Exercise Solved Conceptual Q/A

Chapter 11:Electrostatics

Q1.

Answer:

Electric field may or may not be zero

➜<u>For Charged Hollow Sphere</u> : Inside a charged hollow sphere electric field strength will be zero.

➜<u>Mathematically:</u>

$E = -\Delta V / \Delta r$

V = constant, $\Delta V = 0$ thus $E = \Delta r$

[E = 0]

➜<u>For A Point Charge :</u> At surrounding region of a point charge, the potential is constant at equal distance from the charge but electric field is not zero at those points.

➜<u>Mathematically:</u>

$V = 0$

but

$E \neq 0$

➜<u>Conclusion :</u> Thus inside a charged hollow sphere E will be zero whereas surrounding a point charge $E \neq 0$

Q2.

Yes, point charge will perform rectilinear motion

<u>Reasons:</u>

(i) <u>Direction of field lines</u> : Although the electric field is non uniform meaning it's varying in magnitude but its direction is uniform i.e., in one direction thus causing rectilinear motion of charge.

(ii) <u>Force experienced by charge q</u> : The charge will experience a force F equal to product of E and q.

<u>Mathematically:</u>

$F = qE$

<u>Conclusion</u> : Thus motion of charge will be along field lines due to a force of varying magnitude.

Q3.

Answer:

The two terms are relative and closely related

<u>Explanation:</u>Let a positive charge +q be placed towards high potential between two oppositely charged plates, then electric potential energy will be equal to work done in displacing charge from B to A.

<u>Mathematically:</u>

$W_{(BA)} = \Delta U$

Potential difference will be the work done per unit charge.

<u>Mathematically:</u>

$V = W / q$

<u>Conclusion:</u>Hence electric potential energy is possessed by charge whereas potential difference is associated with the field.

Q4.

Answer;

Volt is unit of potential difference whereas electron volt is the unit of energy

Explanation:

(i) Volt:

If 1 J work is done moving unit positive charge from one point to another, keeping electrostatic equilibrium, then potential difference between two points is one volt (ΔV).

Mathematically:

1 Volt = 1 Joule / 1 Coulomb

(ii) Electron volt:

The energy acquired or lost by an electron as it moves between two points having a potential difference of one volt is called one electron volt.

Mathematically:

$1\ eV = (1e \times 1V)$

$e = 1.6 \times 10^{-19}\ C$

$1\ eV = 1.6 \times 10^{-19}\ J$

Conclusion: Electron volt is unit of energy, volt is unit of electric potential difference or potential energy per unit charge.

Q5.

Answer:

High Electric Potential While Electric Potential Energy Is Low

EXPLANATION:

(i) Gain in kinetic energy & Loss in P.E:

As -q charge travels from negative to positive plate, it loses potential energy and gains kinetic energy because no external work is done on charge.

(ii) High potential of Positive plate:

Positive plate is at high potential. As it attracts the negative charge -q towards itself, the charge reaches a high potential point.

Conclusion: **although the charge -q reaches a high potential point, it loses its electric potential energy during the journey.**

Q6.

Answer:

No, electric potential around non-uniformly charged sphere will not be the same as that of a point charge.

Reasons:

(i) Lack of uniformity of charge in sphere:

As the sphere isn't uniformly charged, the concentration and strength of the electric field around it will vary. Thus, electric potential will also vary.

(ii) Uniform electric field of point charge:

A point charge has a uniform electric field all around, and for a certain distance, electric field strength remains constant. Thus, electric potential remains uniform.

Mathematically:

$V = Kq / r$ (for point charge)

Scenario If We Are Far From Sphere:If we are far enough from the sphere, then its potential may behave like a point charge.

Q7.

Answer:

Capacitor will store more energy in parallel combination than in series

Reason: Energy depends on capacitance and square of voltage

In parallel combination, all capacitors get the same voltage.

So, net energy storage will be the sum of individual energy storages.

