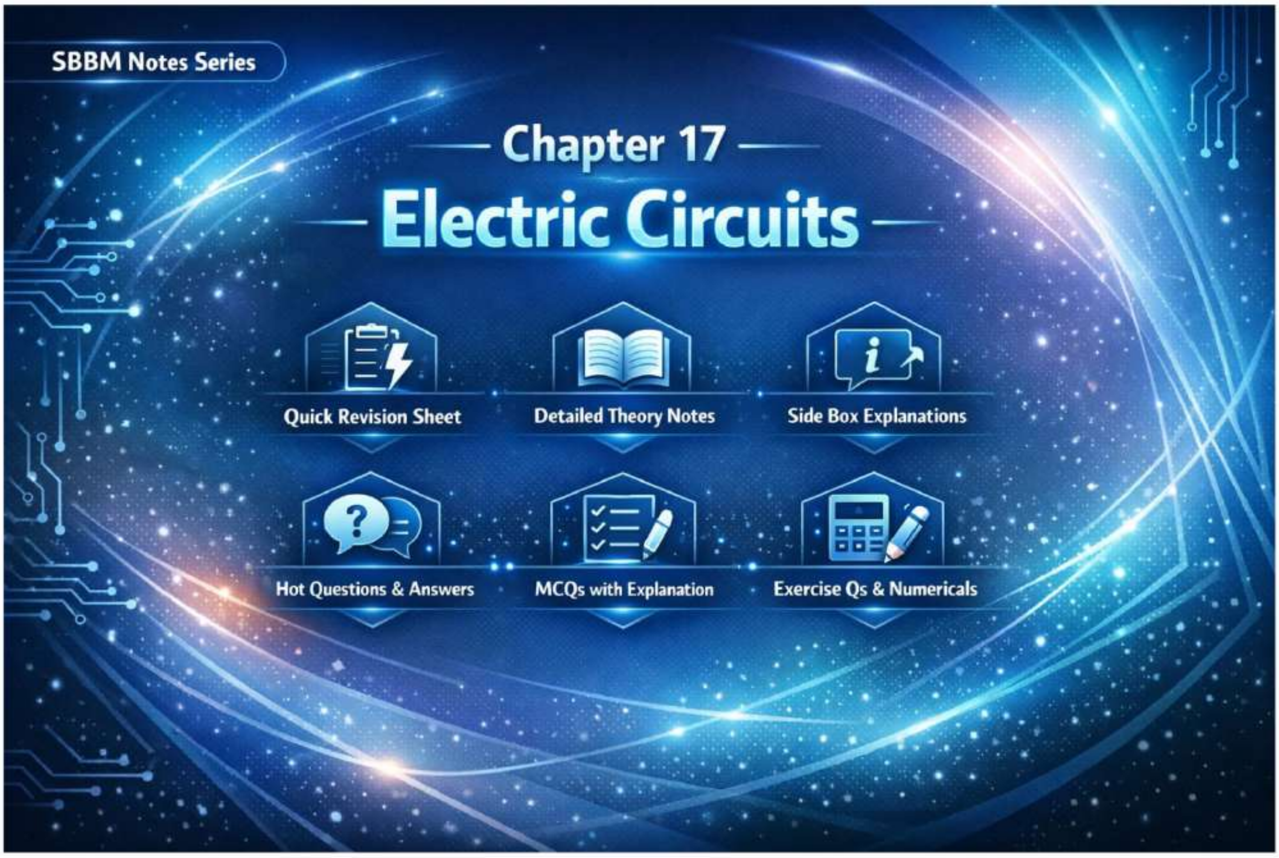
INTRO SHEET


SBBM Notes Series
Chapter 17
Electric Circuits
Quick Revision Sheet
Detailed Theory Notes
Side Box Explanations
Hot Questions & Answers
MCQs with Explanation
Exercise Qs & Numericals

QUICK REVISION SHEET

Unit 17—Electric Circuit

(SBBM One Page Revision Sheet)

17.1 Electric Elements and Diagrams

- **Electric circuit definition:**
  An electric circuit is a set of interconected elements (components) arranged in a specific way.
- **Basic circuit components:**
  - A Simple circuit typically includes:
  - Conductors (wires)
  - A power source (e.g. battery).
  - Load (a device, e.g. lamp or bulb).
- **Circuit Diagram:** Simplified Symbols
- **Applications:** Simple circuits are used in devices like torches or lights (switches).

Battery Lamp Resistor

Potential Divider and Non-Linear Resistors

- **Potential Divider** (Voltage Divider)
  - A fixed voltage V_i is applied across a total resistance $R_1 + R_2$
  - The current is $\frac{V_i}{R_1 + R_2}$
  - Output voltage across R_2:

$V_{out} \frac{R_2}{R_1 + R_2}$

V_{in}, R_1, R_2, V

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

Applications:
- Voltage dividers adjust voltage to smaller values in devices such as sensor circuits

Active vs Passive Elements

- **Active:** supply or generate energy
- **Examples:** batteries, generators
- **Passive:** absorb, store, or dissipate energy (Examples, resistors, capacitors, inductors)

- **Thermistor:** A resistor
  - A resistor whose resistance changes significantly with temperature.
- **Positive Temperature Coefficient)**
  - Resistance increases with rising temperature.
- **Negative Temperature Coefficient)**
  - Resistance decreases with rising temperature.

Types of Resistors

- **Linear Resistors:** Obey Ohm's law ($I = \frac{V}{R}$)
- **Fixed:** Single resistance value,
  - e.g. carbon, metal oxide, used for high-power; applications.
- **Variable Resistors:** Adjustable resistance,
  - e.g. potentiometer, high stability & accuracy

Combination of Resistors

- **Series:** $R_{total} = R_1 + R_2 + \cdots$
- Current remains same. Resistances add up.

$\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Combination of Resistors

- **Series:** $\mathcal{E}_{total} = \mathcal{E}_1 + \mathcal{E}_2 ...$
- **Parallel:** $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$

Combination of EMF Sources

- **Series:** $\mathcal{E}_{total} = \mathcal{E}_1 + \mathcal{E}_2$
  Voltage increases,
  - Twe 1,3V AA battery in series (3V)
- **Parallel:**
  - Voltage remains the same
  - eg. Four 12V;24Ah batteries in parallel yield 12V, 36Ah capacity.

SBBM Revision Sheet – CHAPTER 17 –

ELECTRIC CIRCUITS

1. ELECTRICITY & ITS USES

Heating
- Current through high resistance → produces **heat**
- **Uses:** Irons Heater, Toasters
- **Formula:** $H = I^2Rt$ (Joules)

Lighting
- Electrical → Light energy
- → Uses: Iron, Heater, Toaster

Battery Charging
- → Electrical → Mechanical energy

Powering Motors
- → Electrical → Mechanical energy
- → Uses: Fan, Pump, Washing Machine

Battery Charging
- → Electrical → Chemical energy
- → Uses: Mobile, Laptop, Power Bank

2. ELECTRICAL ENERGY

Definition: Electrical energy is the work done by electric current in

Formulas:
- $E = VIt$
- $E = I^2Rt$
- $E = \frac{V^2}{R} \times t$

Unit: E → Joule (J)

3. ELECTRIC POWER

Definition: Electric power electrical energy.

Formulas:
- $P = VI$
- $P = I^2R$

Unit P – Watt (W)
- 1 kW = 1000 W
- 1 W = 1 J/s

3. ELECTRIC POWER

Definition: Electric power is the rate at which electrical energy is used.

Formulas:
- $P = VI$
- $P = I^2R = \frac{V^2}{R}$
- $P = I^2R$

4. HOUSEHOLD CIRCUITS & SAFETY

Household Wiring
- → Parallel connection
- → Same voltage across all devices

Fuse
- Thin wire • low melting point
- Connected in series
- Protects from overload & Short circuit

MCB (Miniature Circuit Breaker)
- Trips automatically if current exceeds sale limit
- Reusable device.

RCD (Residual Current Device)
- → Detects leakage current to earth
- → Cuts supply in milliseconds
- → Protects from electric shock

Electrical Energy: $E = VIt = I^2Rt = \frac{V^2}{R} t$

Electric Power: $P = VI = I^2R = \frac{V^2}{R}$

Household Safety: + Parallel system → Fuse + MCB + RCD + Earthing

UNIT 17: ELECTRIC CIRCUITS

Circuit elements and diagrams:

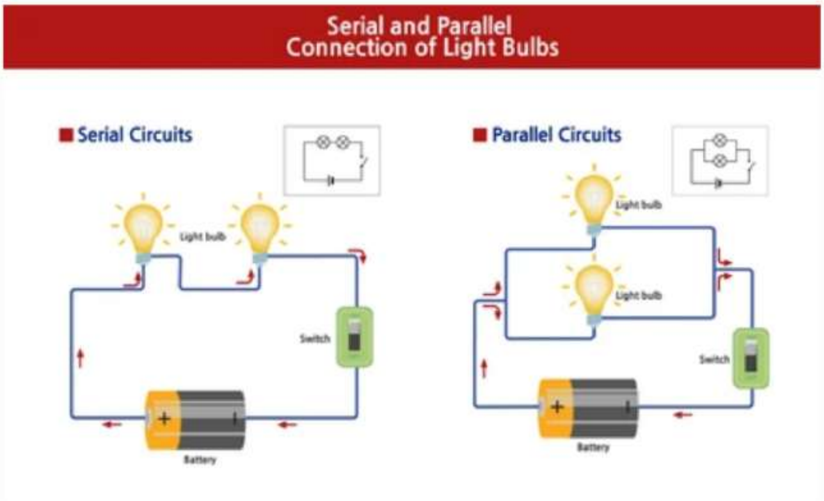
Definition: Electric circuit is a path through which electric current flows. A basic circuit typically includes:

Conductors (often wires)

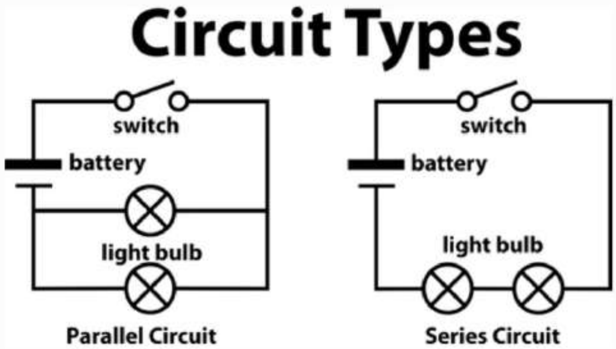
A power source (like a battery)

A Load (for instance a lamp) and a switch to turn the circuit on and off.

This type of circuit can be used for torch light, etc



Physical circuit



Point to Note: A circuit creates a closed -loop, starting and ending at the same point. Mostly, we represent circuit by circuit diagram and often use physical circuit diagram.

Active elements:

1. It can generate or supply energy.
2. It requires an external power source.
3. It can amplify signals

Example;cell,battery

Passive element:

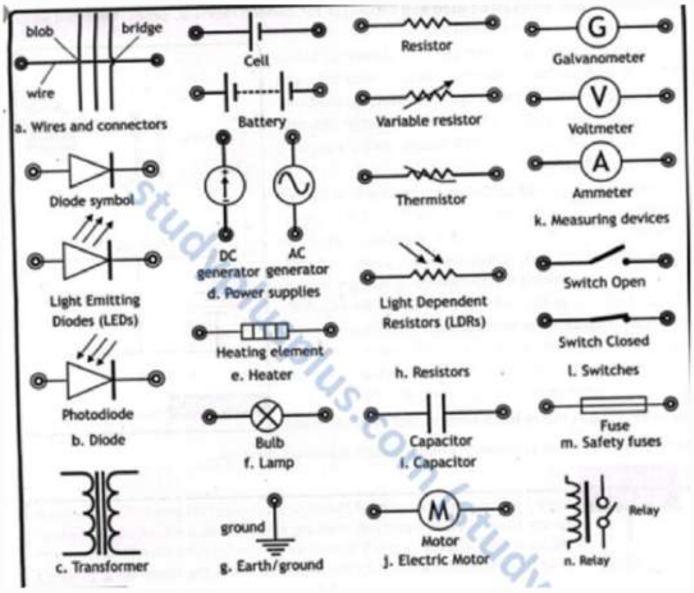
1. It cannot generate electricity. It stores or resists the energy
2. It does not require an external power source.
3. It cannot amplify signals

Example: Resistor, Capacitor.

SCIENCE TIDBITS

Electricity loves to travel in closed loops called circuits! Imagine it like a racetrack for electrons—these tiny particles zoom around the circuit but must start and end at the same point. If there's a break in the track (an open circuit), the electrons come to a halt, and nothing happens. But if the path is complete, they speed along, powering lights, gadgets, and so much more!

Circuit symbol for various circuits:



SCIENCE TIDBITS

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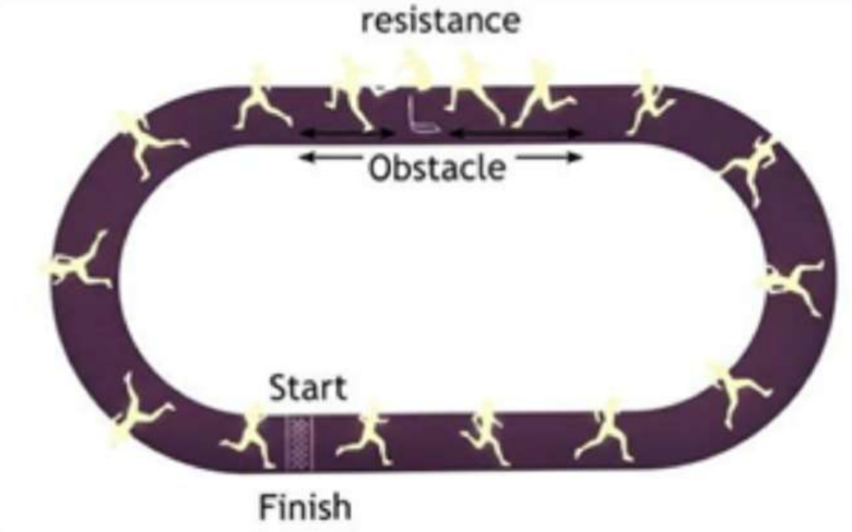


SRQS

Q1 **Differentiate between Active and Passive Elements.**

Feature	Active Elements	Passive Elements
Basic Function	Can **generate** or amplify power.	Can only **consume** or store energy.
Energy Flow	Acts as an **Energy Source**.	Acts as an **Energy Load**.
Control	Can control the flow of current.	Cannot control current flow on its own.
Requirement	Needs an external source to work.	Does not need external power to function.
Examples	**Batteries**, Cells, Transistors.	**Resistors**, Capacitors, Inductors.
Gain	Can provide power gain.	Cannot provide any power gain.
Role	The "Heart" of the circuit.	The "Path" or "Limiter" of the circuit.

Q2: Why should an electric circuit be in a closed loop?

1. ◦ **Definition:** A closed loop is a **complete path** with no breaks or gaps.
2. ◦ **Current Flow:** Electricity only flows when it has a clear path from (+) to (-).
3. ◦ **Air Gap:** An open circuit has an air gap, which has **infinite resistance.**
4. ◦ **Electron Path:** Electrons must return to the source to keep the flow moving.
5. ◦ **Switch Role:** A switch works by making the loop **Closed (ON)** or **Open (OFF).**
6. ◦ **Energy Transfer:** Power only reaches the bulb or fan if the

loop is continuous.

7. **Circuit Safety:** Closed loops keep the current contained in the wires.

8. **Logic:** Just like a water pipe, if there is a cut, the water (current) stops.

Conclusion: Therefore, a closed loop is essential for the **existence and movement** of current.

Q3: What are the main components of a standard circuit diagram?

1. ◦ **Energy Source:** Usually, a **Battery** or Cell that provides Voltage.
2. ◦ **Conducting Path:** Copper **wires** that connect all parts together.
3. ◦ **Control Device:** A **Switch** to turn the flow on or off.
4. ◦ **The Load:** A device like a **Bulb** or motor that uses the energy.
5. ◦ **Protection:** A **Fuse** to prevent damage from high current.
6. ◦ **Measuring Tools: Ammeter** (for current) and **Voltmeter** (for voltage).
7. ◦ **Resistors:** Components used to **limit** the flow of current.
8. ◦ **Symbols:** Each part is represented by a specific **standard symbol.**

Conclusion: All these elements work together to create a **functional and safe** circuit.

MCQS

1. An electric circuit must always:

A) Have a battery

B) Have a bulb

C) Form a closed loop

D) Have resistance

Correct Answer: C) Form a closed loop

Explanation: For current to flow, the path must be complete from the source back to the source. If the loop is broken, electrons cannot circulate.

2. If a switch is open, the circuit becomes:

A) Short circuit

B) Closed circuit

C) Open circuit

D) Parallel circuit

Correct Answer: C) Open circuit

Explanation: An open switch breaks the conducting path. Since the circuit is incomplete, no current flows.

3. Active elements are those which:

A) Store energy only

B) Supply energy

C) Oppose current

D) Reduce voltage only

Correct Answer: B) Supply energy

Explanation: Active elements like batteries and generators provide electrical energy to drive current in a circuit.

4. Which of the following is a passive element?

A) Battery

B) Generator

C) Resistor

D) Cell

Correct Answer: C) Resistor

Explanation: Passive elements do not produce energy. They either store it (capacitor) or consume it (resistor).

5. In a circuit diagram, wires are represented by:

A) Zig-zag lines

B) Straight lines

C) Dotted lines

D) Curved lines

Correct Answer: B) Straight lines

Explanation: Straight lines represent conducting wires connecting components.

6. The load in a simple circuit:

A) Supplies current

B) Consumes electrical energy

C) Stores charge

D) Increases voltage

Correct Answer: B) Consumes electrical energy

Explanation: The load (like a bulb or motor) converts electrical energy into light, heat, or motion.

7. If the path is incomplete, electrons:

A) Move faster

B) Stop moving

C) Reverse direction

D) Multiply

Correct Answer: B) Stop moving

Explanation: Without a complete path, charges cannot move continuously, so current becomes zero.

8. A capacitor mainly:

A) Produces energy

B) Stores energy

C) Increases resistance

D) Converts AC to DC

Correct Answer: B) Stores energy

Explanation: A capacitor stores electrical energy temporarily in the electric field between its plates.

9. Which device converts electrical energy into mechanical energy?

A) Bulb

B) Capacitor

C) Motor

D) Fuse

Correct Answer: C) Motor

Explanation: A motor works on electromagnetic principles and converts electrical energy into mechanical rotation.

