of the spot on the screen.

Q.18 What do you meant by NOT gate? How does it works? 101116097

Ans. A Boolean variable, after NOT operation changes its state and acquires the second possible state. For example, if the value of a Boolean variable is 0, then after NOT operation it will change to 1. Similarly if its value is 1, then after NOT operation, it will be 0. Thus, NOT operation inverts the value of Boolean variable.

Q.19 Differentiate between analogue and digital electronics. 101116098

Ans.

Analogue Electronics	Digital Electronics
The part of electronics consisting of such circuits which process analogue quantities is called Analogue Electronics.	"That branch of electronics which provide the data in the form of maximum and minimum voltage signal is known as digital electronics". **OR** "The branch of electronics which deals with the digital quantities is called digital electronics".

Q.20 What is NAND gate? 101116099

Ans. A NAND gate is formed by coupling a NOT Gate with the output terminal of an AND gate is called NAND gate.

Q.21 Define NOR gate. 101116100

Ans. The gate in which the output of OR gate is coupled with a NOT gate is called NOR gate.

Q.22 What are Logic gates? 101116101

Ans. Such circuits have been designed which implement the various logic operations. These circuits are called Logic gates.

Q.23 Define Boolean variables. 101116102

Ans. Such things which can have only two possible states are known as Boolean variable.

Q.24 Define Boolean algebra? 101116103

Ans. The algebra used to describe logic operations by symbols is called Boolean algebra

Q.25 Write down the names of universal logic gates? 101116104

Ans. The names of universal logic gates are as follows:

i) NAND gate
ii) NOR gate

Q.26 For what purpose electron gun is used in CRO? 101116105

Ans. Electron gun is used for producing a beam of fast moving electrons called cathode rays.

Q.27 Give truth table of NOT operation. 101116106

A	$X = \overline{A}$
0	1
1	0

Q.28 Make the truth table and symbols of AND gate. 101116107

A	B	X=A.B
0	0	0
0	1	0
1	0	0
1	1	1

Symbol

Q.29 Make the truth table and symbols of OR gate. 101116108

A	B	X=A+B
0	0	0
0	1	1
1	0	1
1	1	1

Symbol

Q.30 How does LDR works? 101116109

Ans. LDR (light depending resistors) acts as a switch that is closed when illuminated by light and open in the dark.

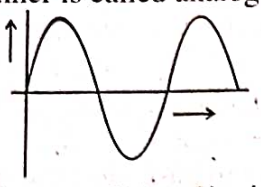
Q.31 What is meant by fluorescent screen? 101116110

Ans. The screen of a cathode-ray tube consists of a thin layer of Phosphor, which is a material that gives light as a result of bombardment by fast moving electrons.

Q.32 Explain digital signals and analogue signals. 101116111

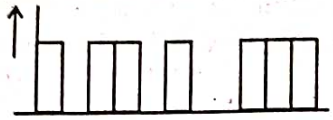
Ans.

Analogue Signal: The signal which vary in a continuous manner is called analogue signal.



Analogue Voltage Signals

Digital Signal: The signal which vary in a non-continuous manner and show result in the



Digital Voltage signals

form of maximum and minimum values are called digital signals.

Q.33 What is meant by thermionic emission. 101116112

Ans. The process of emission of electrons from the hot metal surfaces is called Thermionic Emission

Q.34 Write the parts of cathode ray oscilloscope. 101116113

Ans. Construction of C.R.O.

The Cathode-Ray Oscilloscope (C.R.O). consists of the following components.

- The electron gun
- The deflecting plates
- A fluorescent screen.

Side Information

Q.35 In what ways is an Oscilloscope a Voltmeter? 101116114

Ans. The cathode – ray oscilloscope is used to display the magnitude of changing potentials or currents. The CRO is used for measuring the voltages. So it also acts as Voltmeter because Voltmeter is an electrical instrument to measure voltage. The input of C.R.O. have very high resistance so it behave as an ideal voltmeter.

Q.36 How glow is produced in the tube? 101116115

Ans. The glow in the tube is due to circular motion of electron in the magnetic field. The glow comes from the light emitted from the excitations of the gas atoms in the tube.

Q.37 What is the difference between bit and bytes? 101116116

Ans. A bit represents data using 1's and 0's. Eight bits is a byte – the standard grouping in digital electronics. Digital electronics devices process data in the form of bits.

Q.38 What is digitization? 101116117

Ans. Digitization is the process of transforming information into 1's and 0's.

Q.39 How can you say that rays passing through the cathode ray tube travel in straight line? 101116118

Ans. When an opaque object like a metal cross is placed in the path of a cathode ray tube, a shadow of the metal cross is formed at the end opposite to the cathode. This is evidence that rays of some kind are passing straight through the tube.

Q.40 Which thing is used to deflect electrons to the desired positions on the screen of a television? 101116119

Ans. Electromagnet is used to deflect electrons to the desired positions on the screen of a television.

Q.41 What was the name of beam of electrons before the discovery of electrons and why? 101116120

Ans. The beam of electrons was called a cathode ray because the electrons had not yet been discovered. The old terminology survives in electronic engineering, where a cathode ray tube is any tube constructed along Thomson's line whether in a computer monitor, a television or an oscilloscope.

Q.42 Assume you have an OR gate with inputs A and B. Determine the output C?

For the following cases:

a) A = 1, B = 0

b) A = 0, B =1

If either input is one, what is the output? 101116121

Ans. The output C would be 1 for both cases because in OR operation if any of the input is 1 the output will be 1.

Q.43 What is meant by analog and digital quantities? Or what is the difference between analogue and digital quantities. 101116122

Ans. Analogue quantities:

Analogue quantities are those quantities whose

value increases or decreases continuously with time or remains constant.

Example:

Temperature, Time, Pressure, Distance etc.

Digital quantities:

The quantities whose values vary in non-continuous manner are called digital quantities.

Example:

Modern telephone system, radar system, naval.

Q.44 When a magnet is brought near to the screen of a television tube picture on the screen is distorted. Do you know why? 101116123

Ans. To produce the clear picture on the television screen, electromagnets are used to deflect the electrons to desired places. When a magnet is brought near to the television screen, the electron beam is deflected from its original position so, that's why picture on the screen is distorted.

Q.45 What does double line indicate in Boolean expressions? 101116124

Ans. In Boolean expressions, double line indicates double NOT Operation.

$$X = \overline{\overline{A + B}} = A + B$$

$$X = \overline{\overline{A.B}} = A.B$$

Q.46 Write a brief introduction to Boolean Algebra. 101116125

Ans. The algebra used to describe logic operations by symbols is called Boolean Algebra. Like ordinary algebra English alphabets (A,B,C, etc) are used to represent the Boolean Variables. However, Boolean variable can have only two values, 0 and 1.

Q.47 What is logic function (or) Logic operation? 101116126

Ans. Digital circuits perform the binary arithmatic operation with binary digits '1' and '0'. These operations are called logic function or logic operation.

Q.48 How does TV and telephone signals travel now-a-days? 101116127

Ans. TV and telephone signals once travelled as analogue signals. Electrical signals in copper wires would interfere with each other and give poor quality sound and vision. Today, everything is going digital. The big advantage of digital is quality. There is no interference or loss of strength in digital signals travelling in the optical fibers.

Q.49 Does digital technology become part of our lives? Explain. 101116128

Ans. Digital technology has entered in every part of our lives. e.g.

- Digital TV gives excellent view and allows us to be interactive.
- Digital cameras are fast replacing traditional film equipment. We can download an image into a PC and Crop enhance, airbrush and edit the picture.
- Smart ID cards are being developed. A single Card can be a passport, national insurance card and driving license all in one. The card could also hold biometric data like an eye retina scan and voice scan for unique identification and security. All of this data would be held digitally in the tiny chip.

Q.50 Does cathode ray deflect by external magnetic field? 101116129

Ans. A cathode ray always deflect when it is under the influence of an external magnetic field.

Q.51 What is digitization? 101116130

Ans: Digitization is the process of information into 1's and 0's.

UNIT 17

Information And Communication Technology

Q.1 Define and explain Information and Communication Technology(ICT)? 101117001

OR

What do you understand by Information and Communication Technology? (F. B. 2017)

Ans. Information and Communication Technology:

Information and Communication Technology (ICT) is defined as:

"The scientific methods and means to store, process and transmit vast amounts of information in seconds with the help of electronic equipments".

Explanation: Computer accepts data, processes it and converts it into useful information. This information is transmitted to distant places in the form of sound, picture and computerized data. Information and Communication Technology (ICT) is basically an electronic based system of information transmission, reception, processing and retrieval. ICT is a blend of two fields: information technology and telecommunication.

1. Information Technology (F. B. 2013)

"The scientific method used to store information, to arrange it for proper use and to communicate it to others is called Information Technology".

2. Telecommunication

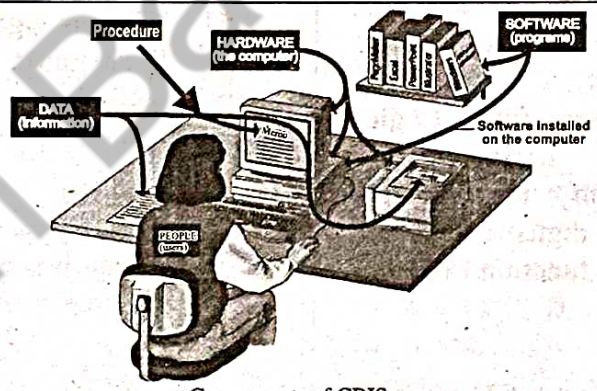
The method that is used to communicate information to far off places instantly is called Telecommunication.

Q.2 Discuss the components of Computer Based Information System (CBIS) in detail.(OR)

What are the components of information technology? Clearly indicate the function of each component. 101117002

Ans. Components of Computer Based Information System

There are five parts that must get together in order to produce a Computer-Based Information System (CBIS). These are called the components of Information Technology. We will discuss these components briefly.



Components of CBIS

Components of Computer:

1. Hardware
2. Software
3. Data
4. Procedures
5. People

Hardware:

The term hardware refers to machinery. Such parts which we can touch or see are called computer hardware. This includes the central processing unit (CPU) and all of its support equipments. Among the support equipments are input and output devices, storage devices and communications devices.

Software:

The term software refers to computer programs and the manuals that support them. Computer programs are machine-readable instructions that direct the circuitry within the hardware parts of the CBIS to produce useful information from data. Programs are generally stored on some input/ output medium, often a disk or tape.

Data:

Data are facts and figures that are used by programs to produce useful information. It may be in the form of text, graphic or figure that can be recorded and that have specific meaning. Like programs, data are generally stored in machine-readable form on disk or tape until the computer needs them.

Procedures:

These are set of instructions and rules to design and use information system. These are written in manuals and documents for use. These methods may change from time to time. The information system must be flexible to incorporate these changes.

People:

Every CBIS needs people if it is to be useful, who influence the success or failure of information systems. People design and operate the software, they feed input data, build the hardware for the smooth running of any CBIS. People write the procedures and it is ultimately people who determine the success or failure of a CBIS.

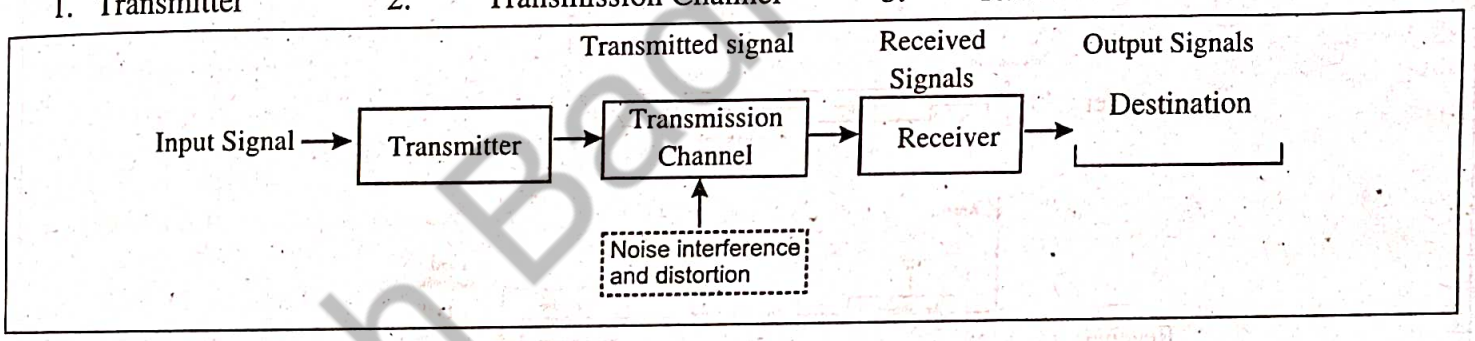
Q.3 What is meant by Flow of Information? Explain. 101117003

Ans. *"The transfer of information from one place to another through different electronic and optical equipments is called flow of information".*

In telephone, information is sent through wires in the form of electrical signals. In radio, television and cell phone information is sent either through space in the form of electromagnet waves, or through optical fibres in the form of light. Radio waves are refracted by different layers in the Earth's atmosphere. This leads to weaken the signal, making it difficult to be received over long distances. Unlike radio waves, microwaves are not refracted. They are used for satellite communications.

There are three essential parts of any communication system:

1. Transmitter 2. Transmission Channel 3. Receiver



1. Function of Transmitter:

The transmitter processes the input signal.

2. Function of Transmission Channels:

The transmission channel is the medium which sends the signal from source to destination. It may be a pair of wires, a coaxial cable, a radiowave or optical fibre cable. So, the signal power progressively decreases with increasing distance.

3. Function of Receiver:

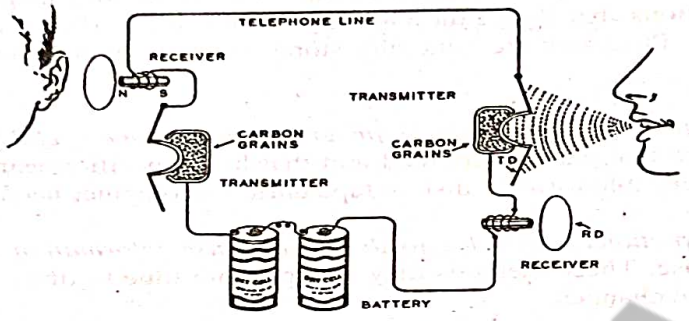
The receiver takes the output signal from the transmission channel and delivers it to the transducer after processing it. The receiver may amplify the input signal to compensate for transmission loss.

Q.4 Explain Transmission of Electrical Signal through wires in detail. 101117004

Ans. Alexander Graham Bell in 1876 made a simple telephone model to send voice in the form of electrical signal from one place to another. It consists of a metal reed, an electric coil, and a vibrating diaphragm. Modern telephone also uses diaphragms to turn voices into electrical signal that are transmitted over phone lines. Telephone system has two parts:

i. the mouth piece

ii. and the earpiece.



Transmission of electrical signals

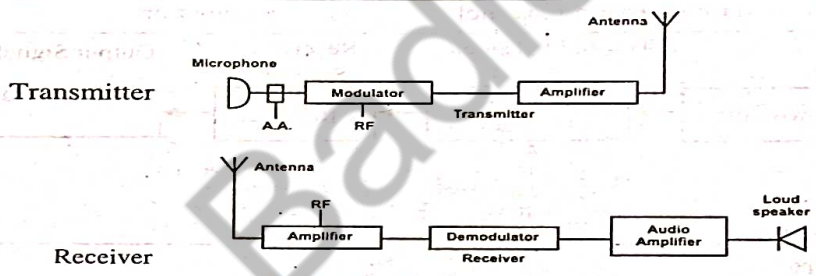
Transmission process of Electric signal:

The mouthpiece and receiver contain carbon granules and a thin metal diaphragm. When we speak into the mouth piece, the sound vibrations also vibrate the diaphragm. A slight vibration of the diaphragm compresses the carbon and thus an electrical current can flow through the wire.

This process is reversed at the other end of the line by the receiver. The electrical current flowing through an electromagnet in the receiver produces a varying magnetic field. This magnetic field attracts the thin metal diaphragm in the receiver, causing it to vibrate. This vibration of the diaphragm produces sound waves.

Q.5 Write a note on transmission of radiowaves through space. **(F. B. 2016)** **101117005**

Ans. Electrical signals representing information from a microphone, a TV camera, or a computer can be sent from one place to another place using either cables or radiowaves. Information in the form of audio frequency (AF) signals may be transmitted directly by cable. However, in order to send information over a long distance it has to be superimposed on electromagnetic waves.



Radio transmission and receiving system

Transmission process of Radio Waves

Sound waves produced at the radio station are changed into electrical signals through microphone. These electrical signals are then introduced into the transmission antenna which consists of two metal rods.

Signals falling on the transmission antenna oscillate the charges which then emit these electrical signals in the form of electromagnetic radiowaves. At the receiving end, the receiver selects and amplifies the modulated signal. The demodulator then extracts the information signal and delivers it to the receptor.

Q.6 Write a brief note on Fax Machine. **101117006**

Fax Machine

Tele facsimile or Fax machines are must for many businesses around the world.

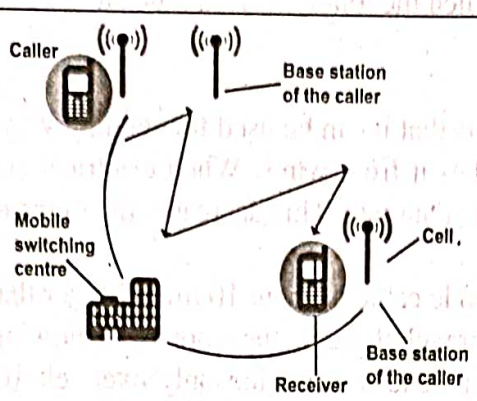
Working

A fax machine basically scans a page to convert its text and graphic into electronic signals and transmits it to another fax machine through telephone line. The receiving machine converts the signal and uses a printer (usually built in) to create the copy of the message that was sent.