(i) $C_p = 3C$ (parallel combination of all)

In series combination, capacitors don't get the same voltage.

So, net energy is less due to less net capacitance.

(ii) $C_s = C / 3$ (series combination of all)

Mathematically:

Parallel $= 1/2 * C_p * V^2$

$= 1/2 * (3C) * V^2 = 3/2 * C * V^2$ (iii)

$U_{series} = 1/2 * C_s * V^2$

$= 1/2 * (C / 3) * V^2 = 1/6 * C * V^2$ (iv)

Dividing (iii) by (iv):

Parallel / Series = $3/2 * C * V^2 \div 1/6 * C * V^2 = 9$

<u>Conclusion:</u>

Parallel combinations store 9 times more energy than series.

Q8.

Answer:

No, equipotential lines never cross each other

<u>Reason:</u>Equipotential lines represent points with the same electric potential.

If they cross each other, it means one point has two different potentials — which is not possible.

In a uniform electric field, where potential changes consistently, equipotential lines stay parallel and never intersect.

<u>Conclusion:</u>Crossing of equipotential lines would mean different electric field directions at one point — which contradicts the concept.

So, they never cross.

Q9.

Answer:

Although water has a high dielectric constant (78.5), it is rarely used as a dielectric in capacitors.

Reasons:

(i) Dipole Moment:

Water molecules have strong dipole moments and can easily be polarized. This reduces the effective electric field between capacitor plates.

(ii) Conductivity:

Water contains H^+ and OH^- ions which conduct electricity, making it unsafe for use in capacitors.

(iii) Mobile Ions:

These ions can leak charge between the plates, leading to discharge of the capacitor.

(iv) Temperature Sensitivity:

The dielectric constant of water varies with temperature, which affects the reliability of the capacitor.

Conclusion: Due to these factors, water is not a suitable dielectric material in practical capacitors.

Q10.

Answer:

Ways to Increase Capacitance (C)

Reasons:

(i) Increase Area of Plates:

Larger plate area allows more charge storage.

(ii) Decrease Distance Between Plates:

Shorter distance enhances electrostatic induction between plates.

(iii) Use Better Dielectric:

Using a dielectric with higher permittivity increases capacitance.

Mathematically:

Capacitance $C \propto (A / d) \times \varepsilon$

Where:

A = Area of plates

d = Distance between plates

ε = Dielectric constant (permittivity)

Conclusion: **By adjusting plate area, distance, and dielectric material, capacitance can be effectively increased.**

Chapter 12: Current Electricity

Q1.

Given:

Current, I = 3 A

Time, $t = 24 \times 60 \times 60 = 86400$ s

Required:

Charge, $Q = ?$

Formula:

$I = Q / t$Or

$Q = I \times t$ ...... (i)

Calculations:

putting values in eq (i), we get:

$Q = 3 \times 86400$

$Q = 259200$ C

Result: The amount of charge flow is 259200 C.

Q2.

Answer:

While analyzing a circuit, the internal resistance is ignored.

Internal Resistance:

Internal resistance is the resistance offered by the electrolyte of a cell.

It acts as if it is connected in series with the source.

Reason For Neglecting:

Internal resistance is ignored because the voltage drop across it is very small and does not significantly affect the overall circuit behavior.

<u>**Mathematically:**</u>

$E = V_t + Ir$

Where:

E = emf of cell

V_t = terminal voltage

r = internal resistance (very small)

Q3.

Answer:

Diameter of aluminum wire is greater.

<u>**Reason:**</u>**Resistivity of aluminum is greater than resistivity of copper.**

Given:

$\rho_{al} = 2.63 \times 10^{-8}\ \Omega\cdot m$

$\rho_{cu} = 1.72 \times 10^{-8}\ \Omega\cdot m$

<u>**Mathematically:**</u>

Resistance, $R = (\rho \times L) / A$

Area, $A = (\pi \times D^2)/4$, so:

$R = (4 \times \rho \times L) / (\pi \times D^2)$

Now, for same length and resistance:

$R_{al} = R_{cu}$

So:

$(\rho_{al} / D_{al}^2) = (\rho_{\square u} / D_{\square u}^2)$

Taking square root:

$(D_{\square u} / D_{al}) = \sqrt{(\rho_{\square u} / \rho_{al})}$

<u>Conclusion:</u>This shows that higher resistivity requires larger diameter to maintain the same resistance.