10. The symbol of earth/ground represents:

A) High voltage

B) Zero potential reference

C) Short circuit

D) Open switch

Correct Answer: B) Zero potential reference

Explanation: Ground is considered as zero volts and is used as a reference point in circuits.

11. Which of these is NOT an active element?

A) Generator

B) Cell

C) Resistor

D) Battery

Correct Answer: C) Resistor

Explanation: A resistor does not supply energy; it only resists current flow.

12. A fuse is used to:

A) Increase current

B) Decrease voltage

C) Protect circuit

D) Store energy

Correct Answer: C) Protect circuit

Explanation: A fuse melts when excessive current flows, preventing damage to the circuit.

13. If resistance increases, current will:

A) Increase

B) Decrease

C) Remain same

D) Become zero

Correct Answer: B) Decrease

Explanation: According to Ohm's Law (I = V/R), if resistance increases and voltage stays constant, current decreases.

14. Which element dissipates energy as heat?

A) Capacitor
B) Resistor
C) Cell
D) Motor

Correct Answer: B) Resistor

Explanation: A resistor converts electrical energy into heat due to opposition to current.

15. Circuit diagrams help to:

A) Decorate circuits
B) Simplify connections
C) Increase voltage
D) Reduce resistance

Correct Answer: B) Simplify connections

Explanation: Circuit diagrams use symbols to represent components clearly and neatly.

16. A short circuit occurs when:

A) Resistance is very high
B) Resistance is very low
C) Switch is open
D) No battery

Correct Answer: B) Resistance is very low

Explanation: Very low resistance causes a large current to flow, which can damage components.

17. Which component stores electrical charge?

A) Resistor
B) Capacitor
C) Fuse
D) Switch

Correct Answer: B) Capacitor

Explanation: A capacitor stores electrical charge and releases it when needed.

18. The flow of electrons requires:

A) Open path
B) Closed path
C) Thick wires only
D) High resistance

Correct Answer: B) Closed path

Explanation: A continuous conducting loop is necessary for current flow.

19. In a simple circuit, energy flows from:

A) Load to battery
B) Battery to load
C) Switch to load
D) Ground to switch

Correct Answer: B) Battery to load

Explanation: The battery provides energy, which the load uses.

20. A relay works using:

A) Mechanical force
B) Magnetic effect
C) Heat effect
D) Light effect

Correct Answer: B) Magnetic effect

Explanation: A relay uses an electromagnet to control another circuit.

21. Which device controls current flow manually?

A) Fuse
B) Switch
C) Capacitor
D) Motor

Correct Answer: B) Switch

Explanation: A switch is used to open or close a circuit manually.

22. Carbon resistors are considered:

A) Active

B) Passive

C) Semiconductor

D) Power source

Correct Answer: B) Passive

Explanation: Carbon resistors do not generate energy; they only oppose current.

23. An open circuit has:

A) Infinite resistance

B) Zero resistance

C) Low voltage

D) High current

Correct Answer: A) Infinite resistance

Explanation: In an open circuit, resistance is extremely high, so no current flows.

24. Which symbol represents resistance in diagrams?

A) Two parallel lines

B) Zig-zag line

C) Circle

D) Triangle

Correct Answer: B) Zig-zag line

Explanation: The zig-zag symbol represents a resistor in circuit diagrams.

25. The main purpose of insulation on wires is:

A) Increase resistance

B) Safety

C) Increase voltage

D) Store energy

Correct Answer: B) Safety

Explanation: Insulation prevents electric shock and short circuits.

26. A bulb glows because:

A) Electrons stop

B) Current produces heat & light

C) Voltage disappears

D) Resistance becomes zero

Correct Answer: B) Current produces heat & light

Explanation: Current heats the filament, which emits light.

27. In a closed loop, electrons start and end at:

A) Different points

B) Same point

C) Battery only

D) Ground only

Correct Answer: B) Same point

Explanation: In a complete circuit, electrons return to their starting point.

28. If the fuse melts, the circuit becomes:

A) Parallel

B) Open

C) Closed

D) Short

Correct Answer: B) Open

Explanation: When the fuse melts, it breaks the circuit.

29. Which one is used to measure current?

A) Voltmeter

B) Ammeter

C) Galvanometer

D) Capacitor

Correct Answer: B) Ammeter

Explanation: An ammeter is connected in series to measure current.

Resistors

Definition: **The component of an electric circuit whose function is to provide a specified value of resistance is called a resistor.**

A resistor is an electrical component that limits or control the flow of electric current in a circuit.

The most used resistors are called carbon resistor.

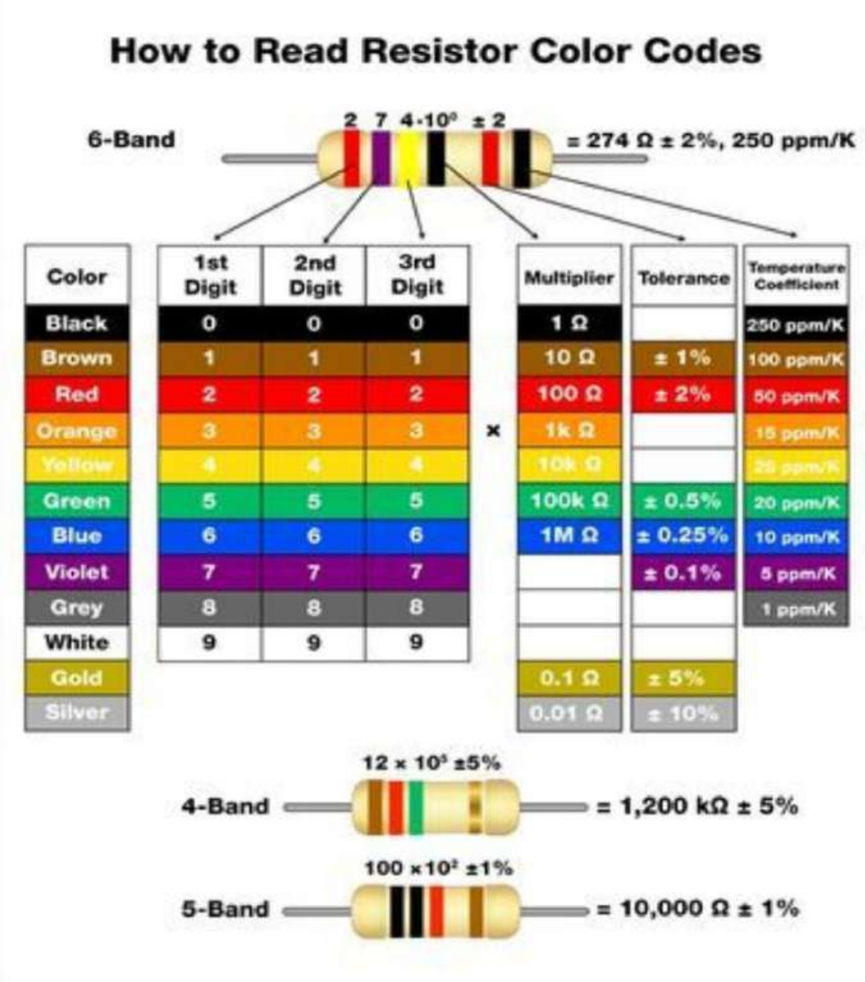
RESISTOR COLOUR CODE

Colour	Value	Multiplier	Tolerance
Black	0	10^0	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Silver		10^{-1}	±05%
Gold		10^{-2}	±10%
Colourless			±20%

This is represented by colour code

BB ROY GBVGW

(BB ROY Great Britain very good woman /or/ Gi BiVi Gi Wakai)



SCIENCE TIDBITS

While reading the colour code, hold the resistor with colour bands to your left. Resistors never start with a metallic band on the left. The sequence "BB ROY GBVGW" helps remember the resistor colour code: Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Grey, and White, which correspond to numerical values used to determine resistance.

SRQS

Q4. Explain the concept of "Colour Coding" in Fixed Resistors.

Purpose: Since resistors are tiny, their values are printed as coloured bands.

1. Standard: Most resistors use the 4-band or 5-band international colour code.
2. Digits: The first two bands represent the first two digits of the resistance value.
3. Multiplier: The third band tells you how many zeros to add to the digits.
4. Tolerance: The final band (usually Gold/Silver) shows the tolerance percentage.
5. Reading Direction: Always read from the end where the bands are crowded together.
6. Memory Aid: Technicians use rhymes like "BB ROY" to remember the colour sequence.

Conclusion: This system allows for quick identification of parts during circuit assembly.

Q5: Why are resistors called "Passive" but "Essential" components?

1. **Passive Nature:** They cannot create energy; they only **oppose** it.
2. **Protection:** Their main job is to **protect** sensitive parts from high current.
3. **Heat Conversion:** They convert excess electrical energy into **Heat.**
4. **Voltage Divider:** They are used to drop voltage to a level a device can handle.
5. **Current Limiting:** Without them, components like LEDs would

burn out instantly.

6. **Speed Breaker:** Think of them as "speed breakers" for electrons on a highway.
7. **Versatility:** They are found in almost **every** electronic device on Earth.
8. **Conclusion:** Although they don't give energy, they are essential for **Circuit Control.**

Q6: Explain the construction of a Wire-Wound Resistor.

1. **Core Material:** It consists of an **insulating core** made of ceramic or glass.
2. **Resistive Wire:** A metal wire (usually **Nichrome**) is wrapped around the core.
3. **Length Factor:** The **length and thickness** of the wire decide the resistance value.
4. **Coating:** The wire is covered with an enamel or ceramic layer for protection.
5. **High Power:** These resistors are designed to handle **high temperatures.**
6. **Accuracy:** They are very precise and stable over a long period of time.
7. **Terminals:** Strong metal caps are attached at the ends for connections.
8. **Conclusion:** Their robust design makes them perfect for **heavy-duty industrial use .**

Q7: How do you calculate the value of a resistor using the 4-Band Colour Code?

1. **Standardization:** Resistors use colours because they are too small for printed text.
2. **First Band:** Indicates the first significant digit of the resistance value.

3. **Second Band:** Indicates the second significant digit of the value.
4. **Third Band (Multiplier):** Tells you the power of 10 to multiply the digits by.
5. **Fourth Band (Tolerance):** Shows the accuracy range
6. **Reading Rule:** Always start from the end where the colour bands are grouped closer.

Conclusion: This system allows technicians to identify parts instantly during repair.

Q8: What is "Tolerance" in resistors and why does it matter?

1. **Definition:** Tolerance is the **percentage of error** in a resistor's value.
2. **Manufacturing:** It is impossible to make every resistor exactly 100 Ω.
3. **Colour Bands:** The **fourth band** (Gold or Silver) represents the tolerance.
4. **Gold Band:** Means the value is accurate within ±10%
5. **Silver Band:** Means the value is accurate within ±05%
6. **Precision:** For sensitive equipment (like satellites), **low tolerance** is needed.
7. **Cost:** High precision resistors are more expensive to manufacture.
8. **Conclusion:** Tolerance tells us how much we can **trust** the labelled value.

Q9: Explain the Carbon Composition Resistor (The standard type).

1. **Mixture:** Made from a mix of **Carbon dust** and powdered Ceramic.
2. **Ratio:** More carbon means lower resistance; more ceramic means higher resistance.
3. **Compact Size:** They are very small and **inexpensive** to produce.

4. **Inductance:** They have very low inductance, making them good for **high frequencies.**

5. **Colour Bands:** Values are marked using the standard **4-band colour code.**

6. **Durability:** They can handle high-voltage surges without breaking easily.

7. **Usage:** Used in TVs, Computers, and basic household electronics.

Conclusion: Their **low cost and reliability** make them the most common resistor.

MCQS

1. A resistor in a circuit primarily:

A) Stores energy

B) Generates current

C) Controls the flow of current

D) Increases voltage

Correct Answer: C) Controls the flow of current

Explanation:

A resistor's main function is to control or limit the current in a circuit. It does not generate current or store energy; it only regulates current flow.

2. A resistor is classified as a:

A) Active component

B) Passive component

C) Power source

D) Semiconductor device

Correct Answer: B) Passive component

Explanation: Resistors do not generate power. They only consume and dissipate energy, so they are called passive components.

3. Resistors mainly dissipate electrical energy in the form of:

A) Light

B) Sound

C) Heat

D) Magnetism

Correct Answer: C) Heat

Explanation:

When current flows through a resistor, electrical energy is converted into heat energy due to resistance.

4. The most used resistor in electronic circuits is:

A) Wire-wound resistor

B) Carbon resistor

C) Variable transformer

D) Silicon resistor

Correct Answer: B) Carbon resistor

Explanation:

According to the book, carbon resistors are widely used because they are small, reliable, and cost-effective.

5. In a carbon resistor, a thin layer of carbon is deposited on:

A) Copper core

B) Iron rod

C) Ceramic core

D) Plastic rod

Correct Answer: C) Ceramic core

Explanation:

Carbon resistors consist of a ceramic core coated with a thin layer of crystalline carbon.

6. Why is colour coding used in resistors?

A) To improve design

B) Because resistors are too small to print numbers clearly

C) To increase resistance

D) To reduce heat

Correct Answer: B) Because resistors are too small to print numbers clearly

Explanation:

Since resistors are very small, printing numerical values is difficult. Therefore, colour bands are used

7. In a 4-band resistor, the first two bands represent:

A) Tolerance

B) Multiplier

C) Significant digits

D) Power rating

Correct Answer: C) Significant digits

Explanation:

The first two bands show the first two numbers of the resistance value.

8. The third band in a resistor indicates:

A) Tolerance

B) Voltage

C) Decimal multiplier

D) Current rating

Correct Answer: C) Decimal multiplier

Explanation:

The third band tells us how many zeros to add (10^n). It multiplies the first two digits.

9. The fourth band represents:

A) Multiplier

B) Resistance value

C) Tolerance

D) Temperature

Correct Answer: C) Tolerance

Explanation:

The fourth band (gold or silver usually) tells how much the actual value may vary from the stated value.

10. If no fourth band is present, tolerance is:

A) ±5%

B) ±10%

C) ±20%

D) ±2%

Correct Answer: C) ±20%

Explanation:

According to the book, if there is no tolerance band, the tolerance is ±20%.

11. The colour code for digit 0 is:

A) Brown

B) Black

C) Red

D) White

Correct Answer: B) Black

Explanation:

Black represents the number 0 in resistor colour coding.

12. The colour brown represents:

A) 0

B) 1

C) 2

D) 5

Correct Answer: B) 1

Explanation:

Brown corresponds to digit 1 and multiplier 10^1.

13. The multiplier for red colour is:

A) 10^1

B) 10^2

C) 10^3

D) 10^4

Correct Answer: B) 10^2

Explanation:

Red represents digit 2 and multiplier 10^2.

14. What does gold colour represent as tolerance?

A) ±5%

B) ±10%

C) ±20%

D) ±2%

Correct Answer: A) ±5%

Explanation:

Gold band indicates tolerance of ±5%.

15. What does silver colour represent as tolerance?

A) ±5%

B) ±10%

C) ±20%

D) ±1%

Correct Answer: B) ±10%

Explanation:

Silver band shows ±10% tolerance.

16. A resistor with bands Green–Blue–Orange–Gold has value:

A) $56 \times 10^2\ \Omega$

B) $56 \times 10^3\ \Omega$

C) $65 \times 10^3\ \Omega$

D) $65 \times 10^2\ \Omega$

Correct Answer: B) $56 \times 10^3\ \Omega$

Explanation:

Green = 5

Blue = 6

Orange = 10^3

So value = $56 \times 10^3\ \Omega$ (56 kΩ)

Gold = ±5%

17. **The value 56 kΩ in standard form is:**

A) $56 \times 10^2\ \Omega$

B) $56 \times 10^3\ \Omega$

C) $56 \times 10^4\ \Omega$

D) $5.6 \times 10^3\ \Omega$

Correct Answer: B) $56 \times 10^3\ \Omega$

Explanation:

$1\ k\Omega = 10^3\ \Omega$

So $56\ k\Omega = 56 \times 10^3\ \Omega$.

18. **Which colour represents digit 5?**

A) Green

B) Blue

C) Violet

D) Brown

Correct Answer: A) Green

Explanation:

Green corresponds to digit 5.

19. **Which colour represents digit 6?**

A) Violet

B) Blue

C) Gray

D) Yellow

Correct Answer: B) Blue

Explanation:

Blue corresponds to digit 6.

20. **The mnemonic "BB ROY GBVGW" helps remember:**

A) Voltage values

B) Current values

C) Resistor colour code sequence

D) Transformer symbols

Correct Answer: C) Resistor colour code sequence

Explanation:

It helps remember: Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray, White.

21. Which component symbol represents Earth/ground?

A) Three decreasing horizontal lines

B) Circle with M

C) Zig-zag line

D) Coil with switch

Correct Answer: A) Three decreasing horizontal lines

Explanation:

The earth symbol is shown by three horizontal lines of decreasing size.

22. The symbol of an electric motor is:

A) M inside a circle

B) Zig-zag line

C) Two parallel lines

D) Coil only

Correct Answer: A) M inside a circle

Explanation:

Motor symbol is represented by "M" inside a circle.

23. A resistor is used in a circuit to:

A) Increase power supply

B) Limit current

C) Produce electricity

D) Store charge

Correct Answer: B) Limit current

Explanation:

Resistors protect components by limiting current.

24. Which colour represents digit 9?

A) Gray

B) White

C) Violet

D) Yellow

Correct Answer: B) White

Explanation: White corresponds to digit 9.

25. Which colour represents multiplier 10^4?

A) Yellow

B) Orange

C) Green

D) Blue

Correct Answer: A) Yellow

Explanation:

Yellow = 4 → multiplier 10^4.

26. A resistor without metallic band should be read:

A) From either side

B) From the metallic side

C) With colour bands to left

D) From the thick band

Correct Answer: C) With colour bands to left

Explanation:

Resistors never start with metallic band; hold colour bands to left.

27. Carbon resistors are preferred because they are:

A) Large and heavy

B) Expensive

C) Cost-effective and small

D) High voltage generators

Correct Answer: C) Cost-effective and small

8. Which colour represents multiplier 10^6?

A) Blue

B) Green

C) Violet

D) Orange

Correct Answer: A) Blue

Explanation:

Blue = 6 → multiplier 10^6.