Q.7 Explain Cell Phone. 101117007

Cell Phone

Radio technology is applied in mobile phone. It is a type of radio having two way communication. A cell phone carries a radio transmitter and a receiver inside it. It sends and receives the message in the form of radio waves.



Cell phone network

Cell Phone Network System:

Cell phone network system consists of

(i) Cell (ii) Base stations (BSs) (iii) Mobile Switching Centre (MSC).

A Base station is a wireless communication station set up at a particular geographical location. The geographical area covered by a single base station is known as cell. The group of cells forms a cluster. All (BSs) within a Cluster are connected to MSC using land lines. The MSC stores information about the subscribers located within the cluster and is responsible for directing calls to them.

Working

When a caller calls another cell phone, sound waves of the caller are converted into radiowaves signal. This radio signal of particular frequency is sent to the local base station of the caller where the signal is assigned a specific radio frequency. This signal is then sent to the base station of the receiver through MSC. Then the call is transferred to the cell phone of the receiver. Mobile receiver again changes the radio waves into sound.

Q.8 Explain Photo Phone. / What is photo phone? 101117008

Ans. Photo Phone

Modern version of photo phone or video phone is a telephone through which speakers can see the pictures of each other. By using the photo and phone numbers of our friends or family members on this telephone we can call them by pressing the pad with their photos. Thus, we can communicate with our relatives or friends on photo phone with the physical appearance of each other.

Q.9 Discuss the transmission of light signals through optical fibres in detail. 101117009

OR

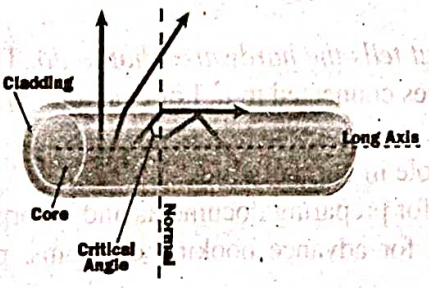
How light signals are sent through optical fibre?

Ans. Waves of visible light have a much higher frequency than that of radio waves. This means, rate of sending information with light beam is larger than that with radiowaves or microwaves.

Optical fibre

It is an equipment which is used for the transmission of light signals.

An optical fibre with a coating of lower refractive index is a thin strand of high quality glass that absorbs very little light. An optical fibre cable is a bundle of glass fibre with thickness of a human hair.



Light entering a glass rod at greater than the critical angle is trapped inside the glass

Working

Light that enters the core at one end of the optical fibre goes straight and hits the inner wall (cladding) of fibre optics. If the angle of incidence with the cladding is less than the critical angle, some of the light will escape the fibre optics and is lost. However, if the angle of incidence is greater than the critical angle, light is totally reflected into the fibre optics. Then the totally reflected beam of light travels in a straight line until it hits the inner wall again, and so on.

Advantage

The advantage of optical fibre is that it can be used for sending very high data rates over long distances. This feature of fibre optics distinguishes it from wires. When electrical signals are transmitted through wires, the signal lost increases with increasing data rate. This decreases the range of the signal.

Multi-Mode Cable

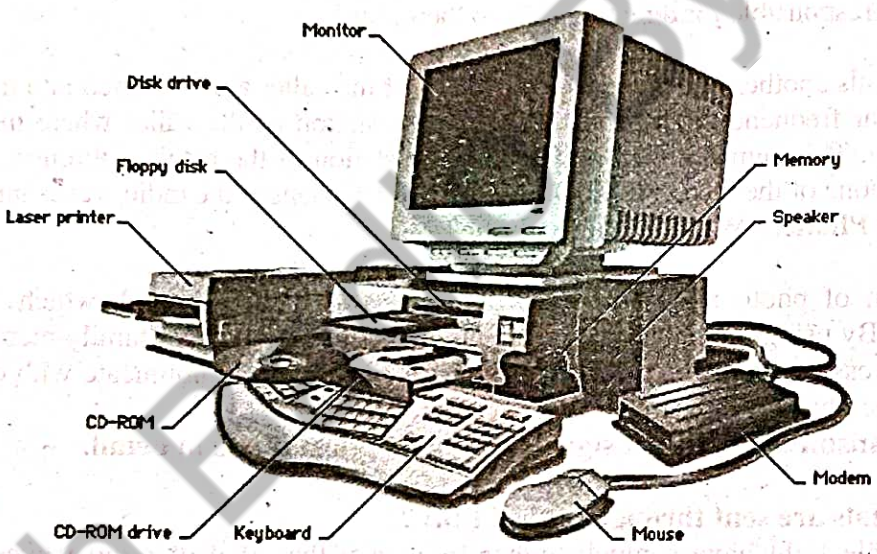
Each optical fibre in a multi-mode cable is about 10 times bigger than fibre optics used in a single-mode cable. This means light beams can travel through the core by following different paths, hence, the name multiple-mode. Multi-mode cables can send information only over relatively short distances and are used to link computer networks together.

Q.10 Write a brief note on computer. 101117010

OR

What is computer? What is the role of computer in everyday life?

Ans. *Computer is an electronic computing machine which accepts data, process it and converts it into useful information.* Computers work through on interaction of hardware and software.



Parts of a computer

Hardware

Such parts of computer which we can see and touch like keyboard mouse, monitor etc. The most important part of hardware is the Central Processing Unit (CPU)that contains a tiny rectangular chip called microprocessor. It is the "brain" of the computer. All the operations are performed inside this part of computer.

Software

Software is set of programs that tells the hardware what to do. The Operating System (OS) is software that manages your computer and devices connected to it. For example, Windows and Linux Operating System.

Role of Computer in our daily life

Computer plays an important role in our daily life.

1. In offices, computers are used for preparing documents and reports.
2. In hotels, computers are used for advance booking of rooms, preparing bills and providing enquiry services.
3. In hospitals, doctors use computer for diagnosing diseases and treatment of diseases.

4. Architects use them for building designing and city planning.
5. In Railways, computers are used for reservation, printing of tickets and preparation of reservation charts.
6. In Meteorology department, computers are used for weather forecasting.

Note: Now usual desktop computers have been replaced by laptops to a great extent. Laptops are more compact and hence are portable.

Q. 11 What do you mean by Primary Memory? 101117011

Ans. Primary Memory

It is based on electronics and consists of integrated circuits (ICs). It is a Random Access Memory (RAM) . It is a temporary memory. All the information stored in a memory is lost when a computer is switched off.

Q.12 What do you mean by Secondary Storage Devices? 101117012

Ans. Secondary Storage Devices.

It is used to store the data permanently in the computer. We can store our information for along time in it. The data storage capacity of secondary memory is much greater as compared to the primary memory. All information stored in Secondary memory is not lost when the computer is switched off.

Q.13 What are information storage devices? 101117013

Ans. *Such devices which are used to store information inside the computer are called information storage devices.* Storage devices work on different principles using electronics, magnetism and laser technology.

Q.14 What are Audio and Video Cassettes? Also explain their working process. 101117014

Ans. Audio and Video Cassettes

These devices are based on magnetism.

i) Audio Cassette:

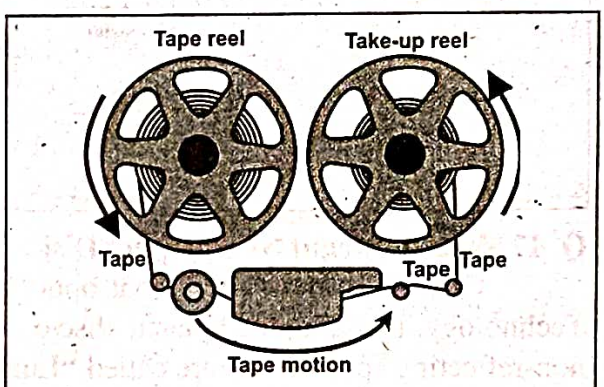
An Audio Cassette is a recording device of music and sounds.

ii) Video Cassette:

A Video Cassette is a recording device of images and sound on a magnetic tape.

Working:

Audio cassettes consists of a tape of magnetic material on which sound is recorded in a particular form of a magnetic field. For this purpose microphone changes sound waves into electric pulses which are amplified by an amplifier. Magnetic tape is moved across the head of audio-cassette recorder which is in factan Electromagnet. Change of current in the electromagnet causes a change in the linked magnetic field. Thus, magnetic tape is magnetized in a particular form according to rise and fall of current. In this way sound is stored in a specific magnetic pattern on this tape.



A magnetic tape storage mechanism

To produce the sound again, the tape is moved past the play back head. Changes in the magnetic field on the tape induce alternating current signals in the coil wound on the head. These signals are amplified and sent to the loudspeakers which reproduce the recorded sound. In video tapeorcassettes pictures are recorded along with sound.

Q.15 Write a brief note on magnetic disks. 101117015

Ans. There are different types of magnetic disks coated with a layer of some magnetic material. The read / write head of disks are similar to the record replay head on a tape recorder. It magnetizes parts of the surface to record information. The difference is that a disk is a digital medium. Binary numbers are written and read.

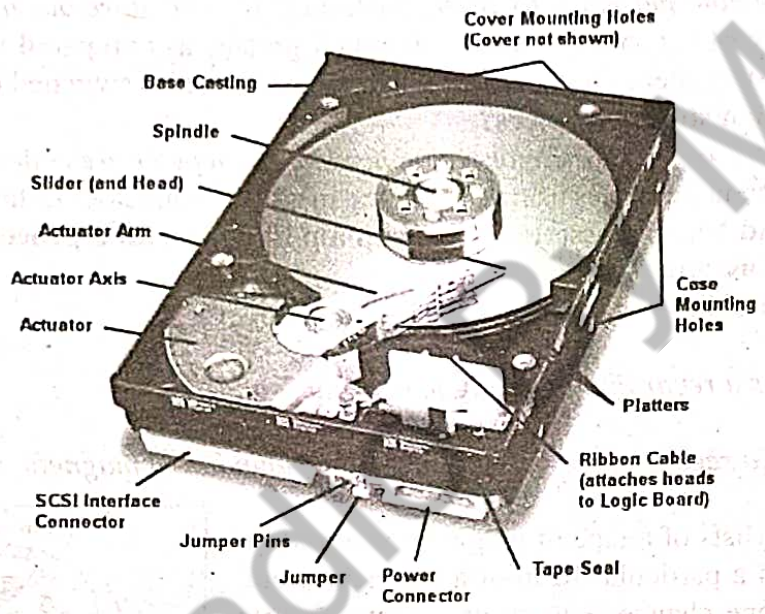
A floppy disc is a small magnetically sensitive, flexible plastic wafer housed in plastic case. It is coated with a magnetic oxide similar to the material used to coat cassettes and video tapes. Most personal computers include at least one disk drive that allows the computer to write it and read from floppy disk. A typical floppy has a storage capacity of between 1 and 3MB

Advantage and Disadvantage

Floppies are inexpensive, convenient, and reliable, but they lack the storage capacity and drive speed fo many large jobs. Data stored on floppy disks is also subject to loss as a result of stray magnetic fields. As far a floppy disks are concerned, they are reliable only for short-term storage and cannot be used longer and n attempts should be made to save the data for a longer period. As the magnetic fields weaken the data will also be lost.

Q.16 What is a Hard Disk? Explain. 101117016

Ans. Most users rely on hard disks as their primary storage devices. A hard disk is a rigid, magnetically sensitive disk that spins rapidly and continuously inside the computer chassis or in a separate box connected to the computer housing. This type of hard disk is never removed by the user. A typical hard disk consists of several platters, each accessed via a read/write head on a moveable arm. A hard disk might hold several hundred thousands of Megabytes of information.

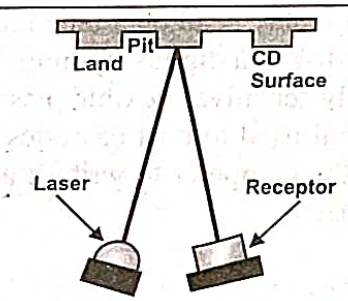


Hard disk

Q. 17 What is meant by Compact Disk. Or Write a note on Compact Disk (CD). 101117017

One of the most prominent optical storage systems is the Compact Disk (CD). This is based on Laser Technology. It is a molded plastic disc on which digital data is stored in the form of microscopic reflecting and non-reflecting spots which are called **"Lands"** and **"Pits"** respectively. **Pits** are the spiral tracks encoded on the top surface of CD and **Lands** are the areas between pits. A fine Laser beam scans the surface of the rotating disk to read the data. Pits and lands reflect different amount of the 'Laser' light falling on the surface of CD. This pattern of different amount of light reflected by the 'Pits' and 'Lands' is converted into binary data. The presence of pit indicates '1' and absence of pit indicates '0'.Because data stored on CD can only be read but cannot be altered or erased. Therefore, CD memory is called Read Only Memory (ROM).

A CD can store over 680 Megabyte of computer data. A DVD, the same size as traditional CD, is able to store upto 17 Gigabytes of data.



Q.18 What is a Flashdrive? Explain. 101117018

Ans. *It is also an electronic based device and consists of data storage ICs.* A flash drive is a small storage device that can be used to transport files from one computer to another. A flash driver is easy to use. Once we have created a file or other work, we can simply plug our flash drive into a USB port. We must make a backup of our created file or project on our Flash drive and save it separate from our computer. Due to small in size we can take it anywhere with us.

Flash drive

Q.19 Write down the names of applications of the computer. 101117019

Ans. Following are the applications of computer:

i. Word Processing **ii.** Data Management – Monitoring and control **iii.** Internet

Q.20 Write a brief note on Word Processing. 101117020

Ans. *"Word processing is such a use of computer through which we can write a letter, article, book or prepare a report .Word Processing is a computer program."*

Using this program we can develop any document, see it on the screen after typing. We can edit the document, add some new text or delete the previous text or make amendments in it. We can move text from one page to another, even from one document to another. Document can be stored in memory and its print can also be taken. By means of modern word processing, we can write it in different styles and in different colours. We can also use graphics.

Q.21 What is Data Management, Monitoring and Control? Explain. 101117021

Ans. *"To collect all information regarding a subject for any purpose and to store them in the computer in more than one inter linked files which may help when needed, is called Data Management."*

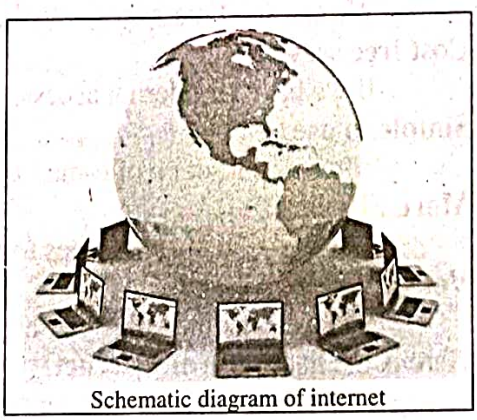
The educational institutions, libraries, hospitals and industries store the concerned information by data management. Additions and deletions are made in the data according to the requirement, which help in the improvement of the management of the institutions.

Data Management through optical scanners

In big departmental stores and super markets optical scanners are used to read with the help of a Laser Beam, the barcodes of a product which indicates the number at which this product is recorded in the register. In this way the detail about its price is obtained.The central computers monitors the bills and the related record of the sold goods. It also helps placing the order of goods being sold in a large quantity and to decide about less selling goods.

Q.22 Write a brief note on Internet. / What is internet? Explain in detail. 101117022

Ans. *"A network of computer networks is called Internet. When many computer networks of the world are connected together, with the purpose of communicating with each other, Internet is formed."* Initially the size of internet was small. Soon, people became aware of its utility and advantages and within short span of time, numerous computers and networks got themselves connected to the internet. Internet is basically a large Computer network, which extends all across the globe. There is hardly any country of the world and important city of the country where internet is not available.



Schematic diagram of internet

In internet, millions of computers remain connected together through well laid communication system. Recall that telephone communication system is well defined, time proven system. Internet makes use of this system and many other systems to connect all the computers. Thus, like a telephone connection any computer of any city can establish a connection with any other computer of any other city and exchange data or messages with it.

Internet Services:

The main services used on the internet include:-

- **Web Browsing:** This function allows users to view web pages using a web browser.
- **E-mail:** allows people to send and receive text messages.
- **Fast Communication:** Allows people to communicate each other.
- **Big Source of Information:** It can provide information quickly.
- **Source of Entertainment:** By using internet we can enjoy music and movies on line.
- **Access to Social Media:** It provides access to social media.
- **Access to Online Services:** Internet provides access to online services.
- **E-Commerce:** E-Commerce is the way of doing business on the web. Most trading companies do their business online.
- **E-Learning:** Internet provides electronic learning courses to the people. It provides course, program or degree delivered completely online.

Q23. What is Browser? **(F. B. 2016)** **101117023**

Ans. Browser:-

"A browser is an application which provides a window to the web". All browsers are designed to display the pages of information located at websites around the world. The most popular browsers on the market today include Internet Explorer, Opera, Safari, Mozilla Firefox, Chrome, The World etc.

Icons of different web browsers

Q.24 How to search the Web? **101117024**

Ans. We can search anything through search engine like Google Chrome, Internet Explorer, Mozilla Firefox, etc.

Q.25 Define Electronic Mail: Write down its three advantages. **101117025**

Ans. One of the most widely used applications of Internet is Electronic Mail (or e-mail), which provides very fast delivery of messages to any enabled site on the Internet. Communication through e-mail is more quick and reliable. Through our e-mail, we can communicate with our friends and institution with more ease and pace. Some advantages of e-mail are as follows:

Fast Communication

We can send messages anywhere in the world instantly.