Hence, aluminum wire (higher ρ) will have greater diameter than copper wire.

Q4.

Answer:

Terminal potential difference of a battery becomes greater than its emf when the battery is being charged.

<u>Explanation:</u>When a battery is being charged, it is connected to another battery with greater emf in opposite direction.

This reverses the current direction, causing the terminal voltage to increase beyond emf.

<u>Mathematically:</u>

$V_t = E - (-I \times r)$

$\Rightarrow V_t = E + Ir$

<u>Conclusion:</u>

this equation clearly shows that during charging, terminal potential difference exceeds emf due to reversal of current direction.

Q5.

Answer:

Difference between Electromotive Force (EMF) and Terminal Potential Difference (V_t)

Point	Electromotive Force (EMF)	Terminal Potential Difference (Vt)
(i) Definition	Energy supplied to unit charge by the cell.	Work done in bringing unit positive charge from +ve to –ve terminal.
(ii) Mathematically	$E = W / Q$	Depends on internal resistance: $V_t = E - Ir$
(iii) Presence	Present even when no current flows. (It is the cause.)	Exists only when current flows. (It is the effect.)
(iv) Dependence	Does not depend on external circuit resistance.	Directly depends on external and internal resistance.

Q6.

Answer:

Kirchhoff's Rules

(1) Kirchhoff's Voltage Law (KVL):

Statement:

In any closed loop of an electrical circuit, the algebraic sum of EMF and voltage drops across all elements is zero.

Mathematically:

$\Sigma E - \Sigma IR = 0$

Explanation:

This law follows the law of conservation of energy.

Energy supplied = Energy consumed in resistors.

(2) Kirchhoff's Current Law (KCL):

Statement:

At any junction in an electrical circuit, the algebraic sum of currents is zero.

Mathematically:

$I_1 + I_2 = I_3 + I_4$

(Current entering the junction = Current leaving the junction)

Explanation:

This law follows the law of conservation of charge.

Charge cannot accumulate at a junction.

Q7.

Answer:

Effect of Temperature on Resistance of a Conductor

Effect on Kinetic Energy of Free Electrons:

When the temperature rises, kinetic energy of free electrons increases.

Effect on Atomic Vibration:

Atoms in the metal lattice vibrate with greater amplitude due to heating.

Effect on Collisions:

Collision rate increases between free electrons and vibrating atoms.

Net Result:

These increased collisions oppose the flow of electrons, thereby increasing the resistance of the conductor.

Mathematically:

$R^T = R_0 (1 + \alpha T)$

Where:

R^T = Resistance at temperature T

R_0 = Resistance at 0°C

α = Temperature coefficient of resistance

As temperature increases, $R^T > R_0$

Q8.

Answer:

Direction of EMF vs Direction of Current

Direction of EMF:

It is independent of current flow direction. It is determined by the internal construction and chemical reactions in the battery.

Explanation:

Inside the battery, chemical reactions move:

➜Positive ions (cations) from –ve to +ve terminal

➜Negative ions (anions) from +ve to –ve terminal

Direction of Conventional Current:

Current always flows from positive to negative terminal of the battery in the external circuit.

Conclusion:

The direction of EMF is due to the internal electrochemical composition of the battery.

Whereas, the direction of current in a circuit follows +ve to –ve terminal (conventional flow).

Q9.

Reason:

Voltage is a relative quantity, not absolute.

It always represents the potential difference between two points.

Explanation:

Voltage is the electric potential difference — the amount of work done per unit charge in moving a positive test charge from one point to another.