29. The tolerance band is usually:

A) First band

B) Second band

C) Third band

D) Last band

Correct Answer: D) Last band

30. A 4-band resistor with Brown–Black–Red–Gold has value:

A) $10 \times 10^2\ \Omega$

B) $10 \times 10^1\ \Omega$

C) $10 \times 10^3\ \Omega$

D) $10 \times 10^4\ \Omega$

Correct Answer: A) $10 \times 10^2\ \Omega$

Explanation:

Brown = 1

Black = 0

Red = 10^2

So $10 \times 10^2 = 1000\ \Omega$ ($1\ k\Omega$)

Gold = ±5%

Types of Resistors

1)Linear resistor

Linear resistors are resistor whose value changes as a function of applied voltage and temperature. Linear resistors and obey ohm's law.

(a) Fixed resistor

A Fixed resistor is an electrical component that opposes the flow of electric current with a constant resistance value. Its resistance is set during. manufacturing and cannot be adjusted. It is used to control current and divide voltage in circuits.

→ **Example:**

1) Carbon resistor
2) Metal Film resistor.

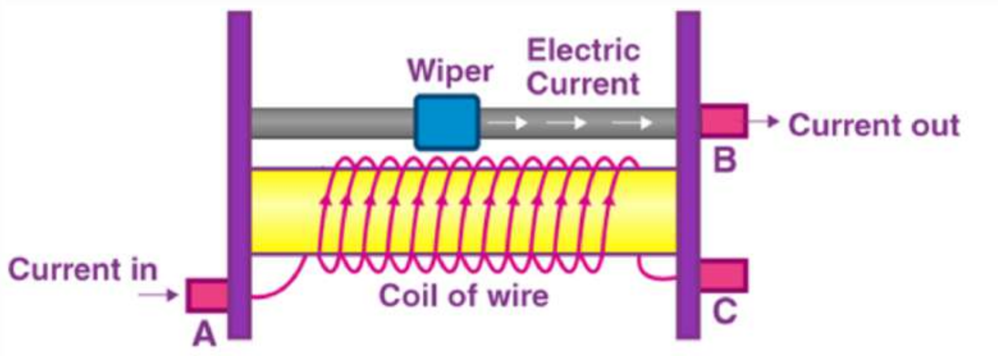
(b) Variable resistor

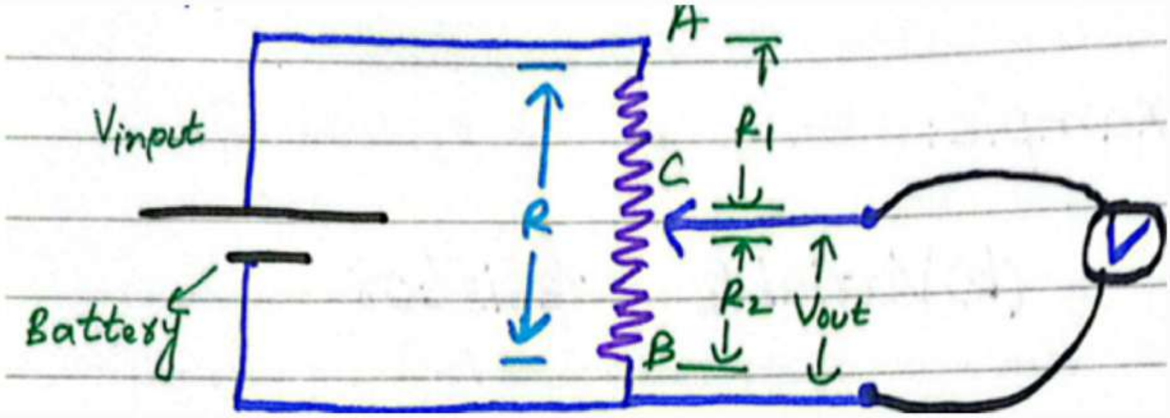
Variable resistors are the resistors, whose resistance value can be adjusted Generally, a mechanical movement is used to modify the resistance.

Rheostat

A rheostat is a variable resistor that allows the manual adjustment of current by changing the resistance.

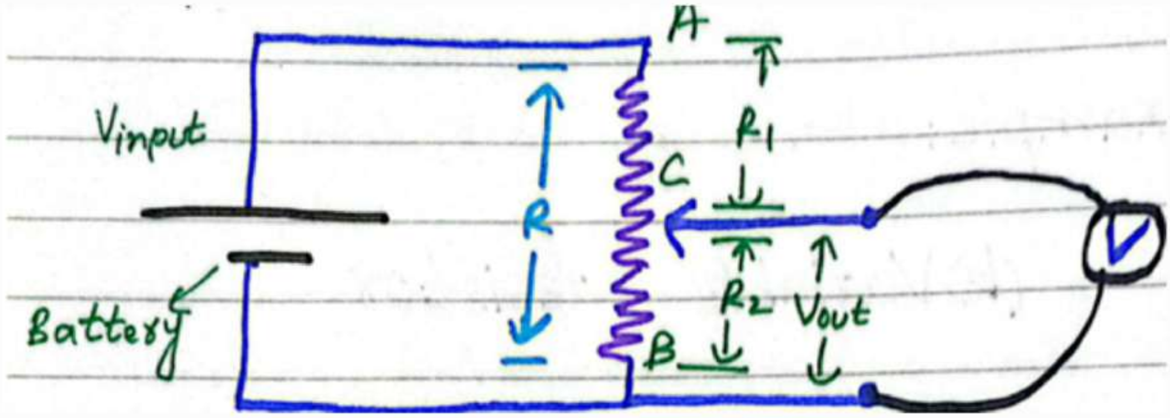
It has two terminals-one fixed and one movable. It can be varied by sliding the contact. It is used to control brightness of lamps, adjust speed of motors and to vary current in experiments. This resistor is adjusted by increasing the length of the wire.





Potential Divider

A Potential Divider is a circuit that divides a voltage into two or more smaller voltages. We can also define it as; A circuit that produces an output voltage (Vout) that is a Fraction of its input voltage (Vin) is called potential divider.



Derivation with Diagram

Let the potential difference across the resistance 'R'

Input P.D $V=IR$----(i)

The potential difference across the length BC having resistance 'R2'

Output P.D $V_2=IR_2$----(ii)

∵ $V = IR$

$I=V/R$----(iii)

Putting eq (iii) into eq (ii)

$V_2=V/R \times R_2$

∵ $R=R_1+R_2$

V2= R2/R × V

V2= R2/ R1+R2 × V

SPECIAL CASE: -

If R1=R2=r, V2=Voutput, V=Vinput then;

Voutput = r/r+r × Vinput

Voutput = r/2r × Vinput

Voutput = ½ Vinput

Voutput = Vinput/2

This means that input voltage is split into two equal halves at output.

1)Linear resistor

Non-linear resistors are those resistors whose resistance value fluctuates in response to temperature, light or voltage. It means, these resistors response do not obey ohms law.

(a) Thermistor

A thermistor is a type of resistor whose resistance varies/change significantly with temperature. The material used in a thermistor is generally a **semiconductor, ceramic or polymer.**

Positive temperature Coefficient (PTC): These thermistors increase its resistance with the increase of temperature.

Negative temperature coefficient (NTC): These thermistors decrease its resistance with the increase of temperature.

Functions of Thermistor

(i) Inrush current limiter:

An inrush current is the peak current drawn by an electrical device when powered on.

For Example: Incandescent bulbs have high inrush currents until their filaments heat up. NTC thermistors can -limit inrush current in power supply by initially exhibiting high circuits resistance, which restricts large currents during startup.

(ii) Overheating alarms:

NTC thermistors can trigger alarms when the temperature of motor, transformer or generator winding rises. They maintain high resistance at lower temperatures, allowing minimal current flow. As temperature increases, resistance drops, allowing more current to flow to an alarm system.

(iii) Temperature measurement:

Thermistors provide precise temperature measurement due to their high temperature coefficient. Their resistance changes, enabling detection of temperature.

(b) Varistors (VDR)

Varistors also known as voltage dependent resistor which are used to protect circuits from voltage spikes. When voltage increases, varistors reduce level of voltage to secure level. This type of resistor is typically made from zinc oxide (ZnO).

Light dependent resistor also known as photoresistor is a light-sensitive device that changes resistance based on the intensity of light.

In daytime, light Falls on LDR, resistance becomes slow. Current easily passes through LDR.

In night, no light, resistance becomes. high. Current cannot go through (DR. relay turns on allowing bulb on.)

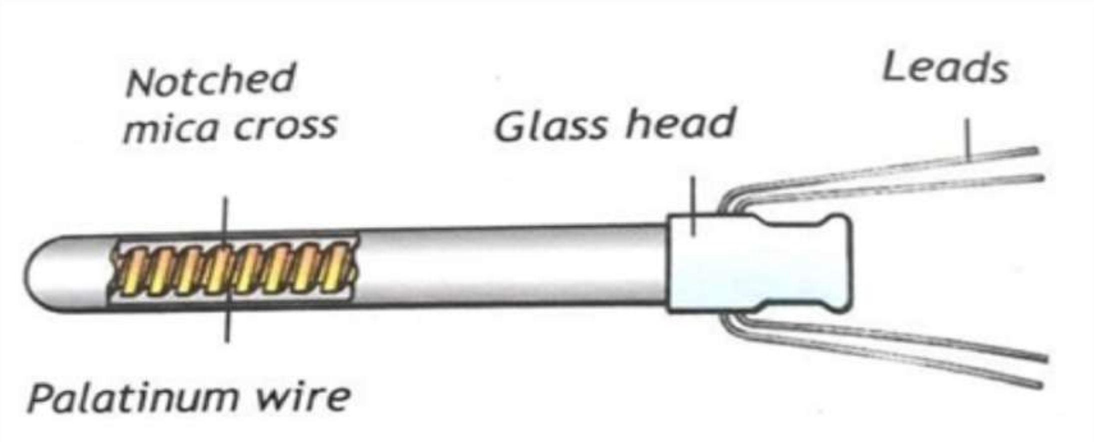
The LDR gives a signal, and current is controlled by relay.

It is used in light-sensing applications including lighting control, photography and security systems. LDRs are versatile and cost-effective components used to detect and respond to changes, in high levels.

SCIENCETIDBITS

Resistance thermometers, also called Resistance Temperature Detectors (RTDs), are sensors used to measure temperature by correlating the resistance of the RTD element with temperature. Most RTD elements consist of a length of fine coiled wire wrapped around a ceramic or glass core. The RTD element is made from a pure material such as Platinum, Nickel, or Copper that has a predictable change in resistance as the temperature changes; it is this predictable change that is used to determine temperature.

Platinum is the best metal for RTDs because it follows a very linear resistance-temperature relationship and it follows the R vs T relationship in a highly repeatable manner over a wide temperature range. The unique properties of platinum make it the material of choice for temperature standards with the range from -185 °C to 630°C.



SHORT RESPONSE QUESTIONS:

1. What is a linear resistor?

Answer: A linear resistor is a type of resistor in which the current through it is directly proportional to the applied voltage, following Ohm's law. The resistance remains constant regardless of the applied voltage or current. Linear resistors are used in circuits where predictable current flow is necessary. They are divided into fixed and variable types. Fixed resistors have a constant resistance, while variable resistors allow adjustment. Linear resistors are essential for controlling current in electronic devices. Their main function is to limit or regulate current. They are widely used in power supplies and signal circuits.

2. What is a fixed resistor?

Answer: A fixed resistor is a resistor that has a single, unchanging resistance value. It is made from materials such as carbon, metal oxide, or wire-wound materials. Fixed resistors can be readily attached to a circuit and are stable under normal operating conditions. They are less affected by temperature, but high temperatures can slightly change their resistance. Fixed resistors are used to limit current, divide voltage, or protect circuits. They form the backbone of most electronic circuits where precise resistance is required. Their main advantage is reliability and stability over long periods.

3. What materials are used for fixed resistors?

Answer: Fixed resistors are commonly made of carbon, metal film, or wire-wound materials. Carbon resistors are inexpensive and widely used in basic electronic circuits. Metal film resistors provide higher precision and stability. Wire-wound resistors are used for high power applications because they can handle high currents and voltages. The choice of material depends on the desired resistance accuracy, temperature stability, and power rating. Metal alloys like nickel-chromium are often used for high-temperature applications. These materials ensure reliable and consistent operation in circuits.

4. Why are fixed resistors considered less stable at high temperatures?

Answer: Fixed resistors are generally stable, but their resistance can change slightly with temperature. High temperatures cause expansion of materials, affecting electron flow and resistance. Carbon resistors are more temperature-sensitive than metal film or wire-wound resistors. The temperature coefficient defines how much the resistance changes per degree of temperature change. For precision circuits, low-temperature coefficient resistors are preferred. Temperature instability may affect sensitive applications like amplifiers or sensors. Therefore, environmental conditions should be considered in resistor selection.

5. What is the purpose of a linear resistor in a circuit?

Answer: The purpose of a linear resistor is to control current and voltage in a predictable manner. Since it obeys Ohm's law, designers can calculate current flow accurately. Linear resistors protect components from excessive current, divide voltage, and create reference voltages. They are also used in signal conditioning and timing circuits. Fixed resistors provide constant resistance, while variable resistors allow tuning of circuit parameters. Their predictable behavior is essential for stable and reliable circuit operation. Linear resistors are the backbone of most electronic systems.

6. What is a variable resistor?

Answer: A variable resistor is a resistor whose resistance value can be adjusted mechanically. It allows fine control of current or voltage in a circuit. Wire-wound variable resistors have a known length of wire wound around an insulating core. Sliding or rotary contacts change the effective wire length, altering resistance. Variable resistors are used in rheostats and potentiometers. They provide flexibility in testing circuits and controlling signal levels. They are widely used in applications like volume controls, light dimmers, and sensor calibration.

7. How does a rheostat work?

Answer: A rheostat is a variable resistor used to control current in a circuit. It is usually connected in series with the load. By moving the slider along the wire-wound coil, the effective resistance changes, limiting the current. Rheostats can handle high currents and are used in motor speed controls and heating applications. The resistance adjustment allows gradual change in current, preventing sudden surges. Nickel or chromium wires are commonly used for high stability. Rheostats are simple, reliable devices for controlling current flow.

8. How does a potentiometer differ from a rheostat?

Answer: A potentiometer is a three-terminal variable resistor used to divide voltage. Unlike a rheostat, it can measure or adjust voltage rather than just limit current. It acts as a voltage divider by connecting a sliding contact across a resistive track. By moving the slider, different fractions of input voltage are obtained. Potentiometers are used in volume controls, adjustable power supplies, and calibration circuits. They are precise devices that provide variable voltage without changing current significantly. Rheostats are generally two-terminal devices for current control, while potentiometers provide voltage control.

9. What is the principle of a potential divider?

Answer: A potential divider is a circuit that divides the input voltage into smaller fractions. It consists of two or more resistors in series. The output voltage depends on the ratio of resistances and can be adjusted by a variable resistor. Potential dividers are used to obtain reference voltages or variable voltage for circuits. The voltage at a specific point can be calculated using $V_{out} = (R2/(R1+R2))\ V_{in}$. They are used in volume controls, sensor circuits, and voltage measurement devices. Proper resistor selection ensures accurate voltage division.

10. How is output voltage calculated in a potential divider?

Answer: The output voltage (Vout) is a fraction of the input voltage (Vin). Using Ohm's law, if two resistors R1 and R2 are in series, Vout = (R2/(R1+R2)) Vin. Adjusting R2 or using a sliding contact changes the output voltage. This principle is used in potentiometers for adjustable voltage. The divider allows a circuit to obtain precise voltages from a single source. Voltage division is critical for reference levels and input signal adjustments. It is widely used in analog circuits and sensors.

11. Why are wire-wound resistors used in variable resistors?

Answer: Wire-wound resistors provide high stability, accuracy, and power handling. The wire's known length allows precise resistance control. Increasing the wire length increases resistance proportionally. Sliding contacts vary the effective length to change resistance. Wire-wound resistors handle heat better than carbon or metal film types. They are used in precision instruments, rheostats, and potentiometers. Their durability ensures long-term performance in high-current applications.

12. What is the function of the slider or wiper in a potentiometer?

Answer: The slider or wiper moves along the resistive element to select a specific resistance. In a potential divider, it selects the fraction of voltage delivered to the output. The movement can be linear or rotary. By adjusting the slider, the output voltage is controlled precisely. Wipers ensure continuous adjustment without breaking the circuit. They are essential for tuning voltage levels in electronics. Wipers allow variable voltage while keeping the current stable.

13. What materials are used for potentiometer resistive tracks?

Answer: Potentiometer tracks are made of carbon, cermet, or conductive plastic. Carbon is common for low-cost applications.

Cermet provides high stability and low temperature coefficient. Conductive plastics offer smooth sliding action and high precision. The choice depends on required accuracy and environmental stability. High-quality potentiometers are used in audio equipment and precision instruments. Material selection affects durability, noise, and resistance stability.

14. How is accuracy maintained in a variable resistor?

Answer: Accuracy is achieved by using materials with low temperature coefficient, precise winding, and smooth wipers. Wire-wound resistors provide exact resistance per unit length. High-quality potentiometers have linear tapering for predictable output. Encapsulation prevents mechanical damage and environmental effects. Accurate resistance ensures correct current and voltage in sensitive circuits. Proper design reduces noise and ensures reliability. Accuracy is crucial for measurement and control applications.

15. Why is resistance higher in longer wire in a rheostat?

Answer: Resistance is proportional to wire length and inversely proportional to cross-sectional area. Longer wire provides more opposition to current flow. In a rheostat, changing the effective wire length controls current. Nickel-chromium wires are preferred for stability at high temperature. The principle is based on Ohm's law: $R = \rho L/A$. Adjustable resistance allows smooth control of current. This property is utilized in motors, heaters, and laboratory circuits.

16. What is a thermistor?

Answer: A thermistor is a resistor whose resistance varies significantly with temperature. It can either increase resistance with temperature (PTC) or decrease (NTC). Thermistors are made from semiconductors, ceramic, or polymer materials. They are used in temperature sensing, inrush current limiting, and overheat protection. Thermistors provide precise and fast response to temperature changes. They are widely used in circuits for monitoring and controlling temperature. They are non-linear because their resistance does not follow Ohm's law.

17. What is an NTC thermistor?

Answer: NTC (Negative Temperature Coefficient) thermistors decrease resistance with increasing temperature. At low temperatures, resistance is high, limiting current. As the temperature rises, resistance drops, allowing more current. NTC thermistors are used in inrush current limiters, sensors, and temperature measurement circuits. They protect circuits from surges during startup. Semiconductor materials provide fast response. NTC thermistors are essential in electronics for safe and precise operation.