Cost free service

If we have an internet access, then we can avail the e-mail service free of cost.

Simple to use

After initial set up of e-mail account, it is easy to use.

More Efficient:

We can send our messages to many friends or people only in one action.

Versatile:

Pictures or other files can also be sent through e-mail. Internet has proved to be very beneficial to us. Here is the list of **use of Internet**.

i. Faster Communication.
ii. Big Source Information.
iii. Source of Entertainment.
iv. Access to Social Media.
v. Access to Online services.
vi. E-commerce
vii. E-learning

Q.26 What are the adverse effect of ICT on Society and the Environment? Explain. 101117026
(OR) What are the risks of ICT to society and environment?

Ans. In the modern age we are expected to rely upon information technology. Following are the adverse effects of ICT on society and the environment:-

1. Over use of computer is dangerous for our health.
2. Computer crimes are also very common these days. Any crime accomplished through knowledge or use of computer technology.
3. Theft is the most common form of Crime. Computers are used to steal money, goods, information and computer resources.
4. Piracy is another issue of importance which is common on computer. It is illegal duplication of copyright material like books, papers and software etc.
5. Hacking is another illegal activity which is committed on computers. It is unauthorized access to computer systems of other persons.
6. Computer hackers can damage some organizations by stealing their credit cards and valuable information.

Following are the ways to reduce the risks of security breaches:

1. One way to reduce the risks of security breaches is to make sure that only authorized persons have access to computer equipment.
2. We can use a key, an ID Card with photo, an ID number, a lock combination, our voice print or finger print as password to secure our computer.

Multiple Choice Questions

Choose the correct answer for the following choices.

1. In computer terminology information means: (F. B. 2017) 101117027
(a)any data (b)raw data
(c)processed data (d)large data

2. Which is the most suitable means of reliable continuous communication between an orbiting satellite and Earth? (F. B. 2016, 17)101117028
(a)microwaves (b)radio waves
(c)sound wave s (d)any light waves

3. The basic operations performed by a computer are 101117029
(a)arithmetic operations
(b)non-arithmetic operations
(c)logical operations
(d)both(a) and (c)

4. The brain of any computer system is: 101117030
(a)monitor (b)memory
(c)CPU (d)control unit

5. Which of the following is not processing? 101117031
(a)arranging (b)manipulating
(c)calculating (d)gathering

6. From which of the following we can get information almost about everything? 101117032
(a)book (b)teacher
(c)computer (d)Internet

7. What does the term e-mail stand for? (F. B. 2016) 101117033
(a)emergency mail
(b)electronic mail
(c)extra mail
(d)external mail

Additional MCQs

8. Radio waves are: 101117034
(a)electric waves
(b)electromagnetic waves
(c)X-rays
(d)Radio-active rays

9. The data stored in C.D. is 101117035
(a)680 MB (b)650 MB
(c)700 MB (d)750 MB

10. Hard disk is made of: 101117036
(a)Aluminium (b)Copper
(c)Iron (d)Plastic

11. CD which is made of soft material is called: 101117037
(a)hard disk (b)floppy disk
(c)iron disk (d)copper disk

12. A device which has two way communication is: 101117038
(a)Television (b)Radio
(c)Hard disk (d)Mobile Phone

13. An example of input device of computer is:
(a)key board (b)Printer 101117039
(c)monitor (d)RAM

14. **A data storage device is:** 101117040
(a)Printer (b)hard disk
(c)Monitor (d)CPU

15. **What is fitted in telephone receiver?**
(a)electromagnet b)diaphragm 101117041
(c)both a and b d)none

16. **Information storage devices work on the principles of:** 101117042
(a)heat (b)sound
(c)light (d)magnetism

17. **Which component is output device of computer?** 101117043
(a)CPU (b)C.D
(c)Keyboard (d)monitor

18. **Which technology is used in mobile phone?** 101117044
(a)heat (b)radio
(c)light (d)Laser

19. **Which of the following reasons increase the importance of computer?** 101117045
(a)speedy
(b)long time storage of memory
(c)quick decision
(d)all of these

20. **The speed of sound in air is:** 101117046
(a)1243kmh^{-1} b)1244kmh^{-1}
(c)1245kmh^{-1} d)1246kmh^{-1}

21. **1 KB = _____ :** 101117047
(a)1024 bytes (b)1024KB
(c)1024MB (d)None of these

22. **1 MB = _____:**
(F. B. 2014) 101117048
(a) 1022 KB (b)1023 KB
(c)1024 KB (d)1025 KB

23. **1 GB = _____ Megabytes:**
(a)1022 MB (b)1023 MB 101117049
(c)1024 MB (d)1025 MB

24. **Coaxial cable are used to transmit signals.**
(a)magnet 101117050
(b)electric
(c)mechanical
(d)both mechanical and magnet

25. **The waves which travel in straight line through space and have strong signals are called:** 101117051
(a)micro waves
(b)mechanical waves
(c)light waves
(d)magnet waves

26. **The advantages of electronic mail are:**
(a)Fast communication 101117052
(b)Cost free service
(c)More efficient
(d)All of these

27. **Micro waves are used in:** 101117053
(a)Radio (b)Television
(c)Mobile Phone (d)All of these

28. **One byte is equal to:** 101117054
(a) 7 bits (b) 5 bits
(c) 8 bits (d) 9 bits

29. **Which is not a hardware?** 101117055
(a) CPU (b) Window
(c) Keyboard (d) Mouse

30. **With broadband information can be loaded.** 101117056
(a) in 1 min. (b) in 1s
(c) in 1 day (d) in 2 days

31. **First voice signal was transmitted in the form of electrical signal in:** 101117057
(a) 1870 (b) 1875
(c) 1876 (d) 1880

32. **The way of doing business by using web is called:** 101117058
(a)Source of entertainment
(b)Web business
(c)E-Commerce
(d)E-mail

33. **Floppy has a storage capacity** 101117059
(a) 4-5 MB (b) 3-4 MB
(c) 1-3 MB (d) 3-6 MB

34. **In CD presence of pits is indicated by:**
(a) 0 (b) 2 101117060
(c) 3 (d) 1

35. **To send or receive digital information we use ____ rays along optical fiber:** 101117061
(a) infra red (b) alpha rays
(c) beta rays (d) mechanical

36. **Cell phone network system consists of:**
(F. B. 2016) 101117062
(a) base station
(b) mobile switching centre
(c) cells
(d) all of these

37. **Waves whose speed is equal to speed of light are:** 101117063
(a)X-rays
(b)Sound rays
(c) Electromagnetic waves
(d)Shock waves

38. **To get a design on the computer screen by moving a pointer with the help of mouse is called:** 101117064
(a) Word processing
(b)Graphic designing
(c) Data managing
(d) Telecommunication

39. **Scientist who transmitted the first radio signal in air is:** 101117065
(a) Galileo (b)Graham Bell
(c) Einstein (d) Marconi

40. **Through which we can get results from computer?** 101117066
(a)Input devices (b)CPU
(c) Output devices (d)Keyboard

41. **We can give data to computer by:**
(a) Input devices (b) CPU 101117067
(c) Output devices (d) Program

42. **Floppy disc is made up of:** 101117068
(a) Iron (b) Plastic
(c) Wood (d) Aluminum

43. **The process through which we can communicate information to far off places instantly is:** 101117069
(a) Telecommunication
(b) Communication
(c) I.T
(d) Computing

44. **The scientific method of storing, arranging information for proper use is called:** 101117070
(a) Telecommunication
(b) Communication
(c) I.T
(d) Computing

45. **The mouth piece and receiver contains _____ granules.** 101117071
(a) Carbon (b) Oxygen
(c) Hydrogen (d) Nitrogen

46. **Waves of visible light have much higher:** 101117072
(a) energy (b) wave length
(c) frequency (d) speed

47. **A DVD can store data upto:** 101117073
(a) 15 GB (b) 14 GB
(c) 17 GB (d) 20 GB

48. **The program through which we can write letters, books etc is called:** 101117074
(a) word processing
(b) graphic designing
(c) data management
(d) web designing

49. **Example of primary memory is.** 101117075
(a) Read only Memory (ROM)
(b) Hard Disk
(c) Floppy Disk
(d) Audio Cassette

50. **Which is fitted in telephone receiver?** (F. B. 2016) 101117076
(a) electromagnet
(b) diaphragm
(c) both (a) and (b)
(d) permanent magnet

Answer Key

1.	c	2.	a	3.	d	4.	c	5.	d	6.	d	7.	b
8.	b	9.	a	10.	a	11.	b	12.	d	13.	a	14.	b
15.	c	16.	d	17.	d	18.	b	19.	d	20.	d	21.	a
22.	c	23.	c	24.	b	25.	a	26.	d	27.	c	28.	c
29.	b	30.	b	31.	c	32.	c	33.	c	34.	d	35.	a
36.	d	37.	c	38.	b	39.	d	40.	c	41.	a	42.	b
43.	a	44.	c	45.	a	46.	c	47.	c	48.	a	49.	a
50.	c												

Review Questions

Q.17.1. What is difference between data and information? 101117077

Ans.

Data	Information
• Data are facts and figures that are used by program to produce useful information. • Raw material is called data. • Data is raw, unorganized facts that need to be processed. • Data can be something simple and useless until it is organized.	• After arranging the fact and figures of data in a suitable manner we get information. • Processed data is called information. • When **data** is processed, interpreted, organized, structured or presented so as to make them meaningful or useful, it is called **information**.

Q.17.2. What do you understand by Information and Communication Technology (ICT)? 101117078

Ans. See Q#1 on Pg# 186

Q.17.3. What are the components of information technology? Clearly indicate the function of each component. 101117079

Ans. See Q#2 on Pg# 186

Q.17.4. Differentiate between primary memory and secondary memory. 101117080

Ans.

Primary Memory	Secondary Memory
i. Primary memory is the memory that is directly accessed by the CPU to store and retrieve information. ii. Primary memory is known as main memory or internal memory. iii. Primary memory is accessed using address and data buses by the CPU. iv. Primary memory does not retain data when the power is turned off (volatile). v. Primary memory is very fast. vi. Primary memory devices are more costly.	i. Secondary memory is not accessible directly by the CPU. ii. Secondary memory is known as additional memory or external memory. iii. Secondary memory is accessed using input/output channels. iv. Secondary memory retains data when the power is turned off (non-volatile). v. Secondary memory has a lower access time. vi. Secondary memory devices are less costly.

Q.17.5. Name different information storage devices and describe their uses. 101117081

Ans. Information storage devices:

Such devices which are used to store information inside the computer are called information storage devices.

There are many information storage devices including floppy disks, USB flash drives, memory cards, memory sticks, tape cassettes, hard disk, CDs and DVDs.

Audio Video Cassettes

Audio and video cassettes are based on magnetism. Audio cassettes consist of a tape of magnetic material on which sound is recorded in a particular pattern of a magnetic field. In video cassettes pictures are recorded along with sound. Today other technology can perform the function of magnetic tapes.

Floppy Disk

A floppy disk is a small magnetically sensitive disk housed in a plastic case. It is coated with a magnetic oxide. It is used to store the data in past now it is replaced by other disk. As far as floppy disks are concerned, they are reliable for short term storage and cannot use it to store data for longer period. The storage capacity of floppy is only 1 to 3 MB.

Hard Disk

Most users rely on hard disk as storage devices. A hard disk is a rigid, magnetically sensitive disk that spins rapidly and continuously inside the computer chassis. This type of hard disk is never removed by the user. Information can quickly transfer to hard disk. Its storage capacity is several thousand gigabytes.

Compact Disc

A **Compact Disc (CD)** is a type of optical **disc**. It is flat and round, and is used to store digital data. It was first used to store music and other sounds (and is sometimes called an "audio **CD**"). The sound on a **CD** is played using a **compact disc** player.

This is based on laser technology. It is molded plastic disc on which digital data is stored in the form of binary numbers. A CD can store over 680 megabytes of computer data. A DVD of the same size is able to store up to 17 gigabytes of data.

680MB

Flash Drive

It is an electronic based device and consists of data storage ICs. A **USB flash drive**, also commonly known as a **USB drive, USB stick, USB key, USB**, and a variety of other names, is a data storage device that includes flash memory with an integrated USB interface. USB flash drives are typically removable and rewritable, and physically much smaller than an Optical disc (CD).

USB **flash drives** are often used for the same purposes, for which floppy disks or CDs were once used, i.e., for storage, data back-up and transfer of computer files. They are smaller, faster, have thousands of times more capacity, and are more durable and reliable because they have no moving parts.

Q.17.6 Explain briefly the transmission of radio waves through space. 101117082

Ans. See Q#5 on Pg# 188

Q.17.7. How light signals are sent through optical fibre? 101117083

Ans. See Q#9 on Pg# 189

Q.17.8. What is computer? What is the role of computer in everyday life? 101117084

Ans. See Q#10 on Pg# 190

Q.17.9. What is the difference between hardware and software? Name different software's. 101117085

Ans.

Hardware	Software
Hardware refers to the parts of a computer that you can see and touch. These includes CPU, monitor, keyboard, mouse, printer etc.	Software refers to the instructions or programs that tell the hardware what to do. Examples of software are: a) Photoshop (b) MS Office (c) CoralDraw.

Q.17.10. What do you understand by the term word processing and data managing? 101117086

Ans. See Q#20,21 on Pg# 193

Q.17.11. what is internet? Internet is useful source of knowledge and information. Discuss. 101117087

Ans. See Q#22 on Pg# 193

Q.17.12. Discuss the role of information technology in school education. 101117088

Ans. Role of Information Technology in Education:

In recent years computers and internet are used to improve effectiveness and efficiency of education at all levels. The use of IT has changed the traditional methods of teaching and learning. Now a days information technology provides lot of sources to enhance the teaching skills and learning abilities.

By using internet students are now able to access information on any subject at any time. Students are using computers for presentation, preparing their projects and assignments. Today students have easy approach to their educational contents e.g. e-books, practice tests and examination, model papers and research papers by using internet.

The role of IT cannot be ignored in teaching field. Today teachers are using multimedia in classrooms to make the teaching and learning process more efficient and effective. Now it is easier for the teachers to impart knowledge and for students to acquire it. The process of teaching and learning is more interacting and innovative. IT is also used in sharing experience and information with others.

Most of educational institutes have online lecture system. Student grading system, details of attendance record, information about school fee and syllabus, all are provided online via internet.

Conceptual Questions

Q.1 Why optical fibre is more useful tool for the communication process?
(F. B. 2014) 101117089

Ans. Waves of visible light have much higher frequency than that of radio waves. This means, rate of sending information with light beams is longer than that with radio waves or microwaves. As well as signal loss in optical fibre is minimum as compare to any other cable.

Q.2 Which is more reliable floppy or a hard disk? 101117090

Ans. Hard disk is more reliable as compared to Floppy Disk. A typical floppy has storage capacity between 1 and 3 MB. A hard disk can store hundreds or thousands of megabytes of information. Information can be transferred quickly by hard disk than with a floppy.

Q.3 What is the difference between RAM and ROM memories? (F. B. 2016, 17) 101117091

Ans.

RAM (Random Access Memory)	ROM (Read Only Memory)
RAM is the Primary Storage device. Data and instructions are stored temporarily in it. When computer is turned off, information stored in RAM is lost.	ROM can be read but new data cannot be written into it so it is read only memory. The manufacturer of the ROM writes the data and programs permanently into it and this data cannot be changed afterwards. The data stored in ROM will not change for long time.

Additional Short Questions

Q.4 Define Word Processing. 101117092

Ans. Word Processing

To type something by computer's keyboard, to correct, to arrange, to amend the document, to add and delete the written portion when required is called Word Processing.

Q.5 Define Data Management.

Ans. Data Management 101117093

To collect all information regarding a subject for any purpose and to store them in the computer in more than one inter-linked files which may help when needed is called data managing.

Q.6 Write the uses of Fax Machine. / How fax machine works? 101117094

Ans. Fax Machine

Documents of considerable importance are sent from one place to other through fax machine with telephone line. Fax machine first gets the reflection of the document like Photostat machine, changes it into electronic signal and then transmits it via telephone line. The message when reaches the receiving fax machine, it produces the signals in an image print on a paper again.

Q.7 What is a computer? 101117095

Ans. Computer

Computer is an electronic machine, which after analyzing and arranging the given information presents it in a very short time. All work is done by the computer in the light of those instructions, which is called a programme and is saved in its memory.

Q.8 What is the main difference between telephone and cellular phone? 101117096

Ans. Telephone changes sound into electrical signal and sends to receiver while mobile phone works on electromagnetic waves.

Q.9 Write down the use of some electromagnetic radiation in modern telecommunications. 101117097

Ans.

(i) Radio waves carry information to local radio and T.V.

(ii) Microwaves are used for mobile phones, radar and transmission to satellites in space.

(iii) Infrared rays are used to send digital information along fibre optic cables.

Q.10 Write two advantages of e-mail. 101117098

Ans.

i. Fast Communication:

We can send messages anywhere in the world instantly.

ii. Cost free service:

If we have an internet access, then we can avail the email services free of cost.

Q.11 Differentiate between hard disk and floppy. 101117099

Ans.

Floppy Disk	Hard Disk
1) Floppy disk is made of flexible plastic. 2) Floppy is inserted into the floppy drive when it has to be used. 3) Its storage capacity is 1MB-3MB. 4) It is housed in a protective jacket.	1) Hard disk is made of aluminum. 2) It is installed inside the CPU. 3) It has several hundred thousand Megabyte information. e.g. 4GB, 10GB, 40GB and so on. 4) It is closed in a jacket.