This work is stored as electric potential energy, which is always relative — not defined at a single point.

➜**Formula:**

Delta V = VB - VA = Delta U / q_0

(Where Delta V is the potential difference,

Delta U is the change in potential energy,

and q_0 is the test charge)

Conclusion:

Voltage is always measured between two points —

one at higher and the other at lower potential.

Q10.

Answer:

(a) Is every EMF a Potential Difference?

Yes

Explanation:

EMF is the potential difference across the battery terminals when no current is flowing, i.e., internal resistance is zero.

Formula:

E = V + Ir

If I = 0 → E = V

(So emf becomes equal to the potential difference)

(b) Is every Potential Difference an EMF?

No

Explanation:

Not every voltage drop in the circuit is emf.

For example:

➜Voltage across a resistor is not emf

➜Voltage between two points in a wire isn't emf

Conclusion:

EMF is the cause (provided by the battery or source)

Other potential differences are effects (due to circuit elements)

So, every emf is a potential difference, but not all potential differences are emf.

Q11.

Given:

Current (I) = 0.0001 A

Time (t) = 1 min = 60 s

Required:

Charge (Q) ?

Formula:

$I = Q / t$

⇒ Rearranged: $Q = I \times t$

Calculations:

$Q = 0.0001\ A \times 60\ s$

$Q = 0.006\ C = 6\ mC$

Result:

The charge that flows in 1 minute is 6 milliCoulombs (6 mC).

Q12.

Answer:

Reason:

➜Current flows only when there is potential difference between two points.

➜At balanced point in a Wheatstone Bridge,

Potential at point B = Potential at point D

➜So, no potential difference exists between B and D.

Mathematically:

$V_B - V_D = 0 \Rightarrow I_g = 0$

Because $V_B = V_D$, no current flows through the galvanometer.

Conclusion:

At balanced condition, potential difference is zero across the galvanometer, so no current flows through it.

Chapter 13:Electromagnetism

Q1.

Answer:

Explanation:

Origin of Deflection:

The deflection is caused by electric force.

Electrostatic Induction:

When a charged plastic rod is brought near a neutral metallic compass needle, it induces opposite charges on the nearby side of the needle.

Deflection of Needle:

Due to electrostatic attraction between the charged rod and the induced opposite charges, the needle is deflected.

Conclusion:

The compass needle gets deflected due to electrostatic forces resulting from induced charges.

Q2.

Answer:

Difference Between Permittivity and Permeability

Feature	Permittivity	Permeability
(i) Related to	Related to electric field; measures opposition to formation	Related to magnetic field; measures support for magnetic flux
(ii) Principle	Based on polarization of electric charges	Based on magnetization
(iii) Representation	Symbol: ε, Unit: Farad/meter	Symbol: μ, Unit: Henry/meter
(iv) Referred as	Known as electric constant	Known as magnetic constant
(v) Application	Used in capacitors	Used in electromagnetic equipment

Q3.

Answer:

Rotating Charged Object Creates Magnetic Field

<u>Explanation:</u>

<u>Rotating Charged Sphere:</u>

When a charged metallic sphere rotates, each charged particle on its surface moves in a circular path, producing a current.

<u>Result:</u> This current generates a magnetic field.

<u>Atomic Analogy:</u>

Just like electrons revolve around the nucleus, they produce a magnetic field due to both:

- **Orbital motion**

- Spin motion (rotation about their own axis)

<u>Conclusion:</u>

A highly charged rotating metallic object behaves like a current loop and hence produces a magnetic field.

Q4.

Answer:

Electron Suffers Greater Deflection in Magnetic Field

<u>Reason:</u>

When charged particles enter a magnetic field at 90°, they experience a maximum magnetic force:

$F = qVB$

<u>Radius of Deflected Path:</u>

The radius of the circular path of a particle is given by:

$r = mv / qB$

This depends on:

- Mass (m)
- Velocity (v)
- Charge (q)
- Magnetic field (B)

Mass Comparison:

Electron mass (me) is much smaller than proton mass (mp)

So, re < rp

Hence, electron is deflected more sharply

(mp ≈ 1836 × me)

Conclusion:

Lighter particles (like electrons) suffer greater deflection in a magnetic field due to their smaller mass.