18. What is a PTC thermistor?

Answer: PTC (Positive Temperature Coefficient) thermistors increase resistance with temperature rise. They are used in overcurrent protection and self-regulating heaters. When temperature rises, resistance rises, reducing current flow automatically. PTC thermistors maintain safety in motors, transformers, and generators. Their behavior is opposite to NTC thermistors. PTC thermistors are reliable for monitoring and control. They prevent overheating and ensure stable operation.

19. How do thermistors limit inrush current?

Answer: NTC thermistors initially have high resistance, limiting the surge of current at startup. As the device warms, resistance decreases, allowing normal current flow. This prevents damage to bulbs, motors, and electronic circuits. They provide a simple and passive method of current limiting. Thermistors react quickly to temperature changes. They are inexpensive and reliable. Inrush current limitation ensures longer life for electrical devices.

20. How are thermistors used in temperature measurement?

Answer: Thermistors change resistance with temperature, which can be measured in circuits. The voltage across a thermistor is proportional to its resistance. This voltage can be calibrated to correspond to temperature. High sensitivity allows accurate detection of small changes. Thermistors are used in thermostats, ovens, and environmental sensors. Their fast response makes them suitable for real-time monitoring. Proper calibration ensures precise temperature readings.

21. What is a varistor and its function?

Answer: A varistor, or Voltage Dependent Resistor (VDR), is a non-linear resistor whose resistance decreases with increasing voltage. It is primarily used to protect circuits from voltage surges and spikes. At normal voltages, its resistance is high, allowing little current to pass. When a sudden voltage spike occurs, resistance drops, diverting excess current safely. Varistors are used in lightning protection, surge protectors, and sensitive electronics. Zinc oxide (ZnO) is the most common material used. They prevent damage to components by clamping voltage levels effectively.

22. Why are varistors non-linear resistors?

Answer: Varistors are non-linear because their resistance changes dramatically with applied voltage, unlike linear resistors which follow Ohm's law. At low voltages, they behave like insulators with high resistance. At voltages above a threshold, resistance drops, allowing current to flow. This behavior protects electronic devices from sudden surges. Non-linear characteristics are due to grain boundaries in zinc oxide or metal oxide materials. Varistors are widely used in power electronics and protective circuits. Their fast response ensures safety during voltage fluctuations.

23. How does a varistor protect circuits from surges?

Answer: A varistor limits voltage spikes by lowering its resistance when voltage exceeds a safe limit. This allows excess current to bypass sensitive components. Once the surge ends, resistance returns to normal, allowing regular operation. They are commonly installed across power lines or parallel to loads. This method is simple, passive, and effective in transient suppression. Varistors prevent damage to semiconductors, motors, and lighting systems. Proper voltage rating selection is critical for effective protection.

24. Where are varistors commonly used?

Answer: Varistors are used in surge protectors, lightning arresters, motor drives, and power supplies. They are placed across AC mains, transformers, or sensitive equipment to absorb voltage spikes. Their fast response prevents transient voltages from reaching critical components. Industrial and household electronics rely on varistors for protection. Zinc oxide-based varistors are popular due to low cost and high efficiency. They are essential for high-voltage environments where surges are common. Varistors ensure device longevity and safe operation.

25. What is the principle behind a varistor?

Answer: The principle of a varistor is based on non-linear resistance of semiconductor grains. At normal voltages, resistance is high, allowing negligible current. When voltage exceeds a threshold, resistance drops sharply, diverting excess current. Grain boundaries in zinc oxide create diode-like junctions responsible for this behavior. This principle enables the varistor to act as a voltage clamp. The device automatically adjusts to protect circuits from surges. It's widely used in power electronics for over-voltage protection.

26. What is an LDR?

Answer: A Light Dependent Resistor (LDR) is a resistor whose resistance decreases with increasing light intensity. It is a non-linear device, used to sense light levels. Materials like cadmium sulfide (CdS) are used for the photosensitive surface. In darkness, resistance is high, and in bright light, resistance drops significantly. LDRs are commonly used in streetlights, automatic brightness control, and alarm circuits. They provide a simple method to convert light intensity into electrical signals. The response is slow compared to electronic photodiodes but sufficient for many applications.

27. How does an LDR work in a light sensor circuit?

Answer: An LDR works by changing its resistance according to light intensity. In darkness, its resistance is high, limiting current flow. When exposed to light, resistance drops, allowing more current through the circuit. This change can be measured as voltage across the LDR or converted to logic signals. Circuits use this property to turn on lights automatically at night. LDRs are simple, low-cost, and easy to implement. Their non-linear response requires calibration for precise applications. They are widely used in security systems and automatic lighting.

28. What are the materials used in LDRs?

Answer: LDRs are commonly made of cadmium sulfide (CdS), cadmium selenide (CdSe), or lead sulfide (PbS). CdS is most popular due to its good sensitivity to visible light. Semiconductor layers are deposited on insulating substrates, forming a photosensitive surface. The resistance of these materials drops under illumination. Choice of material depends on spectral response, sensitivity, and environmental conditions. Modern LDRs may also use thin-film or nanomaterials for better performance. Material quality ensures durability and stable light response.

29. Where are LDRs applied?

Answer: LDRs are used in automatic street lighting, camera light meters, alarm systems, and solar trackers. They detect light levels and convert them into electrical signals. In streetlights, LDRs turn lights on at dusk and off at dawn automatically. In cameras, they adjust exposure according to light intensity. LDRs are simple, passive sensors that don't require a power source themselves. They are widely used in educational electronics projects. Their non-linear response requires calibration in precise measurement systems.

30. Why is LDR considered a non-linear resistor?

Answer: LDRs are non-linear because their resistance does not change proportionally with light intensity. Small changes in light can produce large changes in resistance. This behavior allows sensitive detection of environmental light. The relationship between resistance and illumination is logarithmic. Non-linear behavior is advantageous for automatic control systems like lights or alarms. It provides fast response to significant light changes. Proper circuit design ensures accurate conversion of light intensity to voltage or current signals.

31. How does a potential divider provide a variable output voltage?

Answer: A potential divider uses resistors in series to split input voltage into a fraction. The output is taken across one resistor or a combination of resistors. Using a variable resistor or potentiometer allows adjustment of this fraction. The output voltage can be calculated using $V_{out} = (R2/(R1+R2)) V_{in}$. It is widely used in adjustable power supplies, sensors, and audio controls. The ratio of resistances determines the output voltage. Careful selection of resistors ensures smooth and accurate voltage adjustment.

32. How is a potential divider used in volume control?

Answer: In audio circuits, a potentiometer acts as a variable resistor to divide the input signal voltage. Sliding the wiper changes the voltage applied to the amplifier or speaker. This adjusts the sound level without affecting the source signal. The output voltage is proportional to the wiper position. It allows smooth and continuous control of volume. This method is simple, cost-effective, and widely used in consumer electronics. Proper design prevents distortion and maintains signal integrity.

33. Why is a potential divider important in sensor circuits?

Answer: Sensor circuits often require specific voltage levels to operate. A potential divider converts a higher supply voltage into the required lower voltage. By adjusting resistances, the voltage can match the sensor's input range. It also allows calibration of the sensor for accurate measurement. Many analog sensors use a potential divider to convert resistance changes into measurable voltage. This ensures precise readings in electronic monitoring systems. Without voltage division, sensors may be damaged or provide incorrect output.

34. How is an NTC thermistor used in an inrush current limiter?

Answer: An NTC thermistor has high resistance at room temperature, limiting initial current during startup. As current flows, it heats up, reducing resistance and allowing normal operating current. This protects devices like motors, lamps, and power supplies from current surges. It is a simple and passive method for current control. NTC thermistors react quickly to temperature, ensuring smooth operation. They prevent fuses from blowing and increase component lifespan. The principle relies on the negative temperature coefficient of resistance.

35. How does a PTC thermistor prevent overheating?

Answer: A PTC thermistor increases resistance as temperature rises. When current increases and heat build up, the resistance rises, reducing current automatically. This self-regulating behaviour prevents devices from overheating. PTC thermistors are used in motors, heaters, and transformers. Once the temperature drops, resistance decreases, restoring normal operation. It provides a reliable and automatic protection mechanism. PTC thermistors reduce the need for fuses or complex electronic protection circuits.

36. How do LDRs and potential dividers work together in light-sensitive circuits?

Answer: LDRs are often connected as part of a potential divider.

The varying resistance of the LDR changes the voltage across it as light intensity changes. This voltage can be measured or used to trigger switches, transistors, or relays. The combination allows automatic control of lights, alarms, and sensors. Proper resistor selection ensures the output voltage changes proportionally to light. It is a simple, passive, and effective way to convert light intensity to electrical signals. LDR-potential divider circuits are common in streetlights and environmental monitoring.

37. How does a varistor differ from a thermistor?

Answer: A varistor responds to voltage changes, while a thermistor responds to temperature changes. Varistors protect circuits from surges, whereas thermistors measure or control temperature. Both are non-linear resistors, but the triggering parameter differs. Varistors respond instantly to voltage spikes, while thermistors respond gradually to temperature changes. They are used in complementary applications for protection and sensing. Material composition is different: ZnO for varistors, semiconductors for thermistors. Both enhance circuit reliability in their respective domains.

38. How does a potentiometer act as a sensor?

Answer: A potentiometer can convert mechanical displacement into voltage. Moving the slider changes the resistance ratio in a potential divider, creating a proportional voltage output. This voltage can be measured to determine position, angle, or linear displacement. It is widely used in joystick controls, robotics, and industrial machines. The output voltage is continuous and smooth. High precision potentiometers allow accurate position sensing. This makes them effective sensors in both analog and digital systems.

39. What are the advantages of using a wire-wound rheostat?

Answer: Wire-wound rheostats can handle high currents and dissipate heat effectively. They offer precise and stable resistance. Wire material, usually nickel-chromium, has a low temperature coefficient. The mechanical slider allows smooth adjustment. They are durable and suitable for industrial applications. Wire-wound rheostats provide predictable control of current. They are ideal for motors, heaters, and lab experiments requiring high current adjustments.

40. How is an LDR used in street lighting systems?

Answer: LDRs detect ambient light intensity in streetlights. When it gets dark, the LDR resistance increases, causing a higher voltage at a control circuit. This triggers the lamp to turn on. When light returns, resistance decreases, turning the lamp off automatically. The system is energy-efficient and requires minimal manual intervention. LDRs provide a simple and reliable way to automate lighting. Proper calibration ensures lights switch at the desired light level.

41. How does a varistor limit high voltage in AC mains? Answer: Varistors are connected in parallel across AC mains. Under normal voltage, resistance is high and current flow is negligible. When voltage exceeds a threshold, resistance drops sharply, allowing excess current to bypass the load. This protects appliances from transient spikes caused by lightning or switching. Once voltage returns to normal, resistance increases again. Zinc oxide grain boundaries provide fast response. Varistors prevent damage to sensitive electronics efficiently.

42. Why are NTC thermistors preferred for temperature measurement?

Answer: NTC thermistors provide a significant and predictable decrease in resistance with rising temperature. This allows precise measurement of temperature changes. They respond quickly to temperature variations due to low thermal mass. Voltage across the thermistor can be converted to temperature using calibration curves. They are inexpensive and compact. NTC thermistors are widely used in thermostats, incubators, and temperature sensors. Their high sensitivity makes them ideal for accurate monitoring.

43. How does a PTC thermistor self-regulate current?

Answer: As current increases, the thermistor heats up and resistance rises. This limits the current automatically, preventing overheating. When temperature drops, resistance decreases, restoring normal current. PTC thermistors are used in motors, heaters, and transformers for safe operation. They provide automatic protection without additional components. The self-regulating behavior improves reliability and reduces risk of damage. They are simple and cost-effective devices for current control.

44. How does a potential divider help in sensor interfacing?

Answer: A potential divider converts variable resistance from a sensor into a measurable voltage. For example, an LDR or thermistor can form one part of a voltage divider. The output voltage changes according to resistance variation, allowing microcontrollers to read sensor values. It is a simple interface method for analog sensors. Proper resistor selection ensures linear or proportional output. Voltage division is critical for accurate sensor data acquisition. It is widely used in industrial and consumer electronics.

45. How does a potentiometer control brightness in lamps?

Answer: The potentiometer forms a variable voltage divider with the lamp circuit. Adjusting the slider changes voltage applied to the lamp, controlling current flow. Higher voltage increases brightness, while lower voltage reduces it. This method allows smooth and continuous dimming. It is commonly used in table lamps, studio lights, and LEDs. Potentiometer control is simple and cost-effective. Proper design prevents sudden flickers and ensures smooth operation.

46. What are the limitations of an LDR?

Answer: LDRs respond slowly compared to photodiodes or phototransistors. They have a non-linear response, requiring calibration for precise applications. They are sensitive to temperature and environmental conditions. Their durability may be limited under prolonged exposure to sunlight. LDRs are suitable for general-purpose sensing but not high-speed or highly accurate systems. They are mainly used where approximate light measurement suffices. Careful placement ensures reliable performance.

47. How is a varistor rated for use in circuits?

Answer: Varistors are rated by maximum voltage, energy absorption capacity, and clamping voltage. Maximum voltage defines the limit beyond which resistance drops. Energy absorption indicates how much surge it can safely dissipate. Clamping voltage determines the voltage at which it activates. Proper rating ensures protection without nuisance triggering. Selection depends on mains voltage and device sensitivity. Varistors prevent damage from lightning and switching transients. Correct rating ensures circuit reliability.

48. How does combining a thermistor and potential divider help in measurement?

Answer: A thermistor's changing resistance is connected in a potential divider. As temperature changes, voltage across the thermistor changes proportionally. This voltage can be measured or converted to temperature readings. The combination allows easy analog-to-digital conversion for microcontrollers. Calibration ensures accurate temperature mapping. This method is simple, low-cost, and reliable. It is widely used in thermostats, industrial sensors, and electronic monitoring systems.

49. How do PTC and NTC thermistors differ in applications?

Answer: NTC thermistors are used where resistance must decrease with temperature, such as in inrush current limiters and sensors. PTC thermistors are used where resistance must increase with temperature, such as overcurrent protection or self-regulating heaters. NTC provides fast response and precise measurement. PTC provides automatic protection and current limiting. Both are non-linear resistors but serve complementary purposes. Choice depends on whether temperature rise should increase or decrease current.

50. How does a potential divider help in interfacing LDRs for automatic lighting?

Answer: An LDR is connected as one resistor in a potential divider circuit. As light decreases, LDR resistance increases, changing voltage at the output. This output triggers a transistor or relay to turn on the light automatically. When light increases, voltage changes back, turning off the light. The potential divider converts resistance change into a measurable voltage signal. This setup allows reliable, simple, and energy-efficient automatic street lighting. It is widely used in homes, streets, and garden lighting systems.

MCQS

1. Linear resistors obey which law?

A) Newton's law

B) Ohm's law

C) Faraday's law

D) Lenz's law

Correct: B

Explanation: Linear resistors follow Ohm's law where $V \propto I$.

2. In linear resistors, current is proportional to:

A) Resistance

B) Length

C) Voltage

D) Temperature

Correct: C

Explanation: Current increases when voltage increases.

3. A fixed resistor has:

A) Variable value

B) Constant value

C) Zero value

D) Infinite value

Correct: B

Explanation: Fixed resistors are made to keep one resistance.

4. Fixed resistors are commonly made of:

A) Rubber

B) Wood

C) Carbon

D) Plastic

Correct: C

Explanation: Carbon provides stable resistance.

5. Fixed resistors are slightly affected by:

A) Color

B) Pressure

C) Temperature

D) Size

Correct: C

Explanation: Resistance changes slightly with temperature.

6. Variable resistors allow:

A) Voltage storage

B) Resistance change

C) Heat flow

D) Charge creation

Correct: B

Explanation: Their resistance can be adjusted.

7. Variable resistors work by:

A) Heating

B) Cooling

C) Mechanical movement

D) Magnetism

Correct: C

Explanation: A slider or knob changes resistance.

8. High-accuracy variable resistors are usually:

A) Plastic

B) Wire-wound

C) Rubber

D) Paper

Correct: B

Explanation: Wire-wound resistors are precise.

9. Increasing wire length makes resistance:

A) Decrease

B) Zero

C) Increase

D) Same

Correct: C

Explanation: Longer wire gives more opposition.

10. Nickel-chromium wire is used due to:

A) Shine

B) Cost

C) Low temp. coefficient

D) Weight

Correct: C

Explanation: Its resistance doesn't change much with heat.

Rheostat & Potentiometer

11. Rheostat controls:

A) Voltage

B) Power

C) Current

D) Heat

Correct: C

Explanation: It adjusts current in circuit.

12. Potentiometer works as:

A) Fuse

B) Voltage divider

C) Battery

D) Heater

Correct: B

Explanation: It divides voltage.

13. Sliding contact changes:

A) Voltage source

B) Length of wire

C) Color

D) Battery

Correct: B

Explanation: Effective wire length changes.

14. Rheostat is connected in:

A) Series

B) Parallel

C) Both

D) None

Correct: A

Explanation: It controls current in series.

15. Potentiometer divides:

A) Charge

B) Power

C) Voltage

D) Heat

Correct: C

Explanation: Output is fraction of input voltage.

16. Rheostat symbol is:

A) Fixed resistor

B) Variable resistor
C) Battery
D) Switch
Correct: B
Explanation: It shows adjustable resistance.
17. Potentiometer has:
A) 1 terminal
B) 2 terminals
C) 3 terminals
D) 4 terminals
Correct: C
Explanation: Two ends + one slider.
18. Sliding contact is called:
A) Fuse
B) Wiper
C) Node
D) Coil
Correct: B
Explanation: The moving contact is wiper.
19. Rheostat mainly controls:
A) Voltage
B) Current
C) Power
D) Charge
Correct: B
Explanation: It limits current.
20. Potentiometer can act as:
A) Fixed resistor
B) Motor
C) Generator
D) Switch
Correct: A

Explanation: Using two terminals only.

Potential Divider

21. Potential divider divides:

A) Current

B) Voltage

C) Power

D) Charge

Correct: B

Explanation: It splits voltage.

22. Output voltage is:

A) Greater

B) Fraction

C) Zero

D) Infinite

Correct: B

Explanation: Always part of input.

23. Formula is:

A) V=IR

B) $V_{out}=R_2/(R_1+R_2)V_{in}$

C) P=VI

D) Q=CV

Correct: B

Explanation: Standard divider formula.

24. If $R_1=R_2$ then Vout:

A) Vin

B) Vin/3

C) Vin/2

D) 2Vin

Correct: C

Explanation: Voltage splits equally.

25. Used in:

A) Cooking

B) Volume control

C) Heating

D) Printing

Correct: B

Explanation: Adjusts signal level.