Q.12 Write name of four output devices of a computer. 101117100

Ans. (i) Monitor (ii) Printer
(iii) Speakers (iv) Plotter

Q.13 What is meant by web browsing? 101117101

Ans. Web browsing allows users to view web page.

Q.14 What is CPU? 101117102

Ans. The most important part of computer is the Central Processing Unit (CPU) that contains a tiny rectangular chip called microprocessor. It is the "brain" of the computer. All the operations are performed inside this part of computer.

Q.15 What is floppy disk? 101117103

Ans. A floppy disc is a small magnetically sensitive, flexible plastic wafer housed in plastic case. It is coated with a magnetic oxide similar to the material used to coat cassettes and video tapes. Most personal computers include at least one disk drive that allows the computer to write it and read from floppy disk. A typical floppy has a storage capacity of between 1 and 3MB.

Q.16 Write the function of transmitter and receiver. 101117104

Ans.

Function of Transmitter:

The transmitter processes the input signal.

Function of Receiver:

The receiver takes the output signal from the transmission channel and delivers it to the transducer after processing it. The receiver may amplify the input signal to compensate for transmission loss.

Q.17 Write the advantage of internet. 101117105

Ans. Advantages of Internet:

i) **Big source of information:**
It is a useful source of information and knowledge.

ii) **Fastest Communication:**
Email transmit and receive your message almost instantaneously

iii) **Access to social media:**
You can talk to your friend and relatives across the continent. A web-cam enables us to hear and see the person you are speaking to.

iv) **E-commerce:**
E-commerce is the way of doing business on the web.

v) **Source of entertainment:**
You can play or download games, movies and images.

vi) **Access to online services:**
You can pay bills, buy online products.

Q.18 What is the language of computer? 101117106

Ans. Computer works on high level languages.

Q.19 What is meant by optical fibre? 101117107

Ans: Optical fibre:

It is equipment which is used for the transmission of light signals.

An optical fibre with a coating of lower refractive index is a thin strand of high quality glass that absorbs very little light. An optical fibre cable is a bundle of glass fibre with thickness of a human hair.

Q.20 Define operating system and give an example. 101117108

Ans. The Operating System (OS) is software that manages your computer and devices connected to it. For example, Windows and Linux Operating System.

Q.21 Write the names of some sources of telecommunication. 101117109

Ans. The main means of telecommunication are

(i) Telephone (ii) Mobile phone
(iii) Fax machine (iv) Radio
(v) Television (vi) Internet

Q.22 Write the names of some information storage devices. 101117110

Ans. The information can be stored on the following devices.

(i) Audio and video cassettes
(ii) Hard disk
(iii) Magnetic disks
(iv) Floppy disks
(v) Compact disk
(vi) Flash drives

Q.23 What are super computers?
(F. B. 2015) 101117111

Ans. The most powerful and swift computer which can send an information in one thousand billionth part of a second is called super computer. It contains many processors.

Q.24 What is electronic banking? 101117112

Ans. Now a days home banking is operated on telephone. You can find your bank balance on the telephone. You can pay all the kinds of bills and transfer your funds by pressing a key of your personal identification number. You can draw the money at any time you want with the help of ATM machine.

Q.25 What is coaxial cable? 101117113

Ans. Coaxial cable wires are used to transmit electric signals such as cable TV to your home. To prevent electric and magnetic interference from outside, a covering of conducting material surrounds the coaxial wires.

Q.26 What is radio Tuning Circuit? 101117114

Ans. Radio tuning circuit consists of coils of fine wire wounded on a rod which is connected to the antenna. The Coils are connected to variable capacitors. The tuned circuit selects signals of only particular frequency. It does not amplify the signals from transmitters with slightly lower or higher frequencies. The voltage rises and falls as the frequency of the received signal increases or decreases relative to the constant frequency of the oscillator.

Q.27 How are digital signals transmitted across the world? 101117115

Ans. Microwave, digital and optical fibre technologies are combined to give us today's telecommunication systems. Microwaves travel in straight lines through the space and give a very strong signal. We can connect to the other side of the world in milliseconds. Communication satellites including INTELSAT and SATCOM are geostationary satellites that stay over the same position above and receive and transmit digital signals across the world.

Q.28 What is the importance of Optical Fibre? 101117116

Ans. A single fibre-optic cable can carry more than enough information to support television, telephone, and computer data.

Q.29 How can you say that Internet connect us globally? OR What is global web? 101117117

Ans. Internet is a global web of more than one million nets in which more than 50 million computers are operating and almost 200 million people participate through the world. The number is increasing day by day. Contact can be made at any time during the day or night on internet.

Q.30 What is meant by E-Commerce? 101117118

Ans. E-Commerce is the way of doing business on the web. You can order your favourite book or any other items online. For instance, Amazon.com has been selling books, music and video successfully for years. As time passes on, supermarkets and trading companies will be selling more of their goods online.

Q.31 What are radio waves? 101117119

Ans. Radio waves are electromagnetic waves and they travel with speed of light.

Q.32 Name the scientist who transmitted first radio signal through the space? 101117120

Ans. Marconi has the distinction that he transmitted the first radio signal through the space.

Q.33 Why are sound waves converted into electromagnetic waves for the transmission of signals? 101117121

Ans. The speed of sound in air is just 1246 km per hour and it cannot go far away from its source. Therefore, it is converted into electromagnetic wave so that they can be sent to far off areas with the speed of light.

Q.34 How is mobile phone better than telephone? 101117122

Ans. A mobile phone sends text messages and takes and transmits images. The new 3G technology will make video phones common place.

Q.35 How is data transmitted across the internet? 101117123

Ans. Most of the data transmitted across the internet is carried by light. A network of fibre optic cable across the country carrying data from one computer to another.

Q.36 In which form computers use data? 101117124

Ans. Computers use data in binary from i.e.in the form of 0's and 1's. A bit is a single numeric value, either '1' or '0',that encode a single unit of digital information A byte is equal to eight bits. Larger units of digital data are kilobytes (kB), megabytes

(MB) and gigabytes (GB). These are defined as below:

1kB = 1024 bytes
1MB = 1024 kilobytes
1GB = 1024 megabytes

Q.37 How does computer's hard drive work? 101117125

Ans. A computer hard drive has platter in it. Each platter has a magnetize able coating on each side. The spindle motor turns the platters at several thousand resolutions per minute (rpm). There is one read-write head on each surface of each platter.

Q.38 What is the impact of ICT in education? 101117126

Ans. Following are the impact of ICT in education.

(i) The instant availability of accurate information on wide ranging subjects enhances the quality and volume of education material.
(ii) The use of videos and other visual images enhances the effectiveness of lectures.
(iii) Educational digital content i.e. digital library, e-books are very helpful.

Q.39 Define operating system and give an example. 101117127

Ans. The Operating System (OS) is software that manages your computer and devices connected to it. For example, Windows and Linux Operating System.

Q.40 How can you differentiate between hard disk and floppy with the help of its making material. 101117128

Ans. If the CD is made of metal or glass, it is called hard disk and if it is made of soft material then it is called floppy.

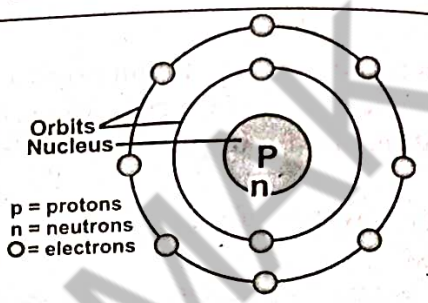
UNIT 18

Atomic and Nuclear Physics

101118001

Q.1 How was atom discovered? Also describe atomic structure.

Ans. In 585 B.C Greek philosopher **Democritus** said that Matter consists of small particle called **atom**. Atom is a Greek word which means **indivisible**.In1911 Rutherford found that central part of atom is called **nucleus**. *The nucleus contains protons and neutrons which are collectively called* ***nucleons***. Atom also contains electrons which revolve in nearly circular orbits about the positively charged nucleus.



The nucleus of an atom consists of protons and neutrons

Atomic Number

The number of protons in the nucleus is called atomic number and is denoted by Z.

Atomic Mass Number

Sum of protons and neutrons in the nucleus is called atomic mass number and is denoted by letter A i, e. A = Z+N

Neutron Number

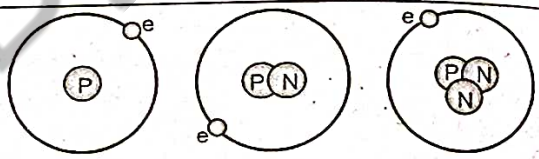
The number of neutrons in the nucleus is called Neutron number and is denoted by N.

Remember that proton is 1836 times heavier than an electron.

Generally an atom is represented by the symbol ${}^{A}_{Z}X$.

Q.2 Define Isotopes. Write the names of isotopes of Hydrogen. **(F. B. 2013)** 101118002

Ans. *Isotopes are atoms of an element which have same atomic number but different atomic mass number. In other words we can say that, "Isotopes are atoms of an element which have same number of protons but different number of neutrons in their nuclei".*



Three isotopes of hydrogen

Protrium $\left({}^{1}_{1}H\right)$, Deutrium $\left({}^{2}_{1}H\right)$, Tritium $\left({}^{3}_{1}H\right)$

For example, Isotopes of hydrogen are protium, deuterium and tritium.

${}^{1}_{1}H$: Contains one proton and one electron

${}^{2}_{1}H$: Contains one proton, one neutron and one electron

${}^{3}_{1}H$: Contains one proton, two neutrons and one electron

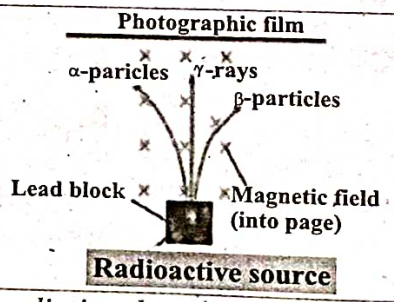
Q.3 Define and explain Natural Radioactivity. **(F. B. 2013)** 101118003

Ans. Natural Radioactivity was accidently found by **Henry Becquerel** in **1896**. He found that Uranium salt crystals emits invisible radiation which ionize the gas and can darken the photographic plate.

Also **Marie Curie** and her husband **Pierre** found two new radioactive element such as **Polonium and Radium**, can also emit radiation. The process of emission of radiations by some elements was called natural radioactivity by **Marie Curie.**

Information about Size of Particles

Atom	10^{-10}m
Nucleus	10^{-14}m
Proton Neutron	10^{-15}m
Electron	$<10^{-18}$m



"The spontaneous emission of radiation by unstable nuclei is called ***natural radioactivity*** *and the elements which do so are called* ***radioactive elements***"

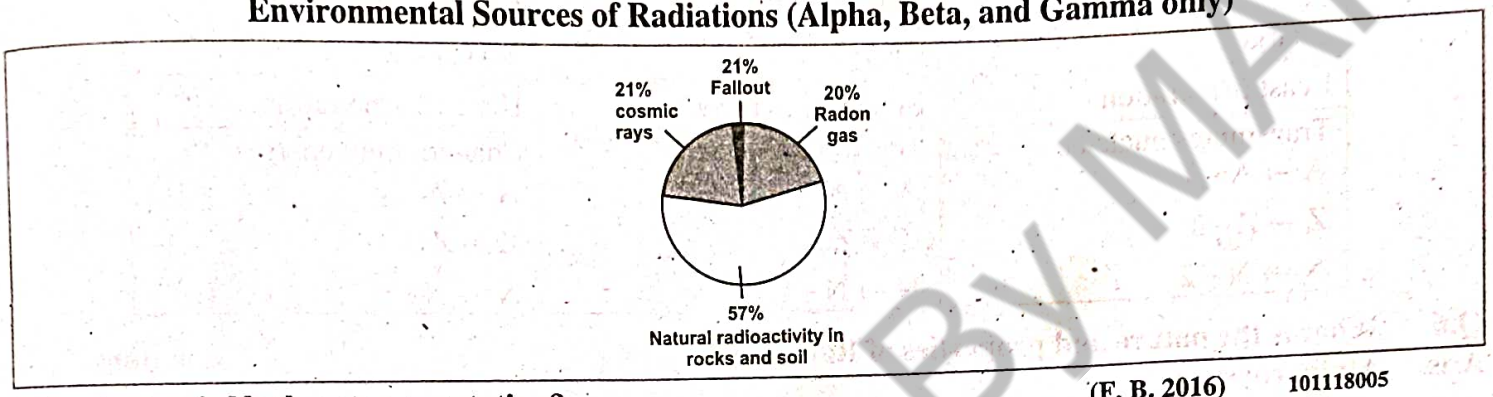
The radiation emitted by radioactive elements are Alpha (α) Beta (β) and Gamma (γ) radiation. If a radioactive source is placed inside the magnetic field. The radiations emitted from the source splits into three components: α and β radiations bend in opposite direction in the magnetic field while γ radiations does not change its direction.

Q.4 What are Background and cosmic radiations? **(F. B. 2017)** **101118004**

Ans. *"Radiations present in atmosphere due to different radioactive substances are called background radiation"*. Rock soil, water and air of our planet are traces of radioactive element. This natural radioactivity is called **background radiation.**

The earth and all living things on it also receive radiation from outer space called **cosmic radiation,** which primarily consists of proton, electrons, alpha particles. The cosmic radiation interact with atom in the atmosphere to create secondary radiation including X-rays, muons, proton, alpha particles. But fortunately our body can tolerate it.

Environmental Sources of Radiations (Alpha, Beta, and Gamma only)



Q.5 What is Nuclear transmutation? **(F. B. 2016)** **101118005**

OR

What are three basic radioactive decay processes and how do they differ from each other?

Ans. Nuclear Transmutation: **(F. B. 2015, 16)**

"The spontaneous process in which a parent unstable nuclide changes into a more stable daughter nuclide with the emission of radiations is called nuclear transmutation".

Explanation

During natural radioactivity, an unstable nucleus of radioactive element disintegrates to become more stable. An unstable parent nuclide 'X' changes into a daughter nuclie 'Y' with the emission of α, β and γ particles.

1. Alpha (α)-decay

General Equation:

$$\underset{\text{Parent Nuclide}}{{}^{A}_{Z}X} \rightarrow \underset{\text{daughter nuclide}}{{}^{A-4}_{Z-2}Y} + \underset{\text{alpha}(\alpha)\text{ -particle}}{{}^{4}_{2}He} + \text{Energy}$$

Example:

$$\underset{\text{radium}}{{}^{226}_{88}Ra} \rightarrow \underset{\text{radon}}{{}^{222}_{86}Rn} + {}^{4}_{2}He + \text{Energy}$$

It means in alpha decay, the proton number or atomic number Z of the parent nuclide reduces by 2 and its mass number or nucleon number A decreases by 4.

2. Beta (β) – decay

General Equation:

$$\underset{\text{Parent Nuclide}}{{}^{A}_{Z}X} \rightarrow \underset{\text{daughter nuclide}}{{}^{A}_{Z+1}Y} + \underset{\text{beta}(\beta)\text{ -particle}}{{}^{0}_{-1}e} + \text{Energy}$$

Example:

$$\underset{\text{carbon}}{{}^{14}_{6}C} \rightarrow \underset{\text{nitrogen}}{{}^{14}_{7}N} + \underset{\text{beta}(\beta)\text{ particle}}{{}^{0}_{-1}e} + \text{Energy}$$

This shows that with the emission of β-rays its mass number or nucleon number (A) remains unchanged and proton number increases by one unit.

3. Gamma (γ)- decay

General Equation:

$$\overset{\wedge}{}_{Z}X \longrightarrow \overset{\wedge}{}_{Z}X + \gamma$$

parent nuclide — daughter nuclide — gamma rays

Example

$$^{60}_{27}Co^{*} \longrightarrow {}^{60}_{27}Co + {}^{0}_{0}\gamma + \text{Energy}$$

Cobalt — cobalt — gamma-rays

This shows that gamma rays are usually emitted at the same moment as either an alpha or a beta particle.

Three types of Radiations		
Alpha Particle	**Beta Particle**	**Gamma Ray**
Charge +2	Charge -1	No Charge
Least penetration	Moderate penetration	Highest penetration
Transmutes nucleus: $A \rightarrow A-4$ $Z \rightarrow Z-2$ $N \rightarrow N-2$	Transmutes nucleus: $A \rightarrow A$ $Z \rightarrow Z+1$ $N \rightarrow N-1$	Changes only energy: $A \rightarrow A$ $Z \rightarrow Z$ $N \rightarrow N$

101118006

Q.6 What is the nature and properties of Radiations?

Ans. Alpha rays:

Alpha particles is helium nucleus having two protons and two neutrons.

An unstable nucleus with large protons and neutrons may decay by emitting alpha radiations.

Beta rays:

Beta radiation is a stream of high-energy electrons which is emitted by unstable nuclei with excess of neutrons.

Gama rays:

Gamma radiations are fast moving light photons. They are electromagnetic radiation of very high frequency (shorter wavelength) emitted by unstable excited nuclei.

101118007

Q.7 What is ionization effect of rays?

Ans. *"The phenomena by which Radiations split matter into positive and negative ions is called ionization".*

All the rays have property to ionize matter but in different extent.