Q5.

Answer:

Magnetic Force May Be Zero

Explanation:

The magnetic force on a moving charge is given by:

F = q v B sin(θ)

Force Becomes Zero In These Cases:

1. Magnetic Field is Zero (B = 0):

No field → No magnetic force

➤ F = 0

2. Motion Parallel or Antiparallel to Magnetic Field ($\theta = 0°$ or $180°$):

➤ $\sin(0°) = 0$ or $\sin(180°) = 0$

➤ Hence, $F = 0$

Special Case: Perpendicular Electric and Magnetic Fields

If a charged particle enters a region with electric field (E) and magnetic field (B) perpendicular to each other — and if forces cancel out:

$F_e = F_B \Rightarrow F_{net} = 0$

Then the particle moves undeflected.

Conclusion:

Magnetic force may be zero if:

$B = 0$

$\theta = 0°$ or $180°$

$F_e = F_B$ (in perpendicular E and B fields)

In all these cases, the particle moves undeflected.

Q6.

Answer:

Spring Contracts When Current Passes Through It

Model Assumption:

Treat the spring as a coil of wire.

Before Current:

- **Spring is relaxed**
- **Loops are spaced apart**

After Current is Passed:

- **Current flows in same direction through all loops**
- **One end becomes North Pole, the other South Pole**
- **Attraction occurs between the loops**

Reason:

Two parallel wires carrying current in the same direction attract each other →

So the loops of the coil pull closer, causing the spring to contract.

Conclusion:

A spring contracts when current passes through it due to magnetic attraction between loops acting like parallel current-carrying wires.

Q7.

Answer:

Explanation:

Cyclotron Principle:

It accelerates charged particles using a combination of:

- **Magnetic field**

- High-frequency alternating voltage

Neutron's Nature:

- A neutron has no electric charge (it's neutral)
- Magnetic force is directly proportional to charge (q)

Mathematically:

$F = q\,v\,B\sin\theta$

If $q = 0$ (for neutron), then:

➤ $F = 0$

➤ No magnetic force

➤ No acceleration

Conclusion:

Neutrons cannot be accelerated using a cyclotron because they experience no magnetic force.

Q8.

Answer:

Condition for No Torque on a Current-Carrying Coil in Magnetic Field

Statement:

No torque acts on a loop when the plane of the coil is perpendicular to the magnetic field.

Explanation:

➜When a current-carrying coil is placed in a magnetic field, it experiences torque unless:

➜The vector area of the coil is parallel to the magnetic field

➜This means the plane of the loop is perpendicular to the field

Mathematically:

Torque (τ) = N I A B sinθ

Where:

N = 1 (single loop)

θ = 0° (vector area ∥ magnetic field)

So:

➤ $\tau = IAB \sin(0) = 0$

➤ **No torque**

Conclusion:

A current-carrying coil will be in equilibrium when its plane is perpendicular to the magnetic field, because in that case, net torque is zero.

Q9.

Answer:

A Current-Carrying Coil Behaves Like a Tiny Bar Magnet

Explanation:

When electric current passes through a coil, it generates a magnetic field that closely resembles the magnetic field of a bar magnet.

Magnetic Poles:

One face of the coil acts as a North Pole, and the opposite face acts as a South Pole.

Magnetic Field Lines:

➤ **Originate from the North face of the coil**

➤ **Terminate at the South face**

Magnetic Field Inside Coil:

➤ **Strong and uniform, similar to that of a bar magnet**

Right-Hand Rule (for Direction of Magnetic Field):

Method:

- **Curl your fingers in the direction of current**
- **Your thumb points towards the North Pole of the coil**
- **The opposite end is the South Pole**

Conclusion:

A current-carrying coil creates a magnetic field similar to a bar magnet, with defined poles and uniform field inside.