26. Moving slider changes:

A) Input

B) Output

C) Battery

D) Wire

Correct: B

Explanation: Output depends on position.

27. Divider resistors are in:

A) Series

B) Parallel

C) Both

D) None

Correct: A

Explanation: Needed for division.

28. Output depends on:

A) Color

B) Ratio

C) Size

D) Shape

Correct: B

Explanation: Resistance ratio matters.

29. Used in music system:

A) Switch

B) Divider

C) Fuse

D) Bulb

Correct: B

Explanation: Volume control uses it.

30. Divider is:

A) Complex

B) Simple

C) Magnetic

D) Optical

Correct: B

Explanation: Basic circuit.

Thermistors

31. Thermistor means:

A) Heat battery

B) Thermal resistor

C) Fuse

D) Motor

Correct: B

Explanation: Heat-sensitive resistor.

32. Thermistors are temp-sensitive:

A) True

B) False

Correct: A

Explanation: Their resistance changes with temp.

33. Made from:

A) Wood

B) Semiconductor ceramic

C) Iron

D) Plastic

Correct: B

Explanation: Semiconductors respond to heat.

34. PTC means:

A) Power control

B) Positive temp. coefficient

C) Partial control

D) Potential change

Correct: B

Explanation: Resistance increases with temp.

35. PTC resistance:

A) Decreases

B) Increases

C) Constant

D) Zero

Correct: B

Explanation: Higher temp → higher resistance.

36. NTC resistance:

A) Increases

B) Decreases

C) Constant

D) Doubles

Correct: B

Explanation: Higher temp → lower resistance.

37. NTC used as:

A) Heater

B) Inrush limiter

C) Bulb

D) Fuse

Correct: B

Explanation: Limits starting current.

38. Thermistors used in:

A) Temp measurement

B) Painting

C) Sound

D) Light

Correct: A

Explanation: Sensitive to temp.

39. NTC has high resistance at:

A) High temp
B) Low temp
C) Medium
D) All
Correct: B
Explanation: Cold → high resistance.
40. Thermistors respond to:
A) Pressure
B) Heat
C) Sound
D) Light
Correct: B
Explanation: Heat changes resistance.
Varistors (VDR)
41. VDR stands for:
A) Variable resistor
B) Voltage dependent resistor
C) Vertical resistor
D) Voltage divider resistor
Correct: B
Explanation: Resistance depends on voltage.
42. Protects from:
A) Heat
B) Light
C) Voltage spikes
D) Pressure
Correct: C
Explanation: Absorbs surges.
43. Made from:
A) Iron
B) Zinc oxide
C) Copper

D) Carbon

Correct: B

Explanation: ZnO is common.

44. Resistance changes with:

A) Current

B) Voltage

C) Temp

D) Size

Correct: B

Explanation: Voltage affects it.

45. Used in lightning protection:

A) True

B) False

Correct: A

Explanation: Stops surge damage.

46. Varistor reduces:

A) Heat

B) Current

C) Voltage surge

D) Power

Correct: C

Explanation: Clamps high voltage.

47. Connected in:

A) Series

B) Parallel

C) Both

D) None

Correct: B

Explanation: Across device.

48. Grain boundaries act as:

A) Colors

B) Non-linear junctions

C) Size factors

D) Strength

Correct: B

Explanation: Provide V-dependent action.

49. Varistor acts as:

A) Sensor

B) Protector

C) Motor

D) Generator

Correct: B

Explanation: Protects circuits.

50. Varistor is non-linear:

A) True

B) False

Correct: A

Explanation: Does not follow Ohm's law.

LDR

51. LDR is also called:

A) Thermistor

B) Photocell

C) Fuse

D) VDR

Correct: B

Explanation: Responds to light.

52. LDR senses:

A) Heat

B) Light

C) Sound

D) Pressure

Correct: B

Explanation: Light controls resistance.

53. In low light resistance is:

A) Low

B) High

C) Zero

D) Same

Correct: B

Explanation: Darkness → high resistance.

54. In bright light resistance is:

A) High

B) Low

C) Same

D) Infinite

Correct: B

Explanation: Light lowers resistance.

55. Used in:

A) Auto lights

B) Fans

C) Motors

D) Heaters

Correct: A

Explanation: Turns lights on/off.

56. Made from:

A) Cadmium sulfide

B) Iron

C) Silver

D) Gold

Correct: A

Explanation: CdS is light-sensitive.

57. Serpentine pattern:

A) Decoration

B) More exposure

C) Cooling

D) Strength

Correct: B

Explanation: Captures more light.

58. Used in security systems:

A) True

B) False

Correct: A

Explanation: Detects light changes.

59. LDR is:

A) Linear

B) Non-linear

C) Fixed

D) Metallic

Correct: B

Explanation: Doesn't obey Ohm's law.

60. Detects:

A) Voltage

B) Light level

C) Current

D) Heat

Correct: B

Explanation: Works as light sensor.

Mixed HOT

61. Rheostat & potentiometer are:

A) Fixed

B) Variable

C) Non-resistors

D) Cells

Correct: B

Explanation: Both adjustable.

62. Thermistor is:

A) Linear

B) Non-linear

C) Fixed

D) Metallic

Correct: B

Explanation: Temp changes resistance.

63. LDR depends on:

A) Heat

B) Voltage

C) Light

D) Pressure

Correct: C

Explanation: Light controls it.

64. Divider output is:

A) Fraction

B) Double

C) Zero

D) Infinite

Correct: A

Explanation: Part of input.

65. Varistor protects from:

A) Heat

B) Shock

C) Voltage spikes

D) Sound

Correct: C

Explanation: Stops surges.

66. Fixed resistors follow:

A) Ohm's law

B) Newton's law

C) Hooke's law

D) Boyle's law

Correct: A

Explanation: Linear relation.

67. Slider adjusts:

A) Battery

B) Length

C) Voltage source

D) Color

Correct: B

Explanation: Changes resistance.

68. NTC useful for:

A) Heating

B) Current limiting

C) Sound

D) Light

Correct: B

Explanation: High cold resistance limits current.

69. PTC used for:

A) Temp sensing

B) Voltage drops

C) Sound

D) Colour

Correct: A

Explanation: Detects temp rise.

70. LDR, thermistor, varistor are:

A) Linear

B) Non-linear

C) Fixed

D) Metallic

Correct: B

Explanation: Their resistance varies with conditions.

PKMZ

Acha dekho bhai, upar wala (Battery/EMF) ne decide kia ke wo 12 volt = 12 arab rupey neeche bhejey ga. Ab yeh paisa jaye ga series combination me;

Awam (R_1), Provincial Govt (R_2), Federal Govt (R_3)

Ab sab ek hi line mein hai koi shortcut nahi is liye current sab jagah same hai.

Jitna **flow** awam ko pass se guzra utna hi provincial or federal ke pass se guzrey ga lekin **voltage** divide hoti hai.

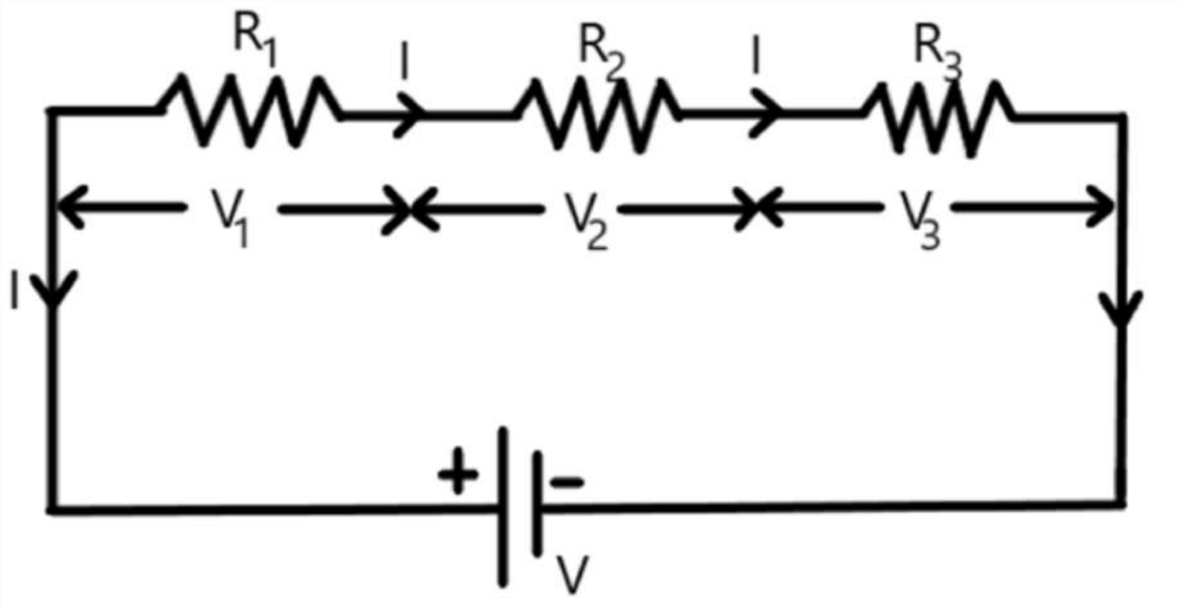
Federal Govt: "Hum system chalate hain" → 7 volt (7 arab) le liye.

Provincial Govt: "Hum pura soba chalate hain" → 4 volt (4 arab) le liye.

Awam: "Piche bacha 1 volt (1 arab) wo mila gareeb awam ko.

Toh total 12V distribute hogi (7 + 4 + 1).

Combination of Resistors



Detail:

In a series circuit, there is only path for charges to follow, so the same current Flows in each device. In such a circuit, the Voltage is divided an among the devices the voltage on first devices plus voltage on second device and so on, equals the voltage of power supply.

For Example: If three lightbulbs with the same resistance are connected in the series to a 12-volt battery, the voltage on each bulb is 4volts. If bulbs had different resistances, each one's share of voltage would be proportional to its resistance. If the resistors are in series, the current I must be same in all of them.

Derivation:

(i) Potential Difference (V): -

Since, the resistors. in are connected series, then, the voltage will drop across each resistor have:-So, we

=) Vnet = V1 + V2 + V3 - (i)

(ii) Current (I): -

Since, the resistors are connected in series so, the Current will same across each resistor.

$I1 = I2 = I3 = I$ −(ii)

R_1

R_1	R_2	R_3
Since from Ohm's Law $V_1 = I_1R_1$ Since I is same $I_1 = I$ $V_1 = IR_1 \rightarrow$ (iii)	Since from Ohm's Law $V_2 = I_2R_2$ Since I is same $I_2 = I$ $V_2 = IR_2 \rightarrow$ (iv)	Since from Ohm's Law $V_3 = I_3R_3$ Since I is same $I_3 = I$ $V_3 = IR_3 \rightarrow$ (v)

Putting eq. (iii), (iv) and (v) in eq. (i) then:

$V_{net} = IR_1 + IR_2 + IR_3$

$V = I(R_1 + R_2 + R_3)$

$V/I = (R_1 + R_2 + R_3)$

⇒ **Total voltage / Total current = Equivalent Resistance**

$V/I = R_{eq}$ ⇒ **$R_{eq} = V/I$**

$R_{eq} = R_1 + R_2 + R_3$

Let we have "n" number of resistors then:

$R_{eq} = R_1 + R_2 + R_3 + ... R_n$

 # $R_{eq} > R_{Ind}$ ~ In series combination the equivalent resistance will be greater than individual Resistance.

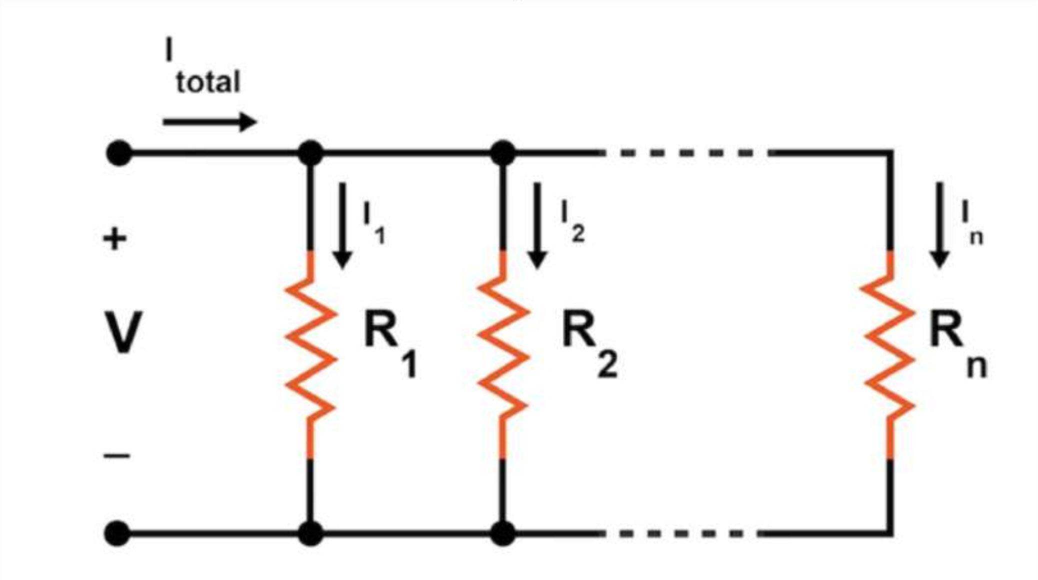
2) Resistors in Parallel

PKMZ

In series, battery (IMF) ne kaha ke is tarah to larai ka khatra hai to inho ne sab me voltage (arab Rs) baant dia taake larai na ho jabke current same nahi hoga because parallel me hai or yeh depend karta ha resistors ki strength par jabke voltage isliye same hai ke har resistor independent laga hua hai battery se.

Detail:

In parallel circuit, the current through the power supply is "shared" among the devices while each has the same voltage. The current flowing in the first device plus the current in second device and so on equals the current output by power supply. The voltage is same because independent all resistors are independent of each other while current is different because of nature and strength of each resistor. In this case, there is more than one path for charges to flow. In this case, three, if one of the devices burns out or is removed, the others still function.



Derivation:

(i) Potential Difference (V): –

Since, the resistors are connected in parallel. So voltage across each. resistor will be same.

$V_1 = V_2 = V3 = V$-- (i)

(ii) Current (I): –

Since, the resistors are connected in parallel so current will not be same due to different nature of resistor.

Inet =I1+I2+I3-- (ii)

Since from Ohm's Law	**Since from Ohm's Law**	**Since from Ohm's Law**
$V_1 = I_1R_1$	$V_2 = I_2R_2$	$V_3 = I_3R_3$
$V_1/R_1 = I_1$	$I_2 = V_2/R_2$	$I_3 = V_3/R_3$
$\therefore V_1 = V$	$\therefore V_2 = V$	$\therefore V_3 = V$
$\mathbf{I_1 = V/R_1 \rightarrow (iii)}$	$\mathbf{I_2 = V/R_2 \rightarrow (iv)}$	$\mathbf{I_3 = V/R_3 \rightarrow (v)}$

Putting eq. (iii), (iv) and (v) in eq. (ii) then:

$I = V/R_1 + V/R_2 + V/R_3$

$I = V(1/R_1 + 1/R_2 + 1/R_3)$

$\mathbf{I/V = 1/R_1 + 1/R_2 + 1/R_3}$ → (vi)

Since from Ohm's Law:

$V = IReq \Rightarrow V/I = Req \Rightarrow$ **$I/V = 1/Req$**

$\mathbf{1/Req = 1/R_1 + 1/R_2 + 1/R_3}$

For n number of resistors, the equivalent resistance is given as:

$\mathbf{1/Req = 1/R_1 + 1/R_2 + 1/R_3 + \ldots\ldots + 1/R_n}$

Req < Rindividual

Point To Note:

In series, resistors are dependent on each other. While in parallel resistors, each resistor is independent of each other.

SHORT RESPONSE QUESTIONS:

1. What is meant by combination of resistors?

Answer: Combination of resistors means connecting two or more resistors together in a circuit to control current and voltage according to the requirement. Resistors can be connected in series, parallel, or mixed form. This helps in obtaining desired resistance values. It is commonly used in electrical and electronic devices. Different combinations affect current and voltage differently.

2. Why is series combination used when high resistance is needed?

Answer: In series combination, resistances add together, so the total resistance becomes large. This reduces the current flowing in the circuit. High resistance is useful in devices that require small current for safety and protection. Series combination is therefore used to limit current. It is also helpful in voltage control applications.

3. Why is parallel combination preferred in household wiring?

Answer: Parallel combination provides the same voltage to all appliances. Each appliance works independently, so if one device fails, others continue working. It also allows each device to draw current according to its own resistance. This makes parallel circuits safe and reliable. That is why homes use parallel wiring systems.

4. Explain why current is same in series combination.

Answer: In series combination, there is only one path for the flow of electric current. Since current has no alternative path, the same amount of charge flows through each resistor. No charge is lost between components. Therefore, current remains constant throughout the series circuit. This is a basic property of series circuits.

5. Explain why voltage is same in parallel combination.
Answer: In parallel combination, each resistor is connected directly across the source terminals. This means each branch gets the full supply voltage. There is no voltage division in parallel circuits. Hence all resistors experience the same potential difference. This allows devices to operate at rated voltage.

6. Why does equivalent resistance increase in series combination?
Answer: In series, resistors are connected end to end, so electrons face more opposition. Each resistor adds its resistance to the flow of current. This increases the total obstruction to current. As a result, equivalent resistance increases. This property is used to control current flow.

7. Why does equivalent resistance decrease in parallel combination?
Answer: Parallel combination provides multiple paths for current. When more paths are available, current flows easily. This reduces the overall opposition to current. Therefore, total resistance becomes less than the smallest resistor. Parallel circuits improve current flow efficiency.

8. Why is a fuse connected in series?
Answer: A fuse must stop current in the entire circuit when excessive current flows. In series connection, all current passes through the fuse. If it melts, the circuit becomes open and current stops. This protects appliances from damage. Therefore, fuse is always connected in series.

9. Why is voltage divided in series circuits?
Answer: In series circuits, total voltage is shared among all

resistors. Each resistor consumes a part of the voltage depending on its resistance. Higher resistance gets more voltage drop. This is called voltage division. It is used in voltage divider circuits.

10. Why is current divided in parallel circuits?

Answer: In parallel circuits, current splits into different branches. Each branch takes current according to its resistance. Lower resistance branch takes more current. Higher resistance branch takes less current. This is called current division and is a property of parallel circuits.