Alpha Rays:

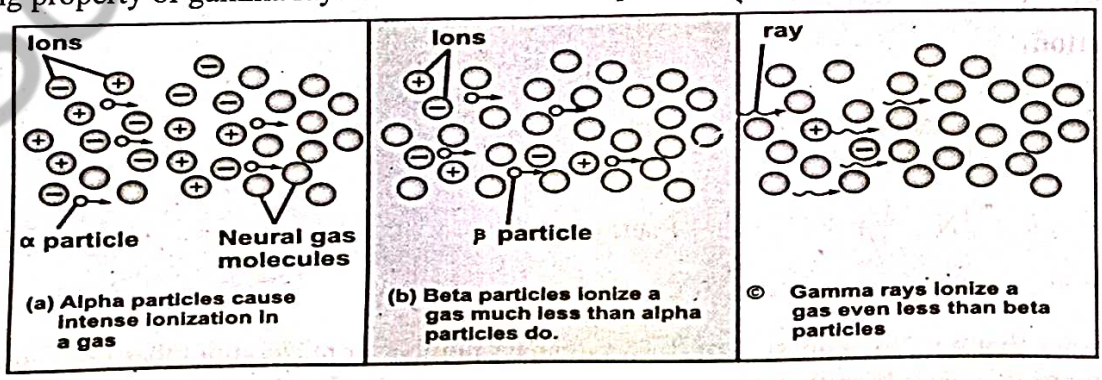
The ionizing property of alpha rays is much greater as compared to beta and gamma rays, due to large positive charge and large mass.

Beta rays:

The ionizing property of beta rays is less as compared to alpha rays.

Gama rays:

Ionizing property of gamma rays is much less as compared to β-rays.



Ionization effect of radiation in gas

Q.8 Explain penetrating ability of radiation. 101118008

And. *"The strength of radiation to penetrate into the matter is called penetrating power".*

All the rays have property to penetrate but their range is different.

1. Alpha rays:

Alpha particles have smallest ranges.

Range: Alpha particles have range of only few centimeters in air.

2. Beta rays:

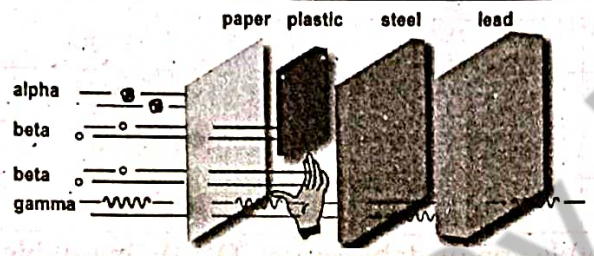
The penetrating power of Beta particles is greater than alpha particles but less than gamma rays due to its charge and strong interaction with matter.

Range: Beta particles have range of several metres in air.

3. Gamma rays:

The penetrating power of gamma rays is much greater as compared to α and β-rays due to large speed and neutral charge.

Range: Gamma rays have a range of several thousand metres in air.



Penetrating power of radiations in different materials

Q.9 What is meant by half-life? Explain. 101118009

OR

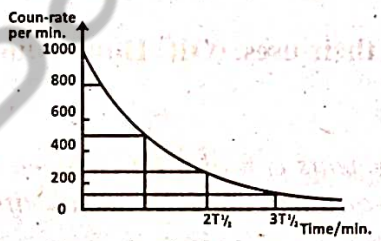
What do you understand by half life of a radioactive element.

Ans. Half Life:

"The time during which half of the unstable radioactive nuclei disintegrate is called the half life of the radioactive element".

Half Life and its measurement

The rate of radioactive decay is proportional to the number of unstable nuclei present, a constant fraction of large number of unstable radioactive nuclei decay in a certain time. So that, the half life time of unstable nuclei is unlimited and is difficult to measure.



Decay of unstable element

Every radioactive element has its own half-life. For example: radium 226 has a half life of 1620 years. That means after 1620 years the element will remain half.

If the half life of radioactive element is $T_{1/2}$ then at the end of this time, the number of atom will become half i.e $\frac{1}{2}$, and after a time 2 $T_{1/2}$ the number of remaining atom will become $\frac{1}{2}.\frac{1}{2}=\frac{1}{2^2}=\frac{1}{4}$ and after 3 $T_{1/2}$, the member of remaining atom will be $\frac{1}{2}.\frac{1}{2}.\frac{1}{2}=\frac{1}{2^3}=\frac{1}{8}$ and at the end of "t", half lives the number of atom will be $\frac{1}{2^t}$.

The number of atoms in the sample of radioactive element left after "t" half live scan be calculated as

$$\text{Remaining atom} = \text{original atom} \times \frac{1}{2^t}$$

Or $$N = N_o \times \frac{1}{2^t}$$

The process of radioactivity does not depend upon chemical combination or reactions and is also not affected by any change in physical conditions like temperature, pressure, electric or magnetic fields.

Half - Lives of Isotopes

Element	Isotope	Half-Life	Radiation Produced
Hydrogen	$^{3}_{1}H$	12.3 years	β
Carbon	$^{14}_{6}C$	5730 years	β
Cobalt	$^{60}_{27}Co$	30 years	β,γ
Iodine	$^{131}_{53}I$	8.07 days	β,γ
Lead	$^{212}_{82}Pb$	10.6 hours	β
Polonium	$^{194}_{84}Po$	0.7 seconds	α
Polonium	$^{210}_{84}Po$	138 days	α,γ
Uranium	$^{235}_{92}U$	7.1×10^{8} years	α,γ
Uranium	$^{238}_{92}U$	4.51×10^{9} years	α,γ
Plutonium	$^{236}_{94}Pu$	2.85 years	α
Plutonium	$^{242}_{94}Pu$	3.79×10^{5} years	α,γ

Q.10 Differentiate between stable and unstable nuclei. OR Define stable and unstable nuclei. 101118010

Ans. Stable Nuclei

Nuclei which do not emit radiation naturally are called stable nuclei. Their atomic number lies between 1 to 82.

For Example

$^{23}_{11}Na$, $^{27}_{13}Al$

Unstable Nuclei

Nuclei which emits radiation naturally and their atomic number is greater than 82 are called unstable nuclei.

For Example

$^{235}_{92}U$

Q.11 What are radio isotopes? Write their uses. (OR) How radio isotopes are used as tracers and in medical field? (F. B. 2013, 17, 18) 101118011

Radio – Isotopes

The stable or non-radioactive elements can also be changed into unstable or radioactive elements by bombarding them with neutrons, protons or alpha particles such artificially produced radioactive elements are called radioisotopes or radioactive isotopes.

Example 1:

$$^{1}_{0}n + {}^{23}_{11}Na \longrightarrow {}^{24}_{11}Na + \text{gamma } (\gamma) \text{ rays}$$

neutron — stable sodium nuclide — sodium radioisotope

Example 2:

$$^{4}_{2}He + {}^{27}_{13}Al \longrightarrow {}^{30}_{15}P + {}^{1}_{0}n$$

alpha particle — stable aluminum nuclide — a phosphorous radioisotope

Uses of Radioisotopes

Radioisotopes are frequently used in medicine, industry and agriculture for variety of useful purposes. A few applications(uses) of radioisotopes are as follows:

1. Tracers

Radioactive tracers are chemical compounds containing some quantity of radioisotopes. Radioactive traces are used to explore the metabolism of chemical reaction in human body, animals and plants.

(i) Tracer in Medical Field:

Radio isotopes are used as tracers in medicines.

Iodine – 131:

Iodine – 131 is used to monitor thyroid function.

Phosphorous – 32:

To diagnose brain tumors phosphorus – 32 is used. The malignant part of the body absorbed more quantity of isotopes and this helps in tracing the effected part of the body.

(ii) Tracer in industry:

In industry tracers are used to locate, the wear and tear of the moving part of the machinery. They are used to locate the leakage in underground pipes.

(iii) Tracer in agriculture:

In agricultural radio phosphorous – 32 is used as a tracer to find that how much the plants absorb the phosphate fertilizer which are crucial to their growth.

2. Use in Medical Treatment

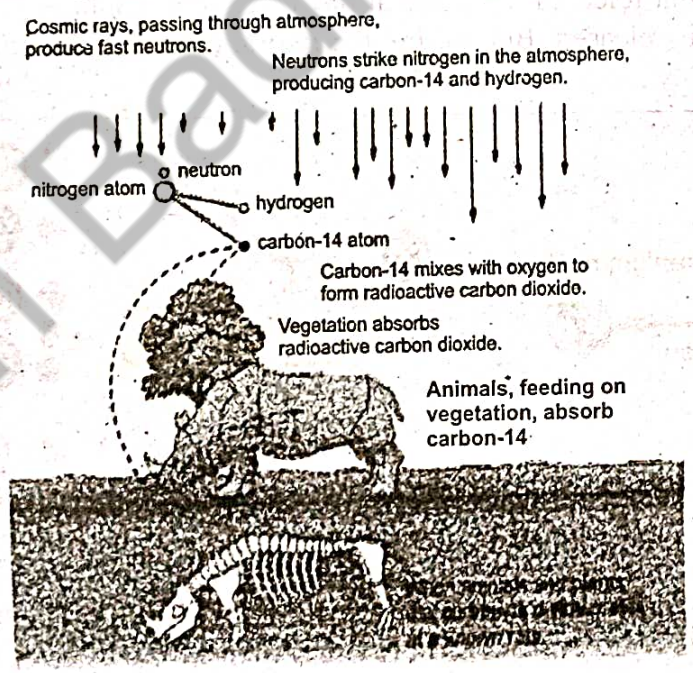
Radio isotopes are used in nuclear medicine for curing various diseases. For example Cobalt – 60 is used for curing cancerous tumors and cells. The radiation kills the cells of malignant tumors.

3. Use in carbon dating

The age of a dead human, animal or tree can be estimated by comparing the activity of carbon – 14 in the live and dead tree. The technique is called carbon dating.

Radioactive carbon - 14 is present in atmosphere in smaller amount live plants used carbon dioxide and therefore becomes slightly radioactive.

Radioactive carbon-14 starts decaying in a dead tree. Since the half life of carbon-14 is 5730 years, the age of dead tree can be calculated by comparing the activity of carbon 14 in the live and dead tree. The activity of the live tree remains almost constant as Carbon 14 is being replenished but in dead tree it is not replenished. So by measuring the activity in the ancient relic, scientist can estimate its age.



Radio carbon dating is possible because plant and animal life absorb radioactive carbon-14 through their intake of CO_2

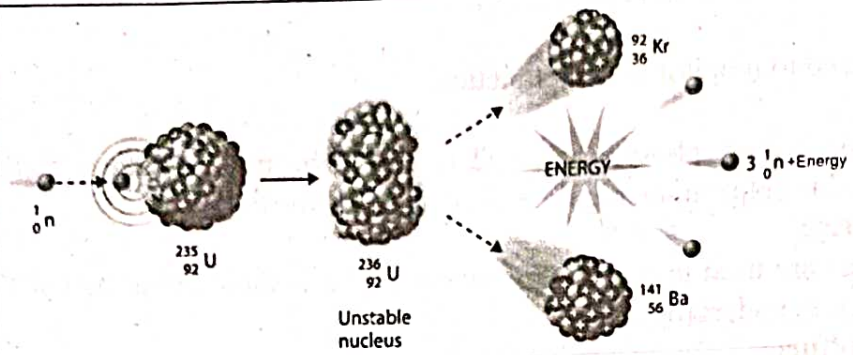
4. Use in Geology:

Some radio isotopes are also used to estimate the age of geological specimens. e.g some rocks contain the unstable potassium K– 40. This decay to the stable Argon nuclide Ar – 40 with half life of 2.4×10^8 years. The age of rock sample can be estimated by comparing the concentration of K – 40 and Ar – 40.

Q.12 What is Fission Reaction? Explain.

Ans. Nuclear Fission:

"Nuclear fission takes place when a heavy nucleus, such as U-235, splits or fission, into two smaller nuclei by absorbing a slow moving (low – energy) neutron".



Nuclear fission reaction

$$^{1}_{0}n + ^{235}_{92}U \longrightarrow ^{236}_{92}U^{*} \longrightarrow X + Y + neutron$$

Where U*-236 is an intermediate state that lasts only for a fraction of second before splitting into nuclei X and Y, called **fission fragments**.

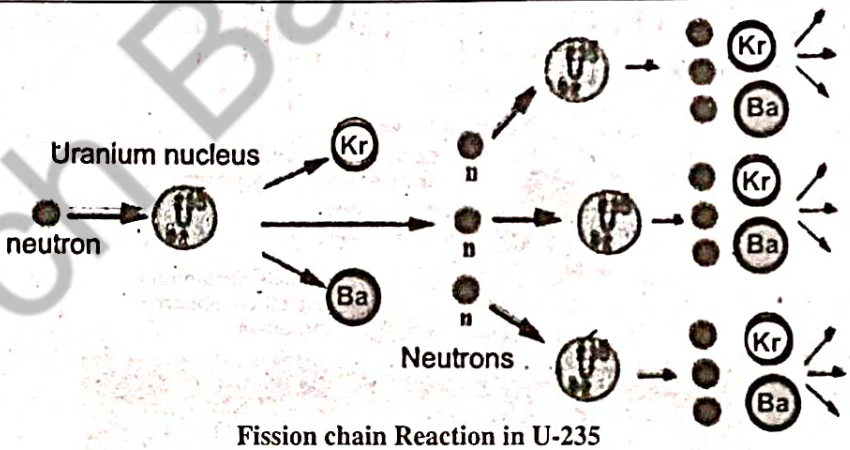
Discovery of Nuclear fission

Nuclear fission was first observed in 1939 by Otto Hahn and Fritz Strassman. The uranium nucleus was split into two nearly equal fragments after absorbing a slow moving (low-energy) neutron. The process also resulted in the production of typically two or three neutrons per fission event. On the average 2·47 neutrons are released per event as represented by the expression.

$$^{1}_{0}n + ^{235}_{92}U \longrightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$$

Explanation

In nuclear fission, the total mass of the products is less than the original mass of the heavy nucleus. Measurements showed that about **200 MeV** of energy is released in each fission event. This is a large amount of energy relative to the amount released in chemical processes. For example, if we burn 1 tonne of coal then about 3.6×10^{10} J of energy is released. But, during the fission of 1kg of Uranium – 235 about 6.7×10^{11}J of energy is released.



Fission chain Reaction in U-235

Neutrons are emitted when U-235 undergoes fission. These neutrons can in turn trigger other nuclei to undergo fission with the possibility of a chain reaction. Calculations show that if the chain reaction is not controlled, it will proceed too rapidly and possibly result in the sudden release of an enormous amount of energy (an explosion).

Controlled Fission Reaction

Fission chain reaction is controlled in nuclear reactors. A nuclear reactor provides energy for useful purposes. In this sort of self sustained reaction extra neutrons liberated in fission reactions are absorbed using some material to slow down chain reaction.

Q.13 Define and explain Nuclear Fusion. 101118013

Ans. Nuclear Fusion:

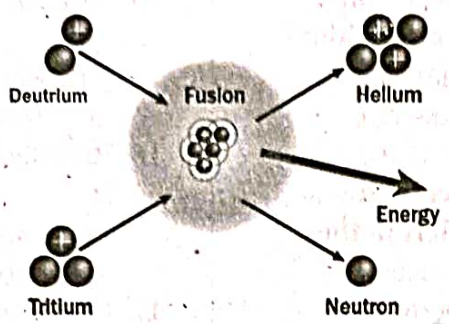
"When two lighter nuclei combine to form a heavier nucleus, with the release of energy the process is called Nuclear Fusion".

Explanation

The mass of the final nucleus is always less than the masses of the original nuclei. According to mass-energy relation this loss of mass converts into energy. If an atom of Deuterium is fused with an atom of Tritium, then a Helium nucleus or alpha particle is formed as given by

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + \text{energy}$$

Fusion reaction is shown in the following figure:



Energy coming from the Sun and stars is supposed to be the result of fusion of hydrogen nuclei into Helium nucleus with the release of energy. The temperature at the centre of the Sun is nearly 20 million Kelvin which makes the fusion favorable. According to this reaction four hydrogen nuclei fuse together to form a helium nucleus along with 25.7 MeV of energy.

Q.14 What are Radiations Hazards? Describe them. **(F. B. 2017)** 101118014

Ans. Although radiation are useful for us, but due to excessive use we have following Hazards.

1. Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin. **(F. B. 2014)**
2. Sterility (i.e. inability to produce children).
3. Genetic mutations in both human and plants. Some children are born with serious deformities.
4. Leukemia (cancer of the blood cells).
5. Blindness or formation of cataract in the eye.

Q.15 What are safety measures of radiation? Write them. **(F. B. 2016)** 101118015

Ans. We should follow the following safety measures of radiation

1. The source should be handled with tongs and forceps.
2. The user should use gloves and hands should be washed carefully after experiment.
3. All radioactive source should be stored in thick lead containers.
4. ever point a radioactive source towards a person.
5. Frequent visits to the radiation sensitive areas should be avoided.

Multiple Choice Questions

Choose the correct answer from the following choices.

Exercise MCQs

1. Isotopes are atom of same element with different: 101118016

(a)atomic mass
(b)atomic number
(c)number of protons
(d)number of electron

2. One of the isotopes of uranium is $^{238}_{92}U$. The number of neutrons in the isotopes is. 101118017

(a)92
(b)146
(c)238
(d)330

3. **Which among the following radiation has more penetrating power?** 101118018
(a) a beta particle
(b) a gamma ray
(c) an alpha particle
(d) all have the same penetrating ability

4. **What happen to the atomic number of an element which emits one alpha particle** 101118019
(a) increases by 1 (b) stays the same
(c) decreases by 2 (d) decreases by 1

5. **The half-life of a certain isotopes is 1 day. What is the quantity of isotopes after 2days?** (F. B. 2017) 101118020
(a) one half (b) one quarter
(c) one eighth (d) none of these

6. **When a uranium(92 protons) ejects a beta particle, how many protons are left in the remaining nucleus?** 101118021
(a) 89 protons (b) 90 protons
(c) 91 protons (d) 93 protons

7. **Release of energy by the sun is due to:** 101118022
(a) nuclear fission (b) nuclear fusion
(c) burning of gases (d) chemical reaction

8. **When a heavy nucleus splits into lighter nuclei, the process would:** 101118023
(a) release nuclear energy
(b) absorb nuclear energy
(c) release chemical energy
(d) absorb chemical energy

9. **The reason of carbon dating work is that:** 101118024
(a) plants and animals are such strong emitters of carbon – 14
(b) after a plant or animal dies, it stops taking in fresh carbon – 14
(c) there is so much non radioactive carbon dioxide in the air
(d) when a plant or animal dies, they absorb fresh C-14.