Chapter 14:Electromagnetic Induction

Q1.

Answer:

The emf induced in the coil of the motor due to change of magnetic flux in it is called back emf.

Factors Effecting Back Emf:

(i) Rate of change of magnetic flux:

Magnitude of back emf induced in a coil is directly proportional to the rate of change of magnetic flux.

Mathematically: $E = \Delta\Phi / \Delta t$

(ii) Speed of motor:

Increasing the speed of motor will increase the back emf and vice versa.

The back emf produced in an armature of motor is given by the relation used for emf induced in generators.

Mathematically: $E = N\omega AB \sin(\omega t)$, $E \propto \omega$

(iii) Inductance (L):

Higher inductance of coil leads to higher back emf.

Mathematically: $E = L\, \Delta I / \Delta t$

(iv) Resistance of circuit:

Back emf in an inductive circuit is inversely proportional to resistance (R) of circuit.

Q2.

Answer:

<u>Reason:</u>

Rate of doing work increases as load to the motor is increased. Increased load decreases back emf.

Increase in moment of inertia of coil:

Connecting load with the armature of the coil increases moment of inertia of coil.

Decrease in rotational velocity:

Increasing moment of inertia decreases ω

Mathematically: $\omega \propto 1 / I$

Effect on rate of change of flux and back emf:

➜Decreasing angular velocity decreases rate of change of flux.

➜Thus back emf also decreases.

➜Mathematically: $E \propto \omega$, $\omega \downarrow \Rightarrow E \downarrow$

Q3.

Answer:

According to Faraday's Law of Electromagnetic Induction, the induced emf is given by:

$E = -N \times (\Delta\Phi / \Delta t)$

Advantage Of Using Coil With Many Turns:

Rate of change of magnetic flux will increase as number of turns increase, and as a result, larger amount of emf is induced.

This happens as surface area exposed to changing magnetic field increases.

Conclusion:

The whole procedure is advantageous for generating higher voltage and improving the efficiency of devices like transformers, generators, and inductors.

Q4.

Answer:

Dimensional Analysis of EMF (E):

Work done / Charge

Dimensions of work = $[M L^2 T^{-2}]$

Dimensions of charge = $[A T]$

Dimensions of emf = $[M L^2 T^{-2}] / [A T] = [M L^2 T^{-3} A^{-1}]$

RHS Dimensional Analysis:

From equation $E = N B A / t$

B (magnetic field) = $[M T^{-2} A^{-1}]$

A (area) = $[L^2]$

t (time) = $[T]$

So:

$E = [M L^2 T^{-3} A^{-1}]$

Result:

Since both LHS and RHS have same dimensions,

Given equation is dimensionally correct.

Q5.

Answer:

Magnetic Flux Linkage

Definition:

"Magnetic flux linkage is the product of magnetic field and number of turns of coil."

Mathematically:

Flux linkage = $N \times \Phi$

Where:

$\Phi = B \times A \times \cos(\theta)$

So,

Flux linkage = $N \times B \times A \times \cos(\theta)$ (Equation i)

But we know:

$\theta = \omega t$

Thus the equation becomes:

Flux linkage = $N \times B \times A \times \cos(\omega t)$ (Equation ii)

Result / Conclusion:

Equation (ii) represents the flux linkage in terms of angular orientation ($\theta = \omega t$).

Q6.

Answer:

Electromagnetic Brake;

Refers to applying brake using electric and magnetic power. These are also called eddy current brakes.

Working:

1. Current through electromagnet:

Current is passed through the electromagnet which produces a magnetic field.

2. Magnetic field through rotating disc:

Magnetic field perpendicularly passes through the rotating metal disc, causing a change in magnetic flux through the disc. This change produces eddy currents.