11. Why are series circuits not suitable for household use?

Answer: In series circuits, all appliances depend on one path. If one appliance fails, the entire circuit stops working. Voltage is also divided, so devices do not get proper voltage. This makes series circuits unreliable. Therefore, they are not used in homes.

12. Why are parallel circuits considered safe?

Answer: Parallel circuits provide independent paths for current. Failure of one branch does not affect others. Each device gets proper voltage. This prevents damage to appliances and ensures safety. Hence parallel circuits are safer and more reliable.

13. What is meant by equivalent resistance?

Answer: Equivalent resistance is the single resistance value that replaces a combination of resistors without changing circuit behavior. It represents the total opposition to current. It simplifies circuit analysis. It depends on how resistors are connected. Series and parallel give different equivalent resistance values.

14. Why does adding a resistor in series reduce current?

Answer: Adding a resistor in series increases total resistance. According to Ohm's law, current is inversely proportional to resistance. As resistance increases, current decreases. This limits current flow. It is used for protection and control.

15. Why does adding a resistor in parallel increase current?

Answer: Adding a resistor in parallel creates an extra path for current. This reduces total resistance. Lower resistance allows more current to flow. Hence total current increases. Parallel circuits are used when high current is needed.

16. Explain the concept of mixed circuits.

Answer: Mixed circuits contain both series and parallel connections. Some resistors are connected in series, while others are in parallel. These circuits are common in real-life devices. They allow control of both voltage and current. Mixed circuits are solved step by step.

17. Why does a parallel circuit draw more current than a series circuit?

Answer: Parallel circuits have lower equivalent resistance. Low resistance allows more current to flow. Multiple paths increase current flow. Series circuits have higher resistance, so they draw less current. Therefore, parallel circuits draw more current.

18. Why do decorative lights use series connection?

Answer: Decorative lights use series connection to reduce voltage across each bulb. It saves cost and power. It also allows many bulbs to glow with a single source. However, failure of one bulb stops all others. This is a disadvantage of series lights.

19. What happens to current when resistance increases?

Answer: When resistance increases, current decreases. This is explained by Ohm's law I = V/R. Higher resistance offers more opposition to current. Therefore, fewer charges flow per second. This principle is used in current control devices.

20. Why does parallel combination increase reliability?
Answer: Parallel combination provides multiple independent paths. If one branch fails, others still work. Devices are not dependent on one path. This improves reliability. That is why parallel systems are widely used.

21. Why does a voltage divider use series resistors?
Answer: Voltage division happens only in series circuits. Series resistors share the supply voltage. Different voltages can be obtained across different resistors. This principle is used in voltage divider circuits. It is used in electronic control systems.

22. Explain current division in parallel circuits.
Answer: In parallel circuits, current splits among branches. Each branch draws current based on resistance. Lower resistance draws more current. Higher resistance draws less current. This principle is called current division.

23. Why is resistance called opposition to current?
Answer: Resistance restricts the flow of electrons. It slows down charge movement in conductors. This opposition reduces current. Therefore, resistance is defined as opposition to current. It controls electric flow.

24. Why does power differ in series resistors?
Answer: In series, same current flows through all resistors. Power depends on resistance. Higher resistance consumes more

power. Lower resistance consumes less power. Hence power distribution is unequal in series circuits.

25. Why does power differ in parallel resistors?

Answer: In parallel, voltage is same for all resistors. Power depends on resistance value. Lower resistance consumes more power. Higher resistance consumes less power. Therefore, power distribution varies.

26. Why is a single path risky in circuits?

Answer: Single path means no alternate route for current. If one component fails, current stops completely. This makes the system unreliable. It causes total failure of the circuit. Hence single-path circuits are risky.

27. Why do parallel circuits allow independent control?

Answer: Each branch works separately. Switching one device does not affect others. Each appliance can be controlled independently. This makes usage convenient and safe. That is why homes use parallel circuits.

28. Why is series connection used for current limiting?

Answer: Series connection increases resistance. Increased resistance reduces current. This protects devices from excess current. It is used in protective circuits. Series resistors are used as current limiters.

29. Why is resistance less in parallel networks?

Answer: More paths are available for electrons. Current flow becomes easier. Total opposition reduces. This causes resistance to decrease. Parallel networks always reduce total resistance.

30. Why does equivalent resistance depend on connection type?

Answer: Resistance combination changes current paths. Series adds opposition, parallel reduces opposition. The flow structure changes. Therefore, equivalent resistance depends on connection type. Circuit behavior changes with configuration.

31. Why do appliances require rated voltage?

Answer: Each appliance is designed for a fixed voltage. Too high voltage damages it. Too low voltage makes it inefficient. Parallel circuits provide rated voltage. This ensures safe and proper functioning.

32. Why does series circuit cause voltage drop?

Answer: Voltage is shared among resistors. Each resistor uses part of the energy. This reduces voltage across each component. This is called voltage drop. It is a property of series circuits.

33. Why does parallel circuit prevent voltage drop?

Answer: Each branch is directly connected to the source. Voltage is not divided. All branches get full voltage. Hence voltage drop does not affect devices. This ensures stable operation.

34. Why are parallel circuits energy efficient?

Answer: Devices draw only required current. Energy is not wasted in voltage loss. Independent operation reduces power loss. This improves efficiency. Parallel systems save energy.

35. Why does mixed circuit help in design flexibility?

Answer: Mixed circuits allow both voltage and current control. Designers can adjust resistance values. Both safety and performance can be achieved. This gives flexibility in circuit design. Most electronic devices use mixed circuits.

36. Why is current constant in series?

Answer: There is only one path. Charges cannot choose alternative routes. Same number of electrons flow through each resistor. Therefore, current remains constant. This is a property of series circuits.

37. Why is voltage constant in parallel?

Answer: All branches connect to same source terminals. Each branch gets same potential difference. No voltage division occurs. Hence voltage remains constant. This is a property of parallel circuits.

38. Why do engineers prefer parallel circuits?

Answer: Parallel circuits are safe and reliable. They allow independent operation. They provide stable voltage. They increase system reliability. Therefore, engineers prefer them.

39. Why does resistance control current?

Answer: Resistance limits electron movement. Higher resistance reduces current. Lower resistance increases current. This allows control of current flow. It is used in electronic circuits.

40. Why is series connection good for voltage increase?

Answer: Voltages add in series. Total EMF increases. This provides higher voltage output. It is useful when high voltage is required. Series is used for voltage boosting.

41. Why is parallel connection good for current increase?

Answer: Parallel paths increase current capacity. More charge can flow. Resistance decreases. This increases total current. Parallel is used for high current devices.

42. Why is resistance important in circuits?

Answer: Resistance controls current flow. It protects devices. It regulates power consumption. It ensures safe operation. Without resistance, circuits would be dangerous.

43. Why does resistance cause heat?

Answer: Resistance opposes current flow. Electrical energy converts into heat. This is called Joule heating. It occurs in resistors. This principle is used in heaters.

44. Why does resistance depend on material?

Answer: Different materials have different electron mobility. Some allow easy flow, others resist it. This affects resistance. Material structure determines resistance. Hence resistance depends on material.

45. Why does resistance depend on length?

Answer: Longer wire offers more obstruction. Electrons collide more. This increases resistance. Shorter wires have less resistance. Therefore, resistance depends on length.

46. Why does resistance depend on area?

Answer: Larger area allows more electrons to flow. This reduces resistance. Smaller area restricts flow. Hence resistance depends on cross-sectional area.

47. Why is equivalent resistance important?

Answer: It simplifies circuit analysis. Complex networks become simple. Calculations become easy. It helps in design and understanding. Equivalent resistance is a key concept.

48. Why are resistors used in electronic circuits?
Answer: They control current and voltage. They protect components. They regulate power. They stabilize circuits. Resistors are essential components.

49. Why do real circuits use mixed combinations?
Answer: Real circuits need both voltage and current control. Series gives voltage control. Parallel gives current control. Mixed circuits provide both. Hence real systems use mixed circuits.

50. Why is understanding resistor combinations important?
Answer: It helps in circuit design. It improves safety. It allows proper voltage and current control. It is essential for electronics and physics. It builds foundation for electrical engineering.

MCQs:

1. The SI unit of resistance is:
A) Volt
B) Ampere
C) Ohm
D) Watt
Correct Option: C
Explanation: Ohm (Ω) is the SI unit used to measure electrical resistance.

2. In a series circuit, the current is:
A) Different in each resistor
B) Same in all resistors
C) Zero at the end
D) Maximum in middle
Correct Option: B
Explanation: In series circuits, the same current flows through all components.

3. In a parallel circuit, the voltage across each resistor is:

A) Different

B) Same

C) Zero

D) Infinite

Correct Option: B

Explanation: Each branch in parallel gets the same potential difference.

4. Equivalent resistance in series is calculated by:

A) Product of resistances

B) Difference of resistances

C) Sum of resistances

D) Reciprocal sum

Correct Option: C

Explanation: In series: $R = R_1 + R_2 + R_3$.

5. Equivalent resistance in parallel is calculated by:

A) Sum of resistances

B) Product of resistances

C) Reciprocal sum

D) Difference of resistances

Correct Option: C

Explanation: In parallel: $1/R = 1/R_1 + 1/R_2 + 1/R_3$.

6. Two resistors of 2Ω and 3Ω in series have equivalent resistance:

A) 1Ω

B) 5Ω

C) 6Ω

D) 0.5Ω

Correct Option: B

Explanation: $R = 2 + 3 = 5\Omega$.

7. Two resistors of 2Ω each in parallel give equivalent resistance:

A) 4Ω

B) 2Ω

C) 1Ω

D) 0.5Ω

Correct Option: C

Explanation: $1/R = 1/2 + 1/2 = 1 \rightarrow R = 1\Omega$.

8. Which combination gives minimum resistance?

A) Series

B) Parallel

C) Both same

D) Depends on voltage

Correct Option: B

Explanation: Parallel combination always reduces total resistance.

9. Which combination gives maximum resistance?

A) Series

B) Parallel

C) Mixed

D) None

Correct Option: A

Explanation: Series combination increases total resistance.

10. If one resistor breaks in a series circuit, the circuit becomes:

A) Complete

B) Short

C) Open

D) Parallel

Correct Option: C

Explanation: Break in series opens the entire circuit.

11. If one branch breaks in a parallel circuit, other branches:

A) Stop working

B) Work normally

C) Short circuit

D) Burn

Correct Option: B

Explanation: Parallel branches work independently.

12. Home appliances are connected in:

A) Series

B) Parallel

C) Mixed

D) Open

Correct Option: B

Explanation: Parallel connection allows independent operation.

13. Fuse is always connected in:

A) Parallel

B) Series

C) Both

D) None

Correct Option: B

Explanation: Fuse must be in series to stop current when overloaded.

14. In series combination, total voltage is:

A) Same as supply

B) Zero

C) Sum of voltage drops

D) Half supply

Correct Option: C

Explanation: Total voltage equals sum of individual voltage drops.

15. In parallel combination, total current is:

A) Same as branch current

B) Sum of branch currents

C) Zero

D) Half current

Correct Option: B

Explanation: Total current is sum of currents in all branches.

16. Equivalent resistance of parallel combination is always:

A) Greater than largest resistor

B) Less than smallest resistor

C) Equal to sum

D) Infinite

Correct Option: B

Explanation: Parallel resistance is always less than the smallest resistor.

17. Voltage divider works on principle of:

A) Parallel combination

B) Series combination

C) Mixed circuit

D) Open circuit

Correct Option: B

Explanation: Voltage division occurs in series circuits.

18. Adding a resistor in series will:

A) Decrease resistance

B) Increase resistance

C) No change

D) Zero resistance

Correct Option: B

Explanation: Series addition increases total resistance.

19. Adding a resistor in parallel will:

A) Increase resistance

B) Decrease resistance

C) No change

D) Infinite resistance

Correct Option: B

Explanation: Parallel paths reduce total resistance.

20. Current is same in:

A) Parallel circuit

B) Series circuit

C) Both

D) None

Correct Option: B

Explanation: Series circuits have same current through all components.

21. Voltage is same in:

A) Series circuit

B) Parallel circuit

C) Both

D) None

Correct Option: B

Explanation: Parallel branches share same voltage.

22. Three 3Ω resistors in series give equivalent resistance:

A) 3Ω

B) 6Ω

C) 9Ω

D) 1Ω

Correct Option: C

Explanation: $R = 3 + 3 + 3 = 9\Omega$.

23. Three 3Ω resistors in parallel give equivalent resistance:

A) 9Ω

B) 3Ω

C) 1Ω

D) 6Ω

Correct Option: C

Explanation: $1/R = 1/3 + 1/3 + 1/3 = 1 \rightarrow R = 1\Omega$.

24. Resistance opposes the flow of:

A) Voltage

B) Power

C) Current

D) Energy

Correct Option: C

Explanation: Resistance resists electric current.

25. Ohm's law is:

A) $V = IR$

B) $V = I/R$

C) $I = VR$

D) $R = VI$

Correct Option: A

Explanation: Ohm's law: Voltage = Current × Resistance.

26. Two 4Ω resistors in series have equivalent resistance:

A) 2Ω

B) 4Ω

C) 6Ω

D) 8Ω

Correct Option: D

Explanation: R = 4 + 4 = 8Ω.

27. Two 4Ω resistors in parallel have equivalent resistance:

A) 8Ω

B) 4Ω

C) 2Ω

D) 1Ω

Correct Option: C

Explanation: 1/R = 1/4 + 1/4 = 1/2 → R = 2Ω.

28. Equivalent resistance in parallel is always:

A) Maximum

B) Zero

C) Minimum

D) Infinite

Correct Option: C

Explanation: Parallel combination reduces total resistance.

29. Equivalent resistance in series is always:

A) Minimum

B) Maximum

C) Zero

D) Constant

Correct Option: B

Explanation: Series combination increases resistance.

30. In series circuit, if resistance increases, current will:

A) Increase

B) Decrease

C) Remain same

D) Become zero

Correct Option: B

Explanation: $I = V/R$, so increase in R decreases I.

31. In parallel circuit, removing one branch will:

A) Decrease resistance

B) Increase resistance

C) No effect

D) Short circuit

Correct Option: B

Explanation: Fewer paths increase total resistance.

32. Parallel circuits are preferred in homes because they:

A) Save wire

B) Reduce voltage

C) Allow independent control

D) Increase resistance

Correct Option: C

Explanation: Each appliance works independently.

33. Series circuits are not used in homes because:

A) Low voltage

B) High current

C) One fault stops all

D) High resistance

Correct Option: C

Explanation: Failure of one device breaks whole circuit.

34. In parallel circuit, current in each branch depends on:

A) Voltage only

B) Resistance only

C) Length only

D) Area only

Correct Option: B

Explanation: Branch current depends on resistance of that branch.

35. Unit of conductance is:

A) Ohm

B) Volt

C) Ampere

D) Siemens

Correct Option: D

Explanation: Siemens (S) is the SI unit of conductance.

36. Total current in series circuit is:

A) Different in each resistor

B) Same everywhere

C) Zero

D) Infinite

Correct Option: B

Explanation: Same current flows through all series components.

37. Total voltage in parallel circuit is:

A) Divided

B) Zero

C) Same as supply

D) Half supply

Correct Option: C

Explanation: Each branch gets full supply voltage.

38. Resistance increases if:

A) Length decreases

B) Area increases

C) Length increases

D) Temperature decreases

Correct Option: C

Explanation: Resistance ∝ Length of conductor.

39. Resistance decreases if:

A) Area decreases

B) Length increases

C) Area increases

D) Temperature increases

Correct Option: C

Explanation: Larger cross-sectional area lowers resistance.

40. Power in a resistor depends on:

A) Voltage only

B) Current only

C) Resistance only

D) Voltage and current

Correct Option: D

Explanation: $P = VI$, depends on both voltage and current.

41. In series circuit, power distribution depends on:

A) Voltage only

B) Resistance

C) Current only

D) Length

Correct Option: B

Explanation: Higher resistance → more power dissipation.

42. In parallel circuit, power depends on:

A) Resistance only

B) Voltage only

C) Current only

D) Voltage and resistance

Correct Option: D

Explanation: $P = V^2/R$, depends on voltage and resistance.

43. Best circuit for distribution of electricity is:

A) Series

B) Parallel

C) Mixed

D) Open

Correct Option: B

Explanation: Parallel circuits provide same voltage and reliability.

44. Symbol of resistance is:

A) I

B) V

C) R

D) P

Correct Option: C

Explanation: R represents resistance.

45. Electric current is measured in:

A) Volt

B) Ohm

C) Ampere

D) Watt

Correct Option: C

Explanation: Ampere (A) is SI unit of current.

46. Potential difference is measured in:

A) Ampere

B) Ohm
C) Watt
D) Volt
Correct Option: D
Explanation: Volt (V) is SI unit of potential difference.

47. Resistors in parallel provide:
A) Same current
B) Same resistance
C) Same voltage
D) Same power
Correct Option: C
Explanation: Voltage is same across all parallel branches.

48. Resistors in series provide:
A) Same voltage
B) Same current
C) Same resistance
D) Same power
Correct Option: B
Explanation: Same current flows through all series resistors.

49. Total resistance in mixed circuit is found by:
A) Only series rule
B) Only parallel rule
C) Step-by-step simplification
D) Direct formula
Correct Option: C
Explanation: Mixed circuits are solved stepwise.

50. Main purpose of parallel combination in circuits is:
A) Increase voltage

B) Increase resistance

C) Independent working of devices

D) Reduce current

Correct Option: C

Explanation: Parallel circuits allow independent operation of devices.

Combination of EMF sources

Combination of EMF sources is referred to when two or more EMF sources are connected in such a way that combined effect of these sources is obtained.