Additional MCQs

10. **The temperature at the centre of sun is:** 101118025
(a) 10 million K (b)20 million K
(c) 30 million K (d)35 million K

11. **The half-life of Lead Pb is:** 101118026
(a)10 hour (b)10.10 hours
(c)10.6 hours (d)1 year

12. **The half-life of carbon -14 is:** 101118027
(a)5730 years (b)5740 years
(c)5750 years (d)5760 years

13. **When 1 kg of Uranium -235 splits then energy released is:** (F. B. 2016) 101118028
(a) 67×10^{10}J (b) 6×10^{7}J
(c)67 J (d)7 J

14. **When 1 tonne of coal is burnt then amount of energy is released:** 101118029
(a) 36×10^{8} J (b) 36×10^{9}J
(c)36J (d) 36×10^{10}J

15. **Nuclear fission was first observed in:** 101118030
(a)1936 (b)1937
(c)1938 (d)1939

16. **Radioactive isotopes present in atmosphere is:** 101118031
(a)cobalt -60 (b)Ph-32
(c)carbon - 14 (d)carbon 20

17. **For observing how fast plants are absorbing phosphate fertilizer we use:** 101118032
(a)I- 131 (b)Ph-32
(c)Co-60 (d)Ar-40

18. **The half life of radium 226 is:** 101118033
(a)1600 year (b)1610 years
(c)1620 years (d)1630 years

19. **Nuclear radiation was found in:** 101118034
(a)1896 (b)1895
(c)1897 (d)1898

20. **Safe limit of radiations exposure in one year:** 101118035
(a)4 rem (b)5 rem
(c)3 rem (d)6 rem

21. **The half life of argon nuclide Ar-40 is.** 101118036
(a) 2×10^{8} years (b) 2.2×10^{8} years
(c) 2.4×10^{8} years (d) 2.8×10^{8} years

22. **The half life of plutonium $^{236}_{94}$Pu is:** 101118037
(a) 2.00 years (b)2.35 years
(c)2.79 years (d)2.85 years

23. **The half life of cobalt $^{60}_{27}$Co is:** 101118038
(a)10 years (b)20 years
(c)30 years (d)40 years

24. **N =** 101118039
(a) $N_o \times \frac{1}{2}$ (b) $N_o \times \frac{1}{2^t}$
(c) $N_o \times 2^t$ (d) $N_o \times 2^{2t}$

25. What happen to the atomic number of an element which emits one alpha particle and a beta particle: 101118040
(a) increased by 1 (b)stays the same
(c) decreased by 2 (d)decreased by 1

26. Phosphorous 32 is used to diagnose the: 101118041
(a)liver diseases (b)diabetes
(c)brain tumor (d)AIDS

27. Radioactive cobalt 60 is used for curing: 101118042
(a)cancerous cells (b)AIDS
(c)poliomyelitis (d)T.B.

28. The radioactive material must be placed in a box of: 101118043
(a)carbon (b)lead
(c)silicon (d)selenium

29. Co-60 emits high energy _____ radiation 101118044
(a)alpha (b)beta
(c)gamma (d)gamma& beta

30. In 1896, radioactivity was discovered by a French scientist: 101118045
(a)Alfred Nobel (b)Hawk
(c)Henry Bacquerel (d)Madam Curie

31. Alpha rays produce in human body: 101118046
(a)fluorescence (b)burn & sores
(c)red spot (d)ulcer

32. If a person is strongly radiated by radiation. Then he can suffer from: 101118047
(a)malignant tumors (b)T.B.
(c)AIDS (d)hepatitis

33. For curing of cancer we use: 101118048
(a) P-32 (b) P-31
(c) I-131 (d) Co-60

34. A nucleon is nearly _____ times heavier than an electron: 101118046
(a) 1936 (b) 1836
(c) 2035 (d) 1736

35. Measuring unit of Nuclear Radiation is: (F.B. 2013) 101118050
(a) hertz (b) coulomb
(c) rem (d) farad

36. The process by which lighter nuclei fuse together to form a heavy nucleus is known as: 101118051
(a)nuclear fission (b)nuclear fusion
(c)radioactivity (d)electron activity

37. When an atom of deuterium is fused with an atom of tritium, then a nucleus will be formed named: 101118052
(a) Kr-nucleus (b)Xe-nucleus
(c) Na-nucleus (d) He-nucleus

38. The charge and mass of electrons is equal to that of _____ rays. 101118053
(a)X- (b) gamma
(c)alpha (d) beta

39. The charge on alpha rays is: 101118054
(a)positive (b) negative
(c)neutral (d) as electron

40. The rays which move with speed of light are: 101118055
(a) gamma rays (b) alpha rays
(c) beta rays (d) ultrasonic rays

41. Radioactive elements have atomic number greater than: 101118056
(a)80 (b)79
(c)81 (d)82

42. 1eV = _____ 101118057
(a) 1.6×10^{18} J (b) 1.6×10^{-19} J
(c) 1.6×10^{19} J (d) 1.6×10^{9} J

43. Size of atom is: 101118058
(a) 10^{11}m (b) 10^{-10}m
(c) 10^{6}m (d) 10^{-6}m

44. When lead-207 (Z = 82) is bombarded with neutrons, it can change into 101118059
(a) lead-208
(b) lead-206
(c) tellurium-208 (Z = 81)
(d) bismuth-208 (Z = 83)

45. Complete the following nuclear reaction: ${}^{16}_{8}O + {}^{4}_{2}He \rightarrow {}^{19}_{10}Ne +$ 101118060
(a) ${}^{1}p$ (b) ${}^{1}n$
(c) ${}^{2}H$ (d) ${}^{3}H$

46. What is the mass of the products of a nuclear fission reaction compared to the mass of the original products? 101118061
(a) greater
(b) less
(c) the same
(d) varies according to the reaction

47. The fuel for nuclear fusion in the center of the Sun is: 101118062
(a) H (b) He
(c) U (d) any radioactive material

48. The fuel for nuclear fission is: 101118063
(a) H (b) He
(c) U (d) any radioactive material

49. In the fission reaction 101118064
$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr +$ **neutrons, the number of neutrons produced is:** 101118065
(a)zero (b)1
(c)4 (d) 3

50. The chief hazard of radiation is: 101118066
(a) Damage to living cells due to ionization.
(b) Damage to cells due to heating.
(c) Damage to living cells due to the creation of chemical impurities.
(d) The creation of new isotopes within the body.

51. Which is the correct order of radiations for penetrating ability? (F.B. 2018) 101118067
(a) $P_\alpha < P_\beta < P_\gamma$ (b) $P_\alpha > P_\beta > P_\gamma$
(c) $P_\beta > P_\alpha > P_\gamma$ (d) $P_\gamma \leq P_\beta \leq P_\gamma$

52. Which of the following particles has the smallest mass? 101118068
(a) Proton (b) Electron
(c) Neutron (d) Nucleus

53. Which of the following is correct for the number of neutrons in the nucleus? 101118069
(a) N = A –Z (b) N = Z – A
(c) N = Z +A (d) N = Z

54.How many electrons are in the $^{12}_{6}C$ atom? 101118070
(a) 12 (b) 6
(c) 18 (d) 9

55. How many nucleons are in the $^{20}_{10}Ne$ atom? 101118071
(a) 30 (b) 18
(c) 10 (d) 20

56.How many neutrons are in the $^{23}_{11}Na$ atom? 101118072
(a) 12 (b) 11
(c) 18 (d) 24

57. How many protons are in the $^{14}_{7}N$ atom? 101118073
(a) 14 (b) 6
(c) 7 (d) 10

58.What force is responsible for the radioactive decay of the nucleus? 101118074
(a) Gravitational force
(b) Weak Nuclear force
(c) Strong Nuclear force
(d) Electromagnetic force

59. An isotope with a high Binding Energy per nucleon: 101118075
(a) will decay in a short period of time.
(b) is very unstable.
(c) is very stable.
(d) has very few electrons.

60. Which of the following is the alpha particle? 101118076
(a) $+1e$ (b) $^{1}_{0}n$
(c) $^{1}_{1}H$ (d) $^{4}_{2}He$

61. Which of the following is the β – particle? 101118077
(a) $+1e$ (b) $^{0}_{-1}e$
(c) $^{1}_{0}n$ (d) $^{1}_{1}H$

62. Which of the following about the gamma ray is true? 101118078
(a) It carries a negative charge.
(b) It can be deflected by a magnetic field.
(c) It can be deflected by an electric field.
(d) It has zero rest mass and a neutral charge.

63. What is the missing element from the following equation $^{226}_{88}Ra \rightarrow ? + {}^{4}_{2}He$ (101118079)
(a) $^{230}_{86}Rn$ (b) $^{220}_{86}Rn$
(c) $^{228}_{86}Rn$ (d) $^{222}_{86}Rn$

64. What is the missing element from the following equation $^{14}_{6}C \rightarrow ? + {}^{8}_{-1}e$? 101118080
(a) $^{12}_{6}C$ (b) $^{17}_{8}O$
(c) $^{16}_{8}O$ (d) $^{14}_{7}N$

65. A 100 g sample of a radioactive element has a half-life of 5 days. How many grams of radioactive material will remain after 15 days? 101118081
(a) 100 g (b) 50 g
(c) 25 g (d) 12.5 g

66. The isotope of $^{1}_{1}H$ contains. (F. B. 2015) 101118082
(a) One neutron (b) Two neutron
(c) No neutron (d) Four Neutron

67. The following reaction
$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n$ **is called:** 101118083
(a) Fusion (b) Fission
(c) alpha decay (d) beta decay

68. The following reaction ${}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}n$ is called: 101118084
(a) Fusion (b) Fission
(c) alpha decay (d) beta decay

69. Which radio – isotope is used for curing cancers tumor? 101118085
(a) Phosphorous – 32 (b) Iodine – 13
(c) Cobalt – 60 (d) Carbon – 14

70. When a neutron emits a β -particle, it changes into a_____. (F.B. 2013) 101118086
(a) Proton (b) Electron
(c) Positron (d) α-particle

71. Alpha particle is a helium nucleus comprising of two protons and two neutrons with a charge of: 101118087
(a) 2e (b) $2e^{-}$
(c) $2e^{+}$ (d) e^{+}, e^{-}

Answer Key

1.	a	2.	b	3.	b	4.	c	5.	b	6.	d	7.	b
8.	a	9.	b	10.	b	11.	c	12.	a	13.	a	14.	b
15.	d	16.	c	17.	b	18.	c	19.	a	20.	b	21.	c
22.	d	23.	c	24.	b	25.	d	26.	c	27.	a	28.	b
29.	d	30.	c	31.	b	32.	a	33.	d	34.	b	35.	c
36.	b	37.	d	38.	d	39.	a	40.	a	41.	d	42.	b
43.	b	44.	a	45.	b	46.	b	47.	a	48.	c	49.	d
50.	a	51.	a	52.	b	53.	a	54.	b	55.	d	56.	a
57.	c	58.	b	59.	c	60.	d	61.	b	62.	d	63.	d
64.	d	65.	d	66.	c	67.	b	68.	a	69.	c	70.	a
71.	a												

Review Questions

Q.18.1. What is difference between atomic number and atomic mass number? Give a symbolical representation of a nuclide. 101118088

Ans. Atomic number

The number of protons present in a nucleus is known as atomic number. It is represented by Z.

Atomic Mass Number

The number of protons and neutron present in the nucleus is called atomic mass number. It is represented by A.

Atomic mass number A=Z+N

Generally the nuclide of an atom is represented by the symbol ${}_{Z}^{A}X$ e.g. Nuclide of hydrogen atom having only one proton is ${}_{1}^{1}H$.

Q.18.2. What do you mean by the term radioactivity? Why some elements are radioactive but some are not? 101118089

Ans. Radioactivity:

The spontaneous emission of radiation by unstable nuclei is called natural radioactivity and the elements which emit such radiation are called radioactive elements.

The SI unit of radioactivity is Becquerel (Bq).

Radioactive and non radioactive elements:

The elements whose atomic number is between 1 and 82 are stable elements they do not emit radiation naturally. Such elements are **non radioactive elements**. On the other hand, the elements whose atomic number is greater than 82 are unstable and these elements emit radiations naturally. Such elements are called **radioactive elements**.

Q.18.3. How can we make radioactive elements artificially? Describe with a suitable example. 101118090

Ans. Artificial radioactive elements

The stable or non-radioactive elements can also be changed into unstable or radioactive elements by bombarding them with neutrons, protons or alpha particles such artificially produced radioactive elements are called radioisotopes or radioactive isotopes.

Example 1:

$$^{1}_{0}n + {}^{23}_{11}Na \longrightarrow {}^{24}_{11}Na + \text{gamma } (\gamma) \text{ rays}$$

neutron; stable sodium; sodium nuclide radioisotope

Example 2:

$$^{4}_{2}He + {}^{27}_{13}Al \longrightarrow {}^{30}_{15}P + {}^{1}_{0}n$$

alpha particle; stable aluminum nuclide; a phosphorous radioisotope

Q.18.4. What are three basic radioactive decay processes and how do they differ from each other? 101118091

Ans. See Q#5 on Pg# 205

Q.18.5. Write the alpha-decay process for $^{234}_{91}Pa$. Identify the parent and daughter nuclei in this decay. (F. B. 2015) 101118092

Ans. For $^{234}_{91}Pa$ alpha decay process is given as:

$$^{234}_{91}Pa \rightarrow {}^{230}_{89}Ac + {}^{4}_{2}He + \text{Energy}$$

Protactinium; Actinium; α – particle

Parent nuclei is $^{234}_{91}Pa$ and daughter nuclei is $^{230}_{89}Ac$.

Q.18.6. Explain whether the atomic number can increase during nuclear decay. Support your answer with an example. 101118093

Ans. Beta (β) decay:

Yes, in beta - decay, the parent nuclide has its proton number (Z)increased by one but its mass number or nucleon number (A) remain unchanged. An electron does not exist inside the nucleus so, it is created at the time of emission when one neutron transforms into a proton and an electron is emitted out of the nucleus as β-particle

$$^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \text{Energy}$$

(Parent Nuclide); (Daughter nuclide); (β–Particle)

Example:

$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \text{Energy}$$

Q.18.7. What do you understand by half life of a radioactive element? 101118094

Ans. See Q. No. 9 on Pg # 207

Q.18.8. Is radioactivity a spontaneous process? Elaborate you answer with a simple experiment. 101118095

Ans. Yes, Radioactivity is the spontaneous process. Radioactive decay involves the spontaneous transformation of one element into another. **Radioactive** decay also known as nuclear decay or **radioactivity**. It is the process by which the nucleus of an unstable atom loses energy by emitting radiation, including alpha particles, beta particles and gamma rays. A material that spontaneously emits such radiation is considered **radioactive**.

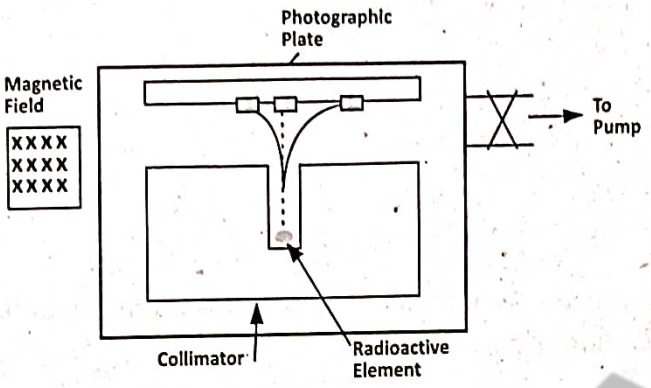
Experiment

The Discovery of Radioactivity

In 1896 Henri Becquerel was using naturally fluorescent minerals to study the properties of X-rays, which had been discovered in 1895 by Wilhelm Roentgen. He exposed the sample to sunlight and then placed it on photographic plates wrapped in black paper, believing that the uranium absorbed the sun's energy and then emitted it as x-rays. This hypothesis was disproved on the 26th-27th of February, when his experiment "failed" because it was overcast in Paris. For some reason, Becquerel decided to develop his photographic plates

anyway. To his surprise, the images were strong and clear, proving that the uranium emitted radiation without an external source of energy such as the sun. Becquerel had discovered radioactivity.

Becquerel used an apparatus similar to that displayed below to show that the radiation he discovered could not be x-rays. X-rays are neutral and cannot be bent in a magnetic field. The new radiation was bent by the magnetic field so that the radiation must have charged and different than x-rays. When different radioactive substances were put in the magnetic field, they deflected in different directions or not at all, showing that there were three classes of radiations: negative, positive, and electrically neutral.



The term radioactivity was actually coined by Marie Curie, who together with her husband Pierre, began investigating the phenomenon discovered by Becquerel. The Curies extracted uranium from ore and to their surprise, found that the leftover ore showed more activity than the pure uranium. They concluded that the ore contained other radioactive elements. This led to the discoveries of the elements polonium and radium. Radioactivity is a natural part of our environment

Q.18.9.Describe two uses of radioisotopes in medicine, industry or research. 101118096

Ans.