3. Interaction of eddy currents with magnetic field:

Eddy currents produce their own magnetic field. According to Lenz's Law, this field interacts with the external magnetic field in such a way that it opposes the rotation of the disc.

Q7.

Answers

<u>Eddy Currents:</u>

Definition:

"Eddy currents are loops of electrical current induced within conductors by changing magnetic field in the conductor."

Disadvantage:

Eddy currents flow in closed loops within the transformer core in planes perpendicular to the magnetic field and produce heat.

<u>Minimization Of Eddy Currents</u>

1. Using laminated core:

Laminated soft iron cores are used, consisting of many thin sheets pressed together but separated by thin insulating layers.

2. Increasing resistance of core:

This reduces the magnitude of eddy currents.

Net Effect: Reduced heating effects and limitation of eddy currents to small thicknesses.

Q8.

Answers:

Cook Tops

Definition:

An electrical device used for cooking and heating the food through electromagnetic induction is called a cooktop.

Working Of Cooktops

1. Production of rapidly oscillating magnetic field:

A coil attached to AC beneath stove top sets up a rapidly oscillating magnetic field.

2. Production of eddy currents:

This rapidly changing magnetic field produces eddy currents in the base of the metal pan.

3. Production of heat:

Eddy currents produce heat energy, which is absorbed by the food. In this way, the food is cooked using induction.

Q9.

Answer:

Back Emf Of Motor

Definition:

"When armature of the motor rotates in a magnetic field by applying potential difference V, then its magnetic flux changes and emf is induced in it which is called back emf."

Opposing Nature:

Induced emf opposes the potential difference running the motor. The net effective voltage is given by:

Effective voltage = V - E (back emf)

Relation With Speed Of Rotation

Back emf induced in the armature of motor is directly proportional to its speed of rotation.

$E \propto \omega$

As motor speeds up: Back emf increases

As motor slows down: Back emf decreases

As load increases: Back emf decreases

If motor is prevented from rotating: Back emf becomes zero

Q10.

Answer:

Advantage of Armature Rotating in Radial Magnetic Field

(i) More efficient induction:

In a radial magnetic field, the changing magnetic flux across the coil is more uniform during rotation, resulting in more efficient induction of emf.

(ii) Simpler construction:

Radial magnetic field configurations often have simpler designs, making them easier to implement in various applications.

(iii) Torque acting on coil:

In a radial magnetic field, magnetic field and vector area of coil are perpendicular to each other ($\theta = 90°$).

Therefore, maximum torque acts on the coil.

Torque (T) = NIAB sin(90) = NIAB

Q11.

Answer:

(a) I would prefer:

Laminated Soft Iron Core

(b) Reason:

(i) Minimize Hysteresis Loss:

Soft iron core reduces hysteresis loss. It makes magnetization and demagnetization easier and more efficient.

(ii) Reduced Eddy Current:

Laminated core plays a crucial role in offering resistance to the induction of eddy currents, which reduces heating.

(iii) Focusing Magnetic Flux:

Laminated soft iron helps increase and concentrate magnetic flux in the transformer coils, improving efficiency.

Conclusion:

Overall energy losses are reduced, and neat power production is ensured.

Aluminum cannot fulfill these requirements, and using only iron without lamination is also less effective.

Chapter 15:Alternating Current

Q1.

Answer:

Explanation:

Self induced emf can be mathematically expressed as:

$\varepsilon = L \times \Delta I / \Delta t$

Straight line:

As induced emf varies directly with rate of change of current, the graph is a straight line.

Significance:

The slope between $\Delta I / \Delta t$ and ε gives the value of self inductance L

Mathematically:

Slope = $\Delta\varepsilon / \Delta(\Delta I / \Delta t)$

So,

$L = \Delta\varepsilon / \Delta(\Delta I / \Delta t)$

Thus, we can calculate the self inductance 'L' of coil through the slope.

Q2.

Answer

Changing Polarity Of Ac

Power Curve:

Alternating current changes polarity resulting in negative and positive I and V values.