1) Series Combination of EMF sources

When positive terminals of an emf source like battery is connected to negative terminals of another source and so on. Finally, the negative terminal of the first emf source is connected to the positive terminal of the last source through other circuit elements like **bulbs, fans, etc.** This combination is used when a high voltage is required as compared to voltage of available. sources

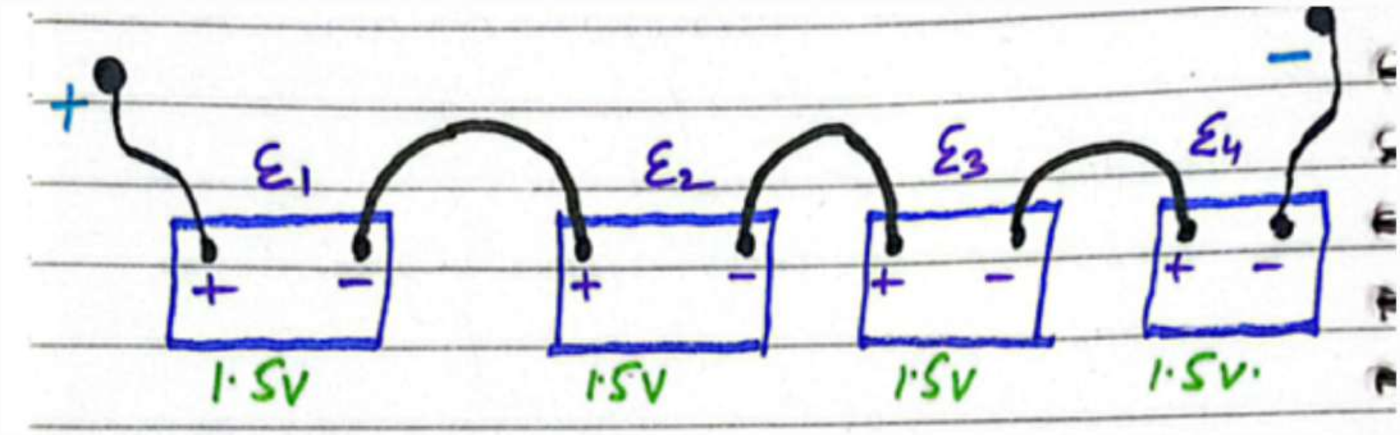
We can write this combination as;

$E_{net} = E1 + E2 + E3 + E4$

– Generally, for 'n' number of batteries connected, we can mathematically give as;

$E_{net} = E1 + E2 + E3 + E4 \ldots\ldots\ldots + En$

Here four batteries are connected in series where the emf of all batteries are added and provide the resultant emf (6V) to the external circuit.



1) Parallel Combination of EMF sources

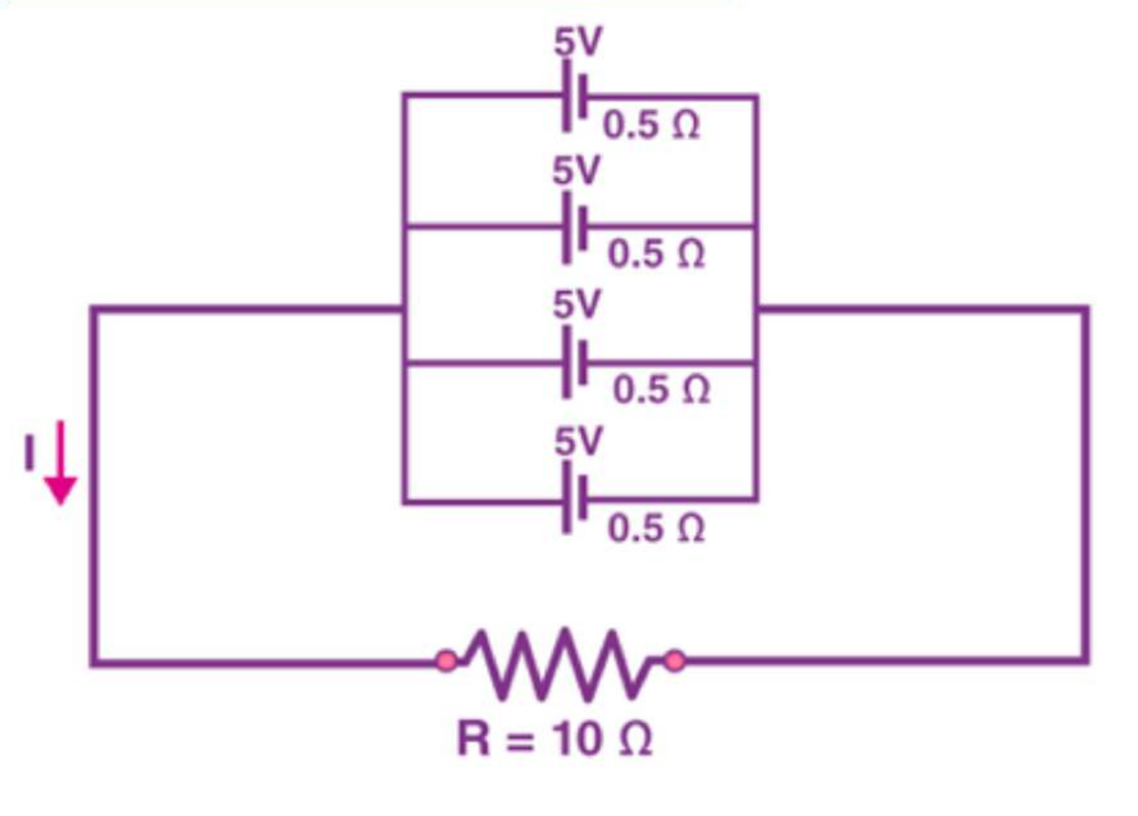
In parallel combination of emf sources, the positive and negative terminals of all the sources are connected to each other respectively. Finally, the load is connected by taking one connection from positive terminal and one from negative terminal.

This is used if one source falls, others still supply current.
This can be mathematically given as;

$E1 = E_2 = E3 = E4$

Generally, For 'n' number of batteries.

$Enet = E1 = E2 = E3 = E4........= En$



Advantages/ Disadvantages of series and parallel combination of EMF sources.

-**Series combination** increases total voltage (emf add up). It is useful when higher voltage is needed for circuit It has some downsides; If one cell fails, the whole circuit stops working.

-**In parallel combination,** it increases current capacity; voltage remains same as a single cell. If one cell fails, others supply current. However, it has some downsides, Unequal emfs can cause internal circulating currents. It is less suitable when high voltage is
Required.

SCIENCE TIDBITS

When batteries are connected in series, their voltages add up, but if one battery is weaker, it can cause issues. The weaker battery may drain faster, which can limit the power of the entire system and reduce performance. It might also get overheated, leading to overheating or damage. Balancing batteries in series is important to keep them balanced using special circuits that monitor each battery's charge or occasionally charge each battery individually. Proper balancing ensures the system works efficiently and safely.

SHORT RESPONSE QUESTIONS

1. Why is series combination of cells used when high voltage is required?

Answer: In series combination, the EMFs of individual cells add together. This increases the total voltage of the battery. High voltage is needed in devices that require a strong electric push for current flow. Series connection provides this increased driving force. Therefore, series combination is used for high voltage applications.

2. Why does parallel combination of cells increase current capacity but not voltage?

Answer: In parallel combination, all cells have the same voltage across their terminals. Their EMFs do not add, so voltage remains the same. However, multiple paths are available for current flow. This increases the total charge supply capacity. Hence current capacity increases but voltage does not.

3. Why do cells in series discharge faster than cells in parallel?

Answer: Series cells provide higher voltage, which causes more current to flow through the circuit. Higher current means faster energy consumption. This leads to quicker discharge. In parallel, current is shared and discharge is slower. Therefore, series cells discharge faster.

4. Why is internal resistance important in the combination of cells?

Answer: Internal resistance limits current flow inside the cell. When cells are combined, internal resistance affects total current and terminal voltage. High internal resistance causes energy loss and voltage drop. It reduces the efficiency of the battery. Therefore, internal resistance plays a key role in performance.

5. Why is terminal voltage less than EMF when current flows?

Answer: When current flows, some voltage is lost inside the cell due to internal resistance. This loss is called internal voltage drop. As a result, the voltage available at the terminals becomes less than the EMF. This effect increases with current. Hence terminal voltage is less than EMF during operation.

6. Why is series-parallel combination used in power banks?

Answer: Power banks require both suitable voltage and high current capacity. Series combination increases voltage. Parallel combination increases current capacity and storage. Series-parallel combination provides both benefits together. That is why power banks use mixed combinations.

7. Why are identical cells preferred in combination?

Answer: Identical cells have the same EMF and internal resistance. This ensures uniform current distribution. It prevents overloading of any single cell. It increases battery life and safety. Therefore, identical cells are preferred in combinations.

8. Why is parallel combination safer than series combination?

Answer: Parallel combination operates at low voltage. Low voltage reduces the risk of electric shock. It also prevents damage to devices. Series combination increases voltage, which is more dangerous. Hence parallel combination is safer.

9. Why does mixed combination improve efficiency?

Answer: Mixed combination balances voltage and current requirements. It reduces energy loss. It prevents excessive current and voltage. This improves overall efficiency. Therefore, mixed combination is more effective.

10. Why is a torch battery connected in series?
Answer: A torch requires higher voltage to glow the bulb properly. Series connection adds the EMFs of cells. This provides the required voltage. Parallel connection would not increase voltage. Therefore, torch batteries are connected in series.

11. Why do parallel cells last longer than series cells?
Answer: Parallel cells share the load current. Each cell supplies less current. This reduces stress and heating. Energy is used slowly. Hence battery life becomes longer in parallel.

12. Why is internal resistance reduced in parallel combination?
Answer: Internal resistances act like parallel resistors. Multiple current paths reduce total resistance. This allows easier current flow. Hence internal resistance decreases in parallel combination.

13. Why does series combination increase internal resistance?
Answer: Internal resistances add in series. More opposition to current is created. This increases energy loss. Therefore, series combination increases internal resistance.

14. Why does high internal resistance reduce battery efficiency?
Answer: High internal resistance causes more heat loss. Energy is wasted inside the battery. Less energy is delivered to the external circuit. This reduces efficiency. Therefore, internal resistance must be kept low.

15. Why is terminal voltage important in practical circuits?
Answer: Terminal voltage is the actual voltage available to devices. EMF is a theoretical value. Devices operate on terminal voltage. Therefore, terminal voltage determines performance. It is

important for practical applications.

16. Why do batteries use multiple cells instead of a single cell?

Answer: A single cell cannot provide high voltage or large current capacity. Multiple cells can be combined to achieve the required power. This allows flexibility in design. Hence batteries use multiple cells.

17. Why does current increase when more cells are added in series?

Answer: Adding cells in series increases EMF. Higher EMF increases the driving force for current. According to Ohm's law, current increases with voltage. Therefore, current increases in series combination.

18. Why does current increase when more cells are added in parallel?

Answer: Adding cells in parallel reduces internal resistance. Lower resistance allows more current to flow. It also increases charge capacity. Therefore, current increases in parallel combination.

19. Why is EMF called the driving force of current?

Answer: EMF provides energy to move charges. It creates a potential difference. This causes electrons to flow. Without EMF, current cannot flow. Hence EMF is called the driving force of current.

20. Why is understanding the combination of EMF sources important in electronics?

Answer: It helps in designing power systems. It allows proper voltage and current control. It improves efficiency and safety. It is essential for battery systems. Therefore, it is very important in electronics.

MCQs

1. EMF stands for:

A) Electric Magnetic Force

B) Electro Motive Force

C) Electric Moving Field

D) Electron Magnetic Field

Correct Option: B

Explanation: EMF means Electromotive Force; the energy supplied per unit charge.

2. SI unit of EMF is:

A) Ampere

B) Ohm

C) Volt

D) Watt

Correct Option: C

Explanation: Volt (V) is the SI unit of EMF.

3. In series combination of cells, total EMF is:

A) Difference of EMFs

B) Product of EMFs

C) Sum of EMFs

D) Average of EMFs

Correct Option: C

Explanation: EMF adds in series: $E = E1 + E2 + E3$.

4. In parallel combination of cells, total EMF is:

A) Sum of EMFs

B) Zero

C) Equal to one cell

D) Double EMF

Correct Option: C

Explanation: EMF remains same in parallel combination.

5. Series combination of cells is used to:

A) Increase current

B) Increase EMF

C) Decrease resistance

D) Reduce voltage

Correct Option: B

Explanation: Series combination increases total voltage (EMF).

6. Parallel combination of cells is used to:

A) Increase EMF

B) Increase current capacity

C) Decrease voltage

D) Increase resistance

Correct Option: B

Explanation: Parallel cells increase current supply capacity.

7. Two 1.5V cells in series give total EMF:

A) 1.5V

B) 2V

C) 3V

D) 4.5V

Correct Option: C

Explanation: 1.5 + 1.5 = 3V.

8. Two 1.5V cells in parallel give total EMF:

A) 3V

B) 1.5V

C) 0.75V

D) 2V

Correct Option: B

Explanation: EMF in parallel remains same.

9. Internal resistance in series combination:

A) Decreases

B) Remains same

C) Increases

D) Becomes zero

Correct Option: C

Explanation: Internal resistances add in series.

10. Internal resistance in parallel combination:

A) Increases

B) Decreases

C) Remains same

D) Becomes infinite

Correct Option: B

Explanation: Parallel internal resistances reduce total resistance.

11. Series combination of cells gives:

A) High EMF, low current capacity

B) Low EMF, high current

C) High EMF, high current

D) Low EMF, low current

Correct Option: A

Explanation: Series increases voltage, not current capacity.

12. Parallel combination of cells gives:

A) High EMF, low current

B) Same EMF, high current capacity

C) High EMF, high current

D) Low EMF, low current

Correct Option: B

Explanation: Parallel increases current capacity only.

13. Cells are connected in series when:

A) Positive to positive

B) Negative to negative

C) Positive to negative

D) Same terminals

Correct Option: C

Explanation: Series connection is positive to negative.

14. Cells are connected in parallel when:

A) Positive to negative

B) Positive to positive and negative to negative

C) Randomly

D) In line

Correct Option: B

Explanation: Same terminals are joined in parallel.

15. Combination of cells is used to:

A) Control current

B) Store charge

C) Obtain required voltage and current

D) Reduce resistance

Correct Option: C

Explanation: Cells are combined to meet voltage/current needs.

16. Torch cells are usually connected in:

A) Parallel

B) Series

C) Mixed

D) Open

Correct Option: B

Explanation: Series connection increases voltage for bulb.

17. Power banks use cells in:

A) Series

B) Parallel

C) Series-parallel

D) Open

Correct Option: C

Explanation: Power banks use mixed combination for voltage and capacity.

18. Battery capacity depends on:

A) EMF

B) Resistance

C) Current capacity

D) Voltage only

Correct Option: C

Explanation: Capacity relates to current supply over time.

19. Parallel cells last longer because:

A) Higher EMF

B) Lower voltage

C) More charge storage

D) More resistance

Correct Option: C

Explanation: Parallel combination increases total charge capacity.

20. Series cells are preferred when device needs:

A) High current

B) High voltage
C) Low resistance
D) Low power
Correct Option: B
Explanation: Series increases EMF (voltage).

21. Internal resistance of battery affects:
A) EMF only
B) Current only
C) Terminal voltage
D) Charge only
Correct Option: C
Explanation: Internal resistance reduces terminal voltage under load.

22. Terminal voltage is always:
A) Greater than EMF
B) Equal to EMF always
C) Less than EMF when current flows
D) Zero
Correct Option: C
Explanation: Due to internal resistance, terminal voltage < EMF.

23. In series cells, internal resistance becomes:
A) r
B) r/2
C) 2r
D) 0
Correct Option: C
Explanation: Internal resistances add: $r + r = 2r$.

24. In parallel cells, internal resistance becomes:

A) r

B) r/2

C) 2r

D) Infinite

Correct Option: B

Explanation: Parallel reduces resistance.

25. Parallel combination is suitable for:

A) Radio

B) Torch

C) Power bank

D) Electric heater

Correct Option: C

Explanation: Power banks need high current capacity.

26. Series combination is suitable for:

A) LED lamp

B) Torch

C) Charger

D) Fan

Correct Option: B

Explanation: Torch needs higher voltage.

27. More cells in series means:

A) More current

B) More voltage

C) Less voltage

D) Less resistance

Correct Option: B

Explanation: Series increases EMF.

28. More cells in parallel means:

A) More EMF

B) More voltage

C) More current capacity

D) More resistance

Correct Option: C

Explanation: Parallel increases current capacity.

29. Mixed combination of cells gives:

A) Only high voltage

B) Only high current

C) High voltage and high current

D) Low voltage and low current

Correct Option: C

Explanation: Series-parallel gives both benefits.

30. EMF depends on:

A) Current

B) Resistance

C) Nature of cell

D) Length of wire

Correct Option: C

Explanation: EMF depends on chemical nature of cell.

31. Battery is a combination of:

A) Resistors

B) Cells

C) Wires

D) Switches

Correct Option: B

Explanation: Battery is made of multiple cells.

32. Purpose of internal resistance is to:

A) Increase voltage

B) Control current

C) Reduce EMF

D) Store charge

Correct Option: B

Explanation: Internal resistance limits current.

33. If identical cells are connected in parallel, EMF becomes:

A) nE

B) E

C) E/2

D) 2E

Correct Option: B

Explanation: EMF remains same.

34. If identical cells are connected in series, EMF becomes:

A) E

B) E/2

C) nE

D) E/n

Correct Option: C

Explanation: EMFs add in series.

35. Parallel cells are safer because:

A) High voltage

B) Low voltage

C) High resistance

D) High EMF

Correct Option: B

Explanation: Low voltage reduces risk.

36. Series cells are dangerous because:

A) Low current

B) High voltage

C) Low resistance

D) Low power

Correct Option: B

Explanation: High voltage increases danger.

37. EMF of a battery is measured using:

A) Ammeter

B) Voltmeter

C) Galvanometer

D) Ohmmeter

Correct Option: B

Explanation: Voltmeter measures potential difference.

38. Combination of EMF sources is used to:

A) Change resistance

B) Change voltage/current supply

C) Store energy

D) Reduce power

Correct Option: B

Explanation: Used to meet voltage and current needs.

39. Internal resistance is represented by:

A) R

B) r

C) I

D) V

Correct Option: B

Explanation: Internal resistance is denoted by r.

40. External resistance is represented by:

A) r

B) I

C) R

D) V

Correct Option: C

Explanation: External resistance is denoted by R.

41. Current in circuit depends on:

A) EMF only

B) Resistance only

C) EMF and resistance

D) Temperature only

Correct Option: C

Explanation: $I = E/(R + r)$.

42. Battery efficiency decreases due to:

A) EMF

B) Internal resistance

C) Voltage

D) Current

Correct Option: B

Explanation: Internal resistance causes energy loss.

43. Terminal voltage decreases when:

A) No load

B) Load increases

C) Circuit open

D) EMF increases

Correct Option: B

Explanation: More current → more voltage drop inside battery.

44. Best combination for long-lasting supply is:

A) Series

B) Parallel

C) Mixed

D) Open

Correct Option: B

Explanation: Parallel increases capacity.

45. Best combination for high voltage devices is:

A) Series

B) Parallel

C) Mixed

D) Open

Correct Option: A

Explanation: Series increases EMF.