Tracer in industry:

In industry tracer are used to locate, the wear and tear of the moving part of the machinery. They are used to locate the leakage in underground pipes.

Use in Medical Treatment

Radio isotopes are used in nuclear medicine for curing various diseases. For example Cobalt – 60 is used for curing cancerous tumors and cells. The radiation kills the cells of malignant tumors.

Tracer in Medical Field:

Iodine – 131:

Iodine – 131 is used to monitor thyroid function.

Phosphorous – 32:

To diagnose brain tumors phosphorus – 32 is used.

Q.18.10. What are two common radiation hazards? Briefly describe the precautions that are taken against them. 101118097

Ans. See Q#14 on Pg# 211

Q.18.11. Complete this nuclear reaction $^{235}_{92}U \rightarrow {}^{140}_{54}X + ? + 2^{1}_{0}n$. Does this reaction involve fission or fusion? Justify your answer. 101118098

Ans. $^{235}_{92}U \rightarrow {}^{140}_{54}X + {}^{93}_{38}Y + 2^{1}_{0}n$

$^{235}_{92}U \rightarrow {}^{140}_{54}Xe + {}^{93}_{38}Sr + 2^{1}_{0}n$

(xenon) (Strontium)

Yes, this is a fission chain reaction in which the heavy nucleus breaks into smaller nuclei with the release of energy.

Q.18.12 Nuclear fusion reaction is more reliable and sustainable source of energy than nuclear fission chain reaction. Justify this statement with plausible arguments. 101118099

Ans. Yes, nuclear fusion is more reliable and sustainable source of energy because it does not contain nuclear waste and there is less danger of radiation and large amount of heat is released with the combination of smaller nuclei.

Q.18.13. A nitrogen nuclide $^{16}_{7}N$ decays to become an oxygen nuclide by emitting an electron. Show this process with an equation. 101118100

Ans: $^{16}_{7}N \longrightarrow {}^{16}_{8}O + {}^{0}_{-1}e$

A nitrogen nuclide $^{16}_{7}N$ decays to become an oxygen nuclide by emitting one β – particle.

Q.18.15. Determine which of these radioactive decay processes are possible. 101118101

(a) $^{214}_{84}Po \rightarrow {}^{214}_{84}Po + {}^{4}_{2}He$

(b) $^{230}_{90}Th \rightarrow {}^{226}_{88}Ra + {}^{4}_{2}He$

(c) $^{233}_{91}Pa \rightarrow {}^{233}_{92}U + {}^{0}_{-1}\beta$

(d) $^{12}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$

Ans:

(a) $^{214}_{84}PO \rightarrow {}^{214}_{84}PO + {}^{4}_{2}He$

This radioactive decay process is not possible because atomic number and mass number does not change in this reaction after decaying α-particle.

(b) $^{230}_{90}Th \rightarrow {}^{226}_{88}Ra + {}^{4}_{2}He$

Th-230 is converted into Ra-226 so decay process is possible.

(c) $^{233}_{91}Pa \rightarrow {}^{233}_{92}U + {}^{0}_{-1}\beta$

Pa-233 is converted into U-233 so this radioactive decay process is also possible.

(d) $^{12}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$ **(not possible)**

$^{12}_{6}C + 2^{1}_{0}n \rightarrow {}^{12}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$ (possible)

This shows that decay is possible by bombarding C-12 with neutrons, otherwise it is not possible.

Conceptual Questions

Q.1 Is it possible for an element to have different types of atoms? Explain. 101118102

Ans. Yes, it is possible for an atom to have different type of atoms called isotopes. For example, Hydrogen has three types of atom i.e. $^{1}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$. They have same atomic number but different mass number.

Q.2 Which nuclear reaction would release more energy, the fission reaction or the fusion reaction? Explain. 101118103

Ans. In fusion reaction more energy in released. Energy from the sun is the result of fusion reaction of hydrogen nuclei into helium nuclei e.g

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + energy$$

In the reaction 257 MeV of energy is produced.

Q.3 Which has more penetrating power, alpha particle or gamma ray photon? Explain. **(F. B. 2016, 17)** 101118104

Ans. Gamma rays have more penetrating power as compared to α particles. Because of greater speed. Gamma rays have more penetrating power as compared to α-particles because it has less interacting power and carry no charge. Gamma rays can penetrate through a considerable thickness of concrete.

Q.4 What is the difference between natural and artificial radioactivity? 101118105

Ans. Natural Radio activity "The spontaneous emission of radiation by unstable nuclei is called natural Radioactivity."

Artificial Radioactivity "The process in which stable nuclide can be changed into unstable nuclide by bombardment of particles like neutrons is called artificial radioactivity.

Q.5 How long would you likely to wait to watch any sample of radioactive atoms completely decay? **(F. B. 2016, 18)** 101118106

Ans. According to radioactive decay rule, none of the elements can decay completely. It depends upon the half life of radioactive element. The total decay time of any radioactive element is infinite, so to observe the complete decay, we have to wait for infinite amount of time.

Q.6 Which type of natural radioactivity leave the number of protons and the number of neutrons in the nucleus unchanged? 101118107

Ans. In case of Gamma Decay, the number of protons as well number neutrons remain unchanged.

$$^{A}_{Z}X \rightarrow {}^{A}_{Z}X + \gamma$$

(parent nuclide) (daughter nuclide) (gamma rays)

Q.7 How much of a 1-gram sample of pure radioactive matter would be left after four half-lives. 101118108

Ans. The No. of elements left after four half lives will be:

$$N = N_o \times \frac{1}{2^t}$$

$$= (1g) \times \frac{1}{2^4}$$

$$= 1g \times \frac{1}{16}$$

$$N = 0.0625g$$

Result: 0.0625g will be left after four half – lives.

Q.8 Tritium, $^{3}_{1}H$ is radioactive isotope of hydrogen. It decays by emitting an electron. What is the daughter nucleus? 101118109

$$^{3}_{1}H + {}^{1}_{0}n \longrightarrow {}^{4}_{2}He + {}^{0}_{1}\beta$$ (F. B. 207)

Hence the daughter nucleus is Helium ($^{4}_{2}He$)

Q.9 What information about the structure of the nitrogen atom can be obtained from its nuclide $^{14}_{7}N$? In what way atom in $^{14}_{7}N$ is different from the atom in $^{16}_{7}N$? 101118110

Ans. In $^{14}_{7}N$

- Number of electrons = 7
- Number of protons = 7
- Number of neutrons = 7

But in $^{16}_{7}N$ number of neutron are 9. So it is different from $^{14}_{7}N$

$_{7}N^{14}$ is more stable as compared to $_{7}N^{16}$.

Additional Short Questions

Q.10 What is meant by artificial radioactivity? 101118111

Ans. The process in which stable nuclide can be changed into unstable nuclide by bombardment of particles like neutrons is called artificial radioactivity.

Q.11 Define nuclear fission and nuclear fusion? 101118112

Ans. Nuclear fission:

Nuclear fission takes place when a heavy nucleus splits or fission into two smaller nuclei by absorbing a slow moving (low-energy) neutron.

Nuclear Fusion:

When two light nuclei combine to form a heavier nucleus, with the release of energy the process is called nuclear fusion.

Q.12 Describe any two hazards of radiations. 101118113

Ans.

i) Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin.

ii) Genetic mutation in both plants and human. Some children born with serious deformation.

Q.13 Write chemical equation for nuclear fusion. 101118114

Ans. Equation for nuclear fusion reaction is

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + energy$$

Q.14 Define atomic mass number and write its formula. 101118115

Atomic mass number: Sum of protons and neutrons in the nucleus is called atomic mass number is denoted by letter A.

Formula: $A = Z + N$

Q.15 Define penetrating ability and ionization. 101118116

Penetrating

Ans. The strength of the radiation to penetrate into the matter is called penetrating ability / power. The phenomena by which radiations split matter into positive and negative ions is called ionization.

Q.16 Describe two safety precautions to avoid hazards of radiations. 101118117

Ans.

1. The source should be handled with tongs and forceps.
2. The user should use gloves and hands should be washed carefully after experiment.

Q.17 How fission reaction is controlled.

Ans. Controlled Fission Reaction. 101118118

Fission chain reaction is controlled in nuclear reactors. A nuclear reactor provides energy for useful purposes. In this sort of self sustained reaction extra neutrons liberated in fission reactions are absorbed using cadmium and were boron road to control the change reaction some material to slow down chain reaction.

Q.18 Define isotopes. 101118119

Ans. Isotopes are atoms of element which have same atomic number but different atomic mass number.

Q.19 What is the difference between atomic number and atomic mass number? 101118120

Ans.

Atomic Number

The number of protons in the nucleus is called atomic number and is denoted by Z.

Atomic Mass Number

Sum of protons and neutrons in the nucleus is called atomic mass number and is denoted by letter A i, e. A = Z+N

Q.20 What is meant by background radiation? Enlist some sources of background radiations.

(F. B. 2017) 101118121

Ans: Radiations present in atmosphere due to different radioactive substances are called background radiation.

Sources of background radiate. Rock, soil, water and radioactive element.

Q.21 Define half life. 101118122

Ans. The time during which half of the unstable radioactive nuclei disintegrate is called the half life of the radioactive element.

Q.22 What is meant by radioactive element? 101118123

Ans. The element which spontaneously emits radiations are called radioactive element.

Q.23 What is neutron number? 101118124

Ans. The number of neutrons in the nucleus is called Neutron number and is denoted by N.

Q.24 What is positron. 101118125

Ans. Positron is a particle with mass equal to the mass of an electron having opposite and equal charge.

Q.25 Differentiate between Nuclear Fission and nuclear fusion. 101118126

Ans.

Nuclear Fission	Nuclear Fusion
(i) Fission is the splitting of a large atom into two or more smaller atoms.	(i) In Fusion two or more light atomic nuclei use to form a single heavier nucleus.
(ii) Fission reaction does not normally occur in nature.	(ii) Fusion occurs in stars such as sun.
(iii) Fission produces many highly radioactive particles.	(iii) Few radioactive particles are produced by fusion reaction.
(iv) Fission takes little energy to split two atoms in a fission reaction.	(iv) Extremely high energy is required to bring two (or) more protons close enough that nuclear forces overcome their electrostatic repulsion.
(v) The energy released by fission is a million times greater than released in chemical reactions, and lower than released b nuclear fusion.	(v) The energy released by fusion is three to four times greater than the energy released by fission.
(vi) One class of nuclear weapon is a fission bomb, also known as atom bomb.	(vi) One class of nuclear weapon is the hydrogen bomb, which uses a fission reaction to trigger a fusion reaction.
(vii) Uranium is the primary fuel used in uncles power plants.	(vii) Hydrogen isotopes are the primary fuel used in experimented fusion power plants.

Q.26Write the characteristics of alpha rays. 101118127

Ans. α-particles

(i) Particle of alpha radiation consists of two protons and two neutrons bound together.

(ii) Alpha-particles are positively charged particles.

(iii) Alpha - particles have least penetration power but greatest ionization power.

(iv) α-rays affect the photographic plates.

(v) α-rays are affected by the electric and magnetic field which show that these are charged particles.

Q.27 Write few characteristics of βeta-rays. 101118128

Ans.β-rays

(i) βeta particles are highly energetic electrons which are released from inside a nucleus.

(ii) They are negatively charged particle and have negligible mass equal to mass of electron.

(iii) Beta particles have less ionization power than α-rays.

(iv) Beta rays have greater penetration power than α-rays.

(v) β-rays affect the photographic plate.

(vi) β-rays are affected by electric and magnetic field.

Q.28 Write the properties of gamma-rays 101118129

Ans. Gamma-rays (γ-rays) (F.B 2013)

(i) gamma -rays are high energy photons that move with the speed of light.

(ii) They are electromagnetic radiation of very high frequency (short wavelength emitted by the unstable nuclei).

(iii) Penetration power of γ-rays is much higher than α-and β-rays. They can penetrate a considerable thickness of concrete.

(iv) Their ionization power is very small.

(v) These rays can also affect the photographic plate.

(vi) They are not affected by the electric and magnetic field which shows that it carry no charge.

Q.29. What is positron? 101118130

Ans. Positron.

Positron is a particle with mass equal to the mass of electron having opposite and equal charge.

Q.30. What do you know about the nuclear accident at Chernobyl Russia? 101118131

Ans. During the nuclear accident at Chernobyl Russia, the explosion of the nuclear reactors melted through a few meters thick concrete housing. This caused a massive destruction of local community and also contaminated vegetation and livestock in the large surrounding area. Millions of dollars were lost as the contaminated vegetables and livestock had to be destroyed.

Side Information

Q.31What is Atom? From which language this word is derived? 101118132

Ans. Atom is the smallest particle which is indivisible. The word atom is derived from the Greek word "otomos", meaning "indivisible". At one time, atoms were thought to be the smallest particles of matter. Today, we know that atoms are composite systems and contain even smaller particles: protons, neutrons and electrons.

Q.32 Why don't proton repel each other with in nucleus? 101118133

Ans. The positively charged protons in a nucleus have huge electrical forces of repulsion between them: But they don't fly apart in response to this force, because there is an attractive force between the nucleons called the strong force. This force acts over only a very short distance. Without this strong nuclear force there would be no atoms beyond hydrogen.

Q.33 In which unit Radioactivity is measured in SI? 101118134

Ans. The SI unit for radioactivity is the **Becquerel, (Bq).**

In SI base units, 1 Bq = 1 disintegration per second (dps). This is a very small unit.

For example, 1.0 g of radium has an activity of 3.73×10^{10}Bq. Therefore, the kilobecquerel (kBq) and the megabecquerel (MBq) are commonly used. The activity of 1.0 g of radium is 3.73 × 10 MBq.

Q.34 What is unit of radiation and what is its safe limit? 101118135

Ans. Nuclear radiation is measured in unit of **roentgen equivalent man (rem)** i.e., unit of equivalent dose. Patient should be exposed to X-rays with the limit of 0.1 to 1.0 rem.

Safe Limit of Radiation:

Safe limit of radiation exposure is 5.0 rem per year.

Q.35 Two half lives do not make a whole life? Why? 101118136

Ans. A half-life is the time a radioactive element takes for half of a given number of nuclei to decay. During a second half-life, half of the remaining nuclei decay, so in two half-lives, three-quarters of the original material has decayed, not all of it.

Q.36 Why is extra care taken to use Gamma Rays? 101118137

Ans. Gamma radiations destroy both cancerous cells and healthy cells. Therefore, the beam of radiations must be directed only at cancerous cells.

Q.37 What Precaution should be used during brain Radio Therapy? 101118138

Ans. During brain radiotherapy, patient is carefully positioned in the helmet to ensure that the gamma rays converge at the desired point in the brain. A lead apron protects the body from exposure to radiation.

Q.38 How can we check the action of fertilizer? 101118139

Ans. To check the action of a fertilizer, researchers combine a small amount of radioactive material with the fertilizer and then apply the combination to a few plants. The amount of radioactive fertilizer taken up by the plants can be easily measured with radiation detectors.

Q.39 Compare the penetrating ability of α, β and γ particles? 101118140

Ans. Alpha Particles :

Positively charged particles (helium nuclei) ejected at high speed with a range of only a few centimetres in air. They can be stopped by an ordinary sheet of thin aluminum foil.

Beta Particles:

Streams of high-energy electrons ejected at various speeds as high as close to the speed of light. Beta particles may be able to penetrate several millimetres of aluminum.

Gamma Particles:

Electromagnetic radiation of high frequency and very short wavelength. Their wavelengths and energies can vary. High-energy gamma rays can penetrate at least 30 cm of lead or 2 km of air.

Q.40 When α and β particles are become harmless? 101118141

Ans. When alpha and beta particles are slowed down by collisions, they become harmless. In fact, they combine to form neutral helium atoms.

Q.41 How many types of radiation can be distinguished from their path followed in external magnetic field? 101118142

Ans. Three types of radiation can be distinguished from their path followed in external magnetic field.

Solved Examples

18.1 Find the number of protons and neutrons in the nuclide by $^{13}_{6}X$ 101118143

Sol:

Atomic number Z	=	6
Atomic mass number A	=	proton + Neutrons
13	=	6 + Neutrons
13-6	=	Neutrons
7	=	Neutrons

Result:

Since number of neutrons are 7 and number of protons are 6 so, it is carbon isotope $^{13}_{6}C$

18.2 The activity of a sample of a radioactive bismuth decreases to one-eight of its original activity in 15 days. Calculate the half life of the sample. 101118144

Sol: Let $T_{1/2}$ is the half life and A_o is the original activity of the sample. After time $T_{1/2}$ activity will be $A_o/2$. After $2T_{1/2}$ activity will become $1/2 \cdot A_o/2 = A_o/4$. While after time $3T_{1/2}$ i.e. after three half lives, the activity will drop to $A_o/8$. It means activity drops to one-eight of original activity in a time of $3T_{1/2}$.

Result:

Therefore, 3T = 15. This means half-life $T_{1/2}$ of the sample will be 5 days.