Power Dissipated in Resistor:

Power loss in AC circuit through resistor is always positive because Voltage and Current are always in-phase.

Mathematically:

Power factor: $\cos 0° = 1$

So,

$\langle P \rangle = V_{rms} \times I_{rms}$

During Positive Half Cycle (0 → 180°):

V and I are positive, thus

$\langle P \rangle = (V_{rms})(I_{rms})$

<u>During Negative Half Cycle (180° → 360°):</u>

V and I are negative, thus

<P> = (-Vrms)(-Irms)

<P> = Vrms × Irms

Q3.

Answer:

Gradient Of A Graph Of Inductive Reactance Against Frequency

<u>Graph:</u>

Gradient of a graph of inductive reactance against frequency helps us to measure self inductance of the inductor.

<u>Explanation:</u>

Inductive reactance:

Inductive reactance can mathematically be expressed as:

$X_L = 2\pi f L$

Straight line:

Since XL varies directly with f, a straight line is obtained.

<u>Gradient or Slope:</u>

Slope = $\Delta XL / \Delta f$

From this we can say:

$\Delta XL = 2\pi(\Delta f)L$

So,

$L = (1 / 2\pi) \times (\Delta XL / \Delta f)$

Conclusion:

With the help of this gradient, we can measure the self inductance of the inductor.

Q4.

Answer:

Effect Of Doubling Frequency

(a) Inductive Reactance:

Inductive reactance is given by:

$XL = 2\pi fL$

Putting f = 2f, we get:

$XL' = 2\pi(2f)L = 2 \times (2\pi fL)$

Result:

When frequency is doubled, XL also becomes double.

(b) Capacitive Reactance:

Capacitive reactance is given by:

$XC = 1 / (2\pi fC)$

Putting f = 2f, we get:

$XC' = 1 / [2\pi(2f)C] = 1/2 \times (1 / 2\pi fC)$

Result:

When frequency is doubled, capacitive reactance becomes half.

Q5.

Answer:

Given Data:

Peak value of voltage Vm = 1000 volts

Required:

Vrms = ?

Formula:

$$V_{rms} = V_m / \sqrt{2} \qquad (1)$$

Calculations:

Putting values in formula (1):

$V_{rms} = 0.707 \times 1000$ **volts**

$V_{rms} = 707$ **volts**

Result:The effective voltage or RMS value of voltage is 707 volts

Q6.

Answer

Reactances

Inductive Reactance

Definition:

"The opposition provided by the inductor in the flow of AC is called inductive reactance."

Mathematically:

$X_L = \omega L = 2\pi f L$

Since $f = 1/T$

So, $X_L = 2\pi(1/T) \times L$

Units:

Unit of L = Vs/A

So,

$X_L = (1/s) \times (Vs/A) = V/A$

Unit of X_L = ohm (Ω)

CAPACITIVE REACTANCE

Definition:

"The opposition offered by a capacitor to the flow of AC is called capacitive reactance."

Mathematically:

$X_C = 1 / \omega C = 1 / (2\pi f C)$

Units:

C = Farad (F)

Farad = As/V

So,

XC = (1/s) × (Vs/A) = V/A

Unit of XC = ohm (Ω)

Q7.

Answer

An ECG is simply a representation of the electrical activity of the heart muscle as it changes with time.

PRINCIPLE OF ECG:

Electrical Depolarization:

At every beat, cardiac muscles contract in response to electrical depolarization of the muscle cells. This electrical activity can be picked up on the skin.

Deflection:

When the wave of depolarization travels towards a recording lead, it results in a positive or upward deflection. A negative deflection indicates that the recorded wave has travelled away from the electrode.

Display:

An ECG machine records electrical activity via electrodes and displays it graphically as electrical potential (mV).

An ECG Curve:

P wave – Atrial depolarization

QRS complex – Ventricular depolarization

T wave – Ventricular repolarization