18.3 A radioactive element has a half-life of 40 minutes. The initial count rate was 1000 per minute. How long will it take for the count rate to drop to (a) 250 per minutes (b) 125 per minutes (c) Plot a graph of the radioactive decay of the element. (F. B. 2014) 101118145

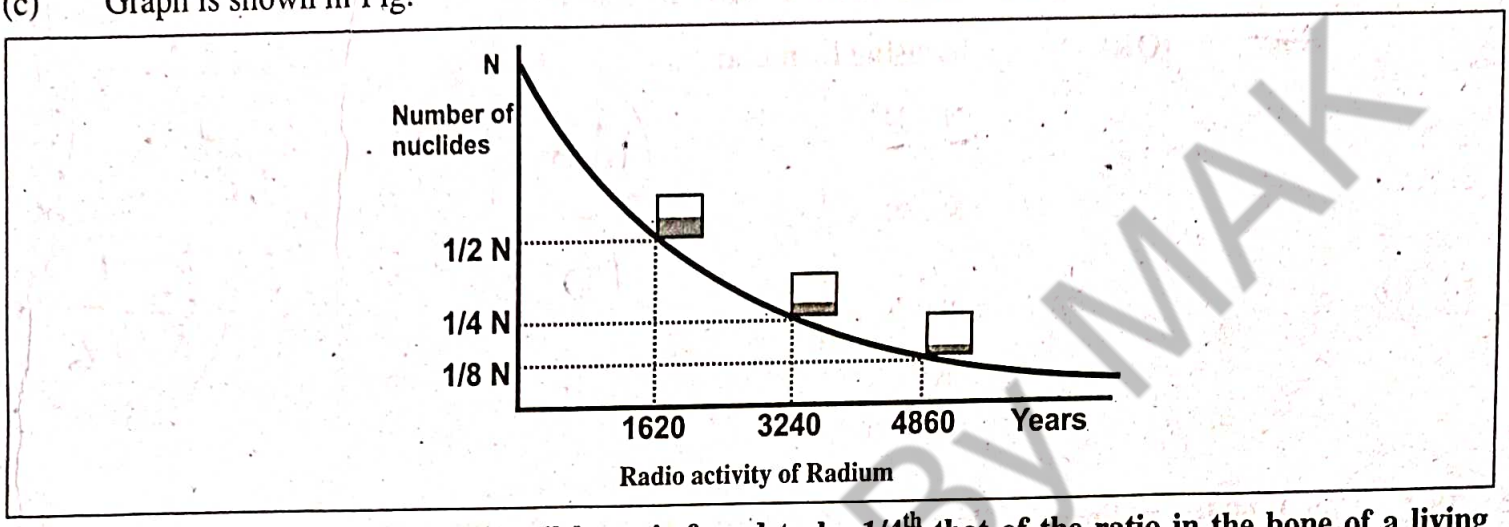
Sol: The initial count rate if 1000, therefore:

$$1000 \xrightarrow{40\text{min}} 500 \xrightarrow{40\text{min}} 250 \xrightarrow{40\text{min}} 125$$

(a) As clear from above, it takes 2 half lives for the count rate to decrease from 1000 to 250 per min, hence
Time taken = 2 × 40 min = 80 min.

(b) It takes 3 half lives for the count rate to decreases from 1000 to 125 per min, hence.
Time taken = 3 × 40 min = 120 min = 2h.

(c) Graph is shown in Fig.



18.4 The C-14: C-12 ratio in a fossil bone is found to be 1/4th that of the ratio in the bone of a living animal. The half-life of C-14 is 5730 years what is the approximate age of the fossil?
(F. B. 2018) 101118146

Sol: Since the ratio has been reduced by factor of 4 therefore, two half-lives have passed. 10118105
Therefore age of the fossil is given by: 2 × 5730 = 11460 years.

Numerical Problems

18.1 The half life of $^{16}_{7}N$ is 7.3s. A sample of this nuclide of nitrogen is observed for 29.2s. Calculate the fraction of the original radioactive isotope remaining after this time. 101118147

Given Data:

Half life of $^{16}_{7}N$ = $T_{\frac{1}{2}}$ = 7.3 sec.

Time = T = 29.2 sec.

To Find:

Remaining fraction of original atom = N_o = ?

Calculation:

$$\text{No. of Half life} = \frac{\text{Time}}{T_{1/2}} = \frac{29.2}{7.3}$$

No. of Half life = t = 4

Fractional part remained after 1st half life = $\frac{1}{2}(N_o)$

Fractional part remained after 2nd half life = $\frac{1}{2}\frac{(N_0)}{2}$

= $\frac{1}{4}(N_0)$

Fractional part remained after 3rd half life $= \frac{1}{2}\left(\frac{N_o}{4}\right)$

$= \frac{N_0}{8}$

Fractional part remained after 4th half life $= \frac{1}{2}\left(\frac{N_o}{8}\right)$

$= \frac{1}{16}(N_o)$

Result: $\frac{1}{16^{th}}$ **part of original sample decayed after 29.2 sec,**

(OR) **By using formula:**

$$N = N_o \times \frac{1}{2^t}$$

$$N = N_o \times \frac{1}{2^4}$$

$$N = N_o \times \frac{1}{16}$$

$$\frac{N}{N_o} = \frac{1}{16th}$$

18.2 Cobalt-60 is a radioactive element with half life of 5.25 years. What fraction of the original sample will be left after 26 years? **(F. B. 2017)** **101118148**

Given data:

Half life of Co-60 = $T_{1/2}$ 5.25 years

Time = T = 26 years

Original Quantity = N_o

To find:

Remaining Fractional Part in 26 years =

No. of half lives = $\frac{\text{Time}}{T_{1/2}}$

Calculation:

No of Half lives= $t = \frac{26}{5.25}$

$t = 5$

Fractional Remaining Part after 1st half life = $\frac{1}{2}(N_o)$

$= \frac{1}{2}N_o$

Fractional Remaining Part after 2nd half life = $\frac{1}{2}\frac{(N_o)}{2}$

$= \frac{(N_o)}{4}$

Fractional Remaining Part after 3rd half life = $\frac{1}{2}\frac{(N_o)}{4}$

$= \frac{1}{8}(N_o)$

Fractional Remaining Part after 4th half life $= \frac{1}{2}\frac{(N_o)}{8}$

$= \frac{1}{16}(N_o)$

Fractional Remaining Part after 5th half life $= \frac{1}{2}\frac{(N_o)}{16}$

$= \frac{1}{32}(N_o)$

Result: $\frac{1}{32^{nd}}$ **part of original quantity will left after 26 years.**

Or

Remaining atom = $\frac{1}{2^t}$ **of original atom**

$= \frac{1}{2^5}$ of N_o

$N = \frac{1}{32}$ of N_o

18.3 Carbon-14 has a half life of 5730 years. How long will it take for the quantity of carbon -14 in a sample to drop to one-eight of the initial quantity? **(F. B. 2016,18)** 101118149

Given data:

Half life of C-14 = $T_{\frac{1}{2}}$ = 5730 years

Fraction to be drop = $\frac{1}{8^{th}}$

To Find

original amount = N_o

Time take = T = ?

Calculation:

Amount of C-14 after 1st half life = $\frac{1}{2}(N_o)$

Amount of C-14 after 2nd half life = $\frac{1}{2}\left(\frac{N_o}{2}\right) = \frac{N_o}{4}$

Amount of C-14 after 3rd half life = $\frac{1}{2}\left(\frac{N_o}{4}\right)$

$= \frac{1}{8}(N_o)$

After 3rd half life $\frac{1}{8^{th}}$ part of initial carbon 14 will left so

$T = 3T_{\frac{1}{2}}$

$= 3(5730 \text{ years})$

$= 17190 \text{ years}$

$= 1.72 \times 10^4 \text{ years}$

Result:

1.72×10^4 years will be required for the quantity of carbon – 14 to drop $\frac{1}{8^{th}}$ for the initial quantity.

18.4 **Technetium-99m is a radioactive element and is used to diagnose brain, thyroid, liver and kidney diseases. This element has half life of 6 hours. If there is 200 mg of this Technetium present, how much will be left in 36 hours.** 101118150

Given data:

Half life of sample = $T_{\frac{1}{2}}$ = 6 hours.

Time = T = 36 hours

Quantity of Technetium – 99 = 200 mg

To Find

Quantity of Technetium after 36 hours = ?

Calculation:

No. of Half lives = $t = \frac{36}{6} = 6$

Quantity of Technetium left after 1st half life = $\frac{1}{2} \times 200 = 100\text{mg}$

Quantity left after 2nd half life = $\frac{1}{2} \times 100 = 50\text{mg}$

Quantity left after 3rd half life = $\frac{1}{2} \times 50 = 25\text{mg}$

Quantity left after 4th half life = $\frac{1}{2} \times 25 = 12.5\text{mg}$

Quantity left after 5th half life = $\frac{1}{2} \times 12.5 = 6.25\text{mg}$

Quantity left after 6th half life = $\frac{1}{2} \times 6.25 = 3.125\text{mg}$

Result:

After passing 36 hours, 3.125mg will be left.

$$N = N_o \times \frac{1}{2^t}$$

$$= 200 \times \frac{1}{2^6}$$

$$= 200 \times \frac{1}{64}$$

$$= \frac{200}{64} = 3.125\text{mg}$$

18.5 **Half life of a radioactive element is 10 minutes. If the initial count rate is 368 counts per minute, find the time for which count rates reaches 23 counts per minute.** 101118151

Given data:

Half life = $T_{\frac{1}{2}}$ = 10 minutes

Initial count rate = 368 / minute

To Find

Time during which 23 count/ minute left = t = ?

Calculation:

No. of counts per minute after 1st half life = $\frac{1}{2}(368)$ = 184 count/min.

No. of counts per minute after 2nd half life = $\frac{1}{2}(184)$

No. of counts per minute after 3rd half life = $\frac{1}{2}(92)$

= 46

No. of counts per minute after 4th half life = $\frac{1}{2}(46)$

= 23Count / min

23 counts/ minute left after 4th half life

T = $4T_{\frac{1}{2}}$

So the time required by radioactive element to attain count rate 23c/min = 4×10

= 40 minutes

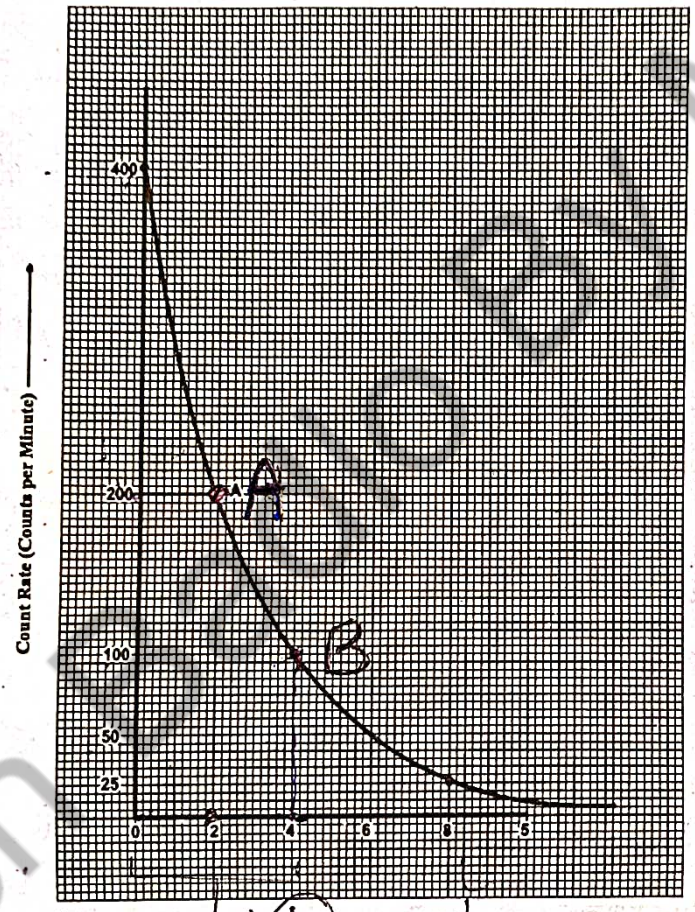
Result:

40 minutes will be required to reduce the count rate from 368 counts per minutes to 23 counts/min.

18.6 In an experiment to measure the half-life of a radioactive element, the following results were obtained: 101118152

Count rate	400	200	100	50	25
Time (in minutes)	0	2	4	6	8

Plot a graph between the count rate and time in minutes. Measure the value for the half-life of the element from the graph.



Let A is a point which is after 2 successive half lives (n=2)

Total time = 4 minutes

Now

Total Time = No of half lives × half life.

$4 = n \times T_{\frac{1}{2}}$

$4 = 2 \times T_{\frac{1}{2}}$

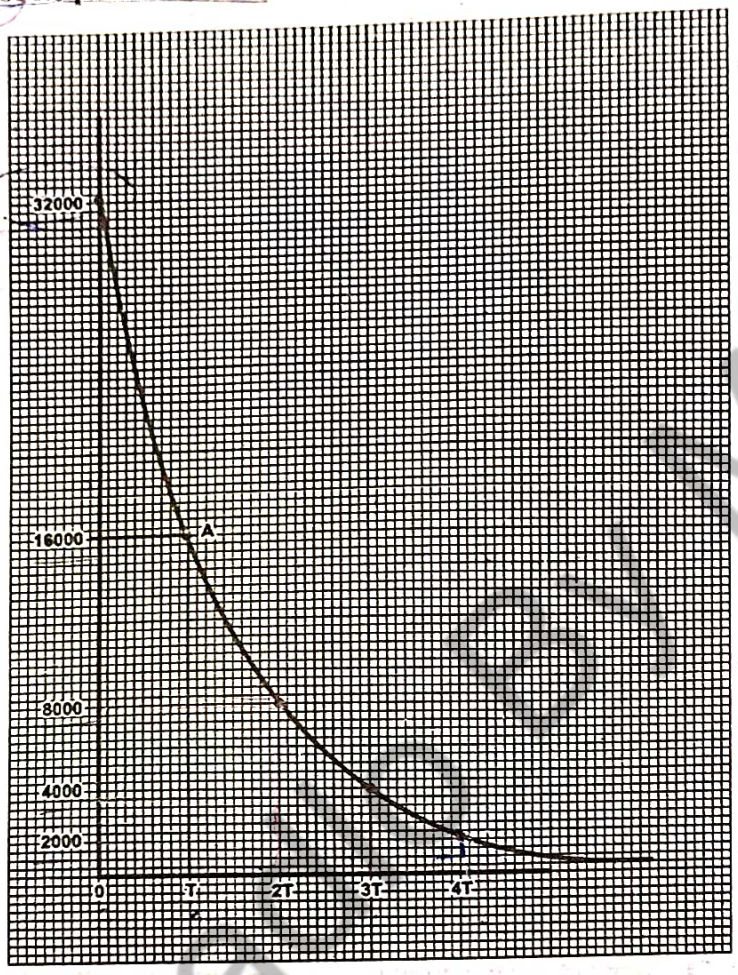
$\frac{4}{2} = T_{\frac{1}{2}}$

$T_{\frac{1}{2}} = 2$ minutes

Half life of ample is 2 minutes.

18.7 A sample of certain radioactive element has a half-life of 1500 years. If it has an activity of 32000 counts per hour at the present time then plot a graph of the activity of this sample over the period in which it will reduce to 1/16 of its present value.

101118153



Given Data:

$T_{1/2} = 1500$ year

N_o = initial count per hour = 32000

N = Remaining $\frac{1}{16}$ of initial count ratio $= \frac{32000}{16}$

To find: n = No. of Half lives= ?

Calculation:

Now $N = N_0 \times \frac{1}{2^t}$

$\frac{32000}{16} = 32000 \times \frac{1}{2^n}$

$\frac{1}{16} = \frac{1}{2^t}$

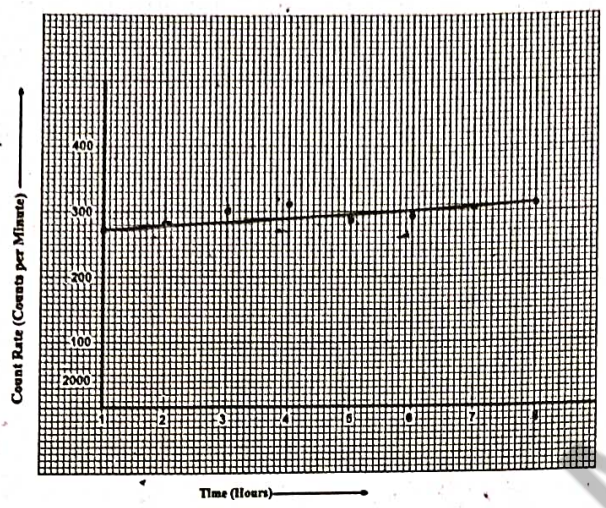
$\frac{1}{2^4} = \frac{1}{2^t}$

$t = 4$

Result:

Thus the number of half lives passed are four.

18.8 Half-life of a radioactive element was found to be 4000 years. The count rates per minute for 8 successive hours were found to be 270, 280, 300, 310, 285, 290, 305, 312. What does the variation in count rates show? Plot a graph between the count rates and time in hours. Why the graph is a straight line rather than an exponential? 101118154



Ans. (variation in count rate shows the random nature of radioactive decay, graph is almost horizontal line rather than exponential curve which is due to long half. Life as compared to period of 8 hours)

18.9 Ashes from a campfire deep in a cave show carbon-14 activity of only one-eight the activity of fresh wood. How long ago was that campfire made? (F. B. 2017) 101118155

Given data:

Half life of C-14 $T_{\frac{1}{2}}$ = 5730 years

Fraction of present C-14 = $\frac{1}{8}$th

To Find:

How long ago Campfire was made = T= ?

Calculation:

Quantity of C-14after 1st half life = $\frac{1}{2}(N_o)$

$= \frac{N_o}{2}$

Quantity of C-14after 2nd half life = $\frac{1}{2}\left(\frac{N_o}{2}\right)$

$= \frac{N_o}{4}$

Quantity of C-14after 3rd half life = $\frac{1}{2}\left(\frac{N_o}{4}\right)$

$= \frac{N_o}{8}$

Hence $T = 3T_{\frac{1}{2}}$

Time taken by campfire = 3×5730

T = 17190 years

Result:

17190 years ago was the campfire made.