46. In series cells, current is:

A) Different in each cell

B) Same in all cells

C) Zero

D) Infinite

Correct Option: B

Explanation: Same current flows through series cells.

47. In parallel cells, voltage is:

A) Different

B) Same

C) Zero

D) Double

Correct Option: B

Explanation: Voltage remains same across all parallel cells.

48. A car battery uses mostly:

A) Series

B) Parallel

C) Series-parallel

D) Single cell

Correct Option: C

Explanation: Car batteries use mixed combinations.

49. EMF is the cause of:

A) Resistance

B) Current flow

C) Power loss

D) Heat

Correct Option: B

Explanation: EMF drives current in circuit.

50. Main purpose of combining EMF sources is to:

A) Increase resistance

B) Control temperature

C) Obtain required voltage and current

D) Reduce power

Correct Option: C

Explanation: Cells are combined to get desired voltage and current output.

Electricity and its Uses

(a) Heating: Electricity is used to produce heat in devices like electric irons, heaters and ovens. These work by converting electrical energy into heat.

(b) Lighting: Electricity powers bulbs, tube lights and lamps to produce light helping us see in the dark and making our homes and streets bright.

(c) Powering motors: Electric motors use electricity to make machines work like fans, washing machines and water pumps. The electric energy changes into mechanical energy.

(d) Battery charging: Electricity is used to as charge batteries in devices such as mobile phones, laptops, and electric vehicles. It stores energy for later use.

(e) Powering electronic system: Electricity runs computers, TVs and other electronic gadgets allowing them to work process information.

Electrical Energy

Electrical energy is the energy possessed by moving electric charges. It is produced when an electric current flows through a conductor due to potential difference.

PKMZ:

Energy is VITamin

$E = VIT$

Derivation:

Since; $V = W/q \therefore W = E$

$V = E/q \Rightarrow$ **$E = qV \rightarrow$ (i)**

Since from the definition of current;

$I = q/t \Rightarrow$ **$q = I \times t \rightarrow$ (ii)**

Putting eq. (ii) in eq. (i) then;

$E = I \times t \times V$

$E = VIt$

Now, Since Electrical energy;

$E = VIt \rightarrow$ (x)

Since from Ohm's law;

$V = IR \rightarrow$ (u)

Putting eq. (u) in eq. (x) then;

$E = (IR)\ It$

$E = I^2Rt$

Since from Ohm's law;

$V = IR \Rightarrow$ **$I = V/R \rightarrow$ (ii)**

Putting eq. (ii) in eq. (x) then;

$E = V(V/R)t$

$E = V^2t/R$

i.e.

$E = VIt$

$E = I^2Rt$

$E = V^2t/R$

SCIENCE TIDBITS

Why is the battery charger plug for the electric vehicle bigger than the cell phone charger?

ANS: The battery charger plug for an electric vehicle is larger than a cell phone charger due to power delivery and safety reasons. Electric cars require significantly more power to charge their larger batteries compared to phones. Electric vehicle chargers can deliver thousands of watts, ranging from 2.4 kW to 350 kW, while phone chargers typically deliver only 5W to 30W. The larger size of the EV charger plug is necessary to handle the higher power safely, with thicker wires and larger connectors to accommodate the increased current flow. Additionally, EV chargers require extra safety features like overload protection and grounding to prevent overheating and electrical hazards, which take up more space in the plug design

Electric Power

The rate at which electric work is done by the voltage source in maintaining electric current in electric circuit is called electric power or the electrical energy consumed by a device per unit time is called electric power.

Derivation:

$$P = E/t$$

↓ ↓ ↓

$P = VIt/t$ $P = I^2Rt/t$ $P = (V^2t/R)/t$

$$P = VI \qquad P = I^2R \qquad P = V^2/R$$

Point to Ponder: Kilowatt Hour

The unit kilowatt hour has a unit of power which suggest that it might be unit of power. However, it measures electrical energy not electric power.

Since;

P = E/t =) P × t = E

J = w × s

E= P × t

↓ ↓

KW 1Hr

(103 W)

1kWh = one unit.

(1kwh) = 103W×lhour.

= 103 W × 3600S.

= 3,600×103 Ws.

= 3.6 × 103 ×103 ws

1kWh = 3.6×1006J=36MJ

Household Wiring system

A main circuit is composed of three wires: a live wire (line wire), a neutral wire and an earth wire.

The live wire also known as line wire is responsible for carrying the electric current from the power source to the electrical devices or appliances. The neutral on other hand is responsible for completing the electric circuit. It provides return path for electric current. The earth wire also known as grounding wire for extra current to flow in ground.

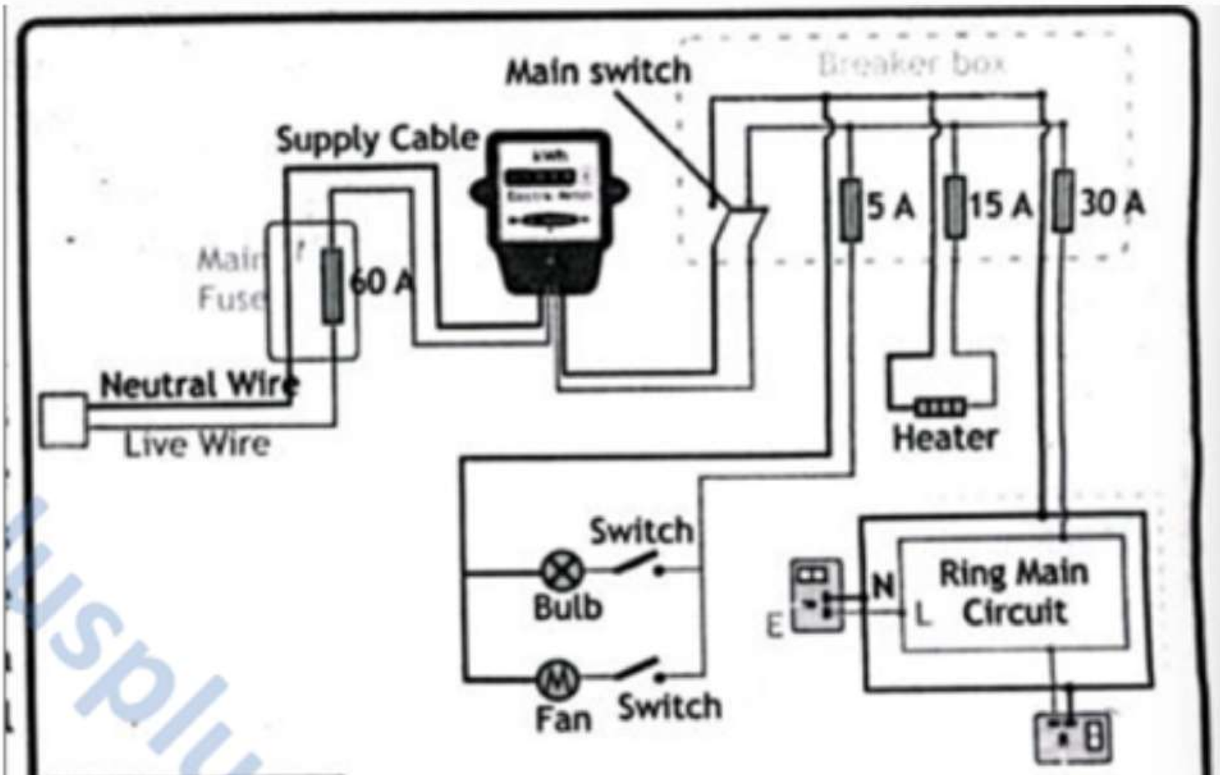


FIGURE 17.17 Basic household wiring

SCIENCE TIDBITS:

1) A common misconception is that electrons are used up in an electric circuit, but this is not true. We pay the electric company for the energy needed to power our devices and move electrons through the circuit. **2)** The electrical power produced (dissipated) by a resistor is 12 R. It depends on the square of the current. Hence, if current is doubled, the power will increase by four times. Similar explanation holds true for voltage also.

SHORT RESPONSE QUESTIONS:

1. What is the relationship between voltage, work, and electrical energy?

Answer: The relationship between voltage, work, and electrical energy is given by:

$V = W / q$

1). Voltage (V) is the electric potential difference between two points. 2). Work (W) is the energy transferred to or from an object by a force. 3). Charge (q) is a fundamental property of matter.

For example, if it takes 10 joules to move a charge of 2 coulombs between two points, the voltage is:

$V = 10 / 2 = 5$ volts

2. Define electric current and its relationship to charge and time.

Answer: Electric current (I) is defined as the flow of electric charge per unit time:

$I = q / t$

1). q is the charge 2). t is the time

This can also be expressed as:

$q = I \times t$

3. What are the factors that determine the unit of electrical energy?

Answer: The unit of electrical energy is typically measured in joules (J). The factors that determine the unit include:

1). Voltage (V) in volts 2). Current (I) in amperes (A) 3). Time (t) in seconds (s)
Using the equation E = ItV, the unit of electrical energy can be derived as:
1J = 1A × 1s × 1V

4. Explain why the battery charger for an electric vehicle is bigger than a cell phone charger.
Answer: The battery charger plug for an electric vehicle is larger than a phone charger plug because electric vehicles require significantly more power to charge their large batteries. Electric vehicle chargers range from 2.4 kW to 350 kW, while phone chargers typically range from 5W to 30W. The larger size of the EV charger plug accommodates higher power delivery and safety features like overload protection and grounding.

Topic: Electric Power

1. Define electric power.
Answer: Electric power is defined as the rate at which electrical work is done by the voltage source maintaining electric current in a circuit. It is also referred to as the electrical energy consumed by a device per unit time.
Mathematically, electric power is expressed as:
P = E / t
1). P is electric power in watts (W) 2). E is the electrical energy in joules (J) 3). t is time in seconds (s)

2. What are the units of electric power?
Answer: The SI unit of electric power is the watt (W). A power of 1 watt is said to be consumed in an electrical circuit if a potential difference of 1 volt causes a current of 1 ampere to flow through

the circuit.

3. Why is electric power loss minimized in transmission lines?

Answer: Electric power loss in transmission lines is minimized for the following reasons:

1). To reduce loss, current must be minimized. 2). Using high voltage reduces current for the same power.

Hence, electricity is transmitted at high voltage and low current.

This saves energy and reduces heating in transmission wires.

Transformers step up voltage for transmission and step it down for domestic use.

MCQs:

1. Electrical energy supplied to a device is given by:

A) $E = V/I$

B) $E = qV$

C) $E = I/R$

D) $E = V/R$

Answer: B

Explanation: Electrical energy equals charge × potential difference.

2. If $V = 12$ V and $q = 4$ C, electrical energy is:

A) 3 J

B) 16 J

C) 48 J

D) 8 J

Answer: C

Explanation: $E = qV = 4 \times 12 = 48$ J.

3. From the definition of electric current:

A) $q = Vt$

B) $q = It$

C) $q = IR$

D) $q = V/R$

Answer: B

Explanation: Current = charge/time, so $q = It$.

4. Electrical energy in terms of I, V and t is:

A) $E = IV$

B) $E = IVt$

C) $E = I^2R$

D) $E = V^2/R$

Answer: B

Explanation: Substitute $q = It$ in $E = qV$.

5. If I = 3 A, V = 5 V, t = 4 s, energy is:

A) 60 J

B) 20 J

C) 15 J

D) 12 J

Answer: A

Explanation: $E = IVt = 3 \times 5 \times 4 = 60$ J.

6. Substituting V = IR in E = IVt gives:

A) $E = IRt$

B) $E = I^2Rt$

C) $E = V^2t$

D) $E = R^2It$

Answer: B

Explanation: $E = I(IR)t = I^2Rt$.

7. Another expression for electrical energy is:

A) $E = V^2/R \times t$

B) $E = V/R$

C) $E = I/R$

D) $E = Rt$

Answer: A

Explanation: Using $I = V/R$ in $E = IVt$.

8. If $I = 2$ A, $R = 6\ \Omega$, $t = 5$ s, energy is:

A) 60 J

B) 120 J

C) 30 J

D) 12 J

Answer: B

Explanation: $E = I^2Rt = 4 \times 6 \times 5 = 120$ J.

9. If $V = 10$ V, $R = 5\ \Omega$, $t = 2$ s, energy is:

A) 20 J

B) 40 J

C) 10 J

D) 50 J

Answer: B

Explanation: $E = V^2/R \times t = 100/5 \times 2 = 40$ J.

10. SI unit of electrical energy is:

A) Watt

B) Joule

C) Volt

D) Ampere

Answer: B

Explanation: Energy is measured in joules.

11. If time doubles and other factors remain constant, energy will:

A) Remain same

B) Double

C) Half

D) Four times

Answer: B

Explanation: Energy is directly proportional to time.

12. If current doubles, energy becomes:

A) Double

B) Four times

C) Half

D) Same

Answer: B

Explanation: $E \propto I^2$.

13. If 100 J energy is supplied at 20 V, charge transferred is:

A) 5 C

B) 2000 C

C) 0.2 C

D) 2 C

Answer: A

Explanation: $q = E/V = 100/20 = 5$ C.

14. Potential difference is defined as:

A) Charge per unit time

B) Work per unit charge

C) Resistance per charge

D) Power per unit time

Answer: B

Explanation: $V = W/q$.

15. If resistance increases while voltage remains constant, energy will:

A) Increase

B) Decrease

C) Remain same

D) Double

Answer: B

Explanation: $E = V^2/R \times t$, so $E \propto 1/R$.

16. If $I = 4$ A, $R = 3\ \Omega$, $t = 2$ s, energy is:

A) 96 J

B) 24 J

C) 48 J

D) 12 J

Answer: A

Explanation: $E = 16 \times 3 \times 2 = 96$ J.

17. If voltage becomes zero, energy supplied will be:

A) Maximum

B) Infinite

C) Zero

D) Constant

Answer: C

Explanation: $E = IVt$, so if $V = 0 \rightarrow E = 0$.

18. Which quantity does not affect electrical energy?

A) Current

B) Time

C) Voltage

D) Colour of wire

Answer: D

Explanation: Energy depends on I, V, R and t.

19. If $I = 5$ A, $V = 8$ V, $t = 1$ s, energy is:

A) 13 J

B) 40 J

C) 5 J

D) 8 J

Answer: B

Explanation: $E = 5 \times 8 \times 1 = 40$ J.

20. Electrical energy converted into heat follows:

A) Joule's Law

B) Newton's Law

C) Boyle's Law

D) Ohm's Law only

Answer: A

Explanation: Joule's Law states $E = I^2Rt$.

21. If both current and time are doubled, energy becomes:

A) Double

B) Four times

C) Eight times

D) Same

Answer: C

Explanation: $E = I^2Rt \rightarrow (2I)^2 \times (2t) = 8I^2Rt$.

22. If I = 1 A, V = 5 V, t = 10 s, energy is:

A) 50 J

B) 15 J

C) 5 J

D) 10 J

Answer: A

Explanation: $E = 1 \times 5 \times 10 = 50$ J.

23. If resistance is zero, energy using I^2Rt will be:

A) Zero

B) Infinite

C) Maximum

D) Same

Answer: A

Explanation: If R = 0, then E = 0.

24. If voltage doubles and resistance remains constant, energy becomes:

A) Double

B) Four times

C) Half

D) Same

Answer: B

Explanation: $E \propto V^2$.

25. Energy depends directly on:

A) Time only

B) Current only

C) Voltage only

D) Current, voltage and time

Answer: D

Explanation: From E = IVt.

Topic: Electric Power

1. Electric power is defined as:

A) Energy × time

B) Energy per unit time

C) Current × resistance

D) Voltage per unit charge

Answer: B

Explanation: Power is the rate of doing electrical work, $P = E/t$.

2. If 200 J energy is consumed in 10 s, power is:

A) 20 W

B) 2000 W

C) 0.05 W

D) 2 W

Answer: A

Explanation: $P = E/t = 200/10 = 20$ W.

3. From $P = E/t$ and $E = IVt$, power becomes:

A) $P = IV$

B) $P = I^2Rt$

C) $P = V^2Rt$

D) $P = IR$

Answer: A

Explanation: Substitute $E = IVt$ in $P = E/t \rightarrow P = IV$.

4. If V = 12 V and I = 3 A, power is:

A) 36 W

B) 4 W

C) 15 W

D) 9 W

Answer: A

Explanation: $P = IV = 12 \times 3 = 36$ W.

5. Using Ohm's law, $P = IV$ becomes:

A) $P = IR$

B) $P = I^2R$

C) $P = V/R$

D) $P = R/I$

Answer: B

Explanation: Replace V by IR → $P = I(IR) = I^2R$.

6. Another expression for power is:

A) $P = V^2/R$

B) $P = V/R^2$

C) $P = R^2/V$

D) $P = I/R$

Answer: A

Explanation: Using $I = V/R$ in $P = IV$.

7. If I = 2 A and R = 5 Ω, power is:

A) 20 W

B) 10 W

C) 5 W

D) 2.5 W

Answer: A

Explanation: $P = I^2R = 4 \times 5 = 20$ W.

8. If V = 10 V and R = 2 Ω, power is:

A) 50 W

B) 20 W

C) 5 W

D) 100 W

Answer: A

Explanation: $P = V^2/R = 100/2 = 50$ W.

9. SI unit of electric power is:

A) Joule

B) Watt

C) Volt

D) Ampere

Answer: B

Explanation: Power is measured in watts.

10. One watt is defined as:

A) 1 J × 1 s

B) 1 V × 1 A

C) 1 C/s

D) 1 Ω × 1 A

Answer: B

Explanation: 1 W = 1 V × 1 A.

11. If voltage doubles and resistance remains constant, power becomes:

A) Double

B) Four times

C) Half

D) Same

Answer: B

Explanation: $P = V^2/R$, so $P \propto V^2$.

12. If current doubles, power using $P = I^2R$ becomes:

A) Double

B) Four times

C) Half

D) Same

Answer: B

Explanation: Power $\propto I^2$.

13. If resistance increases while current remains constant, power

A) Increase

B) Decrease

C) Remain same

D) Become zero

Answer: A

Explanation: $P = I^2R$, so $P \propto R$.

14. If resistance increases while voltage remains constant, power will:

A) Increase

B) Decrease

C) Remain same

D) Double

Answer: B

Explanation: $P = V^2/R$, so $P \propto 1/R$.

15. A device uses 60 W power for 5 s. Energy consumed is:

A) 12 J

B) 300 J

C) 65 J

D) 55 J

Answer: B

Explanation: $E = Pt = 60 \times 5 = 300$ J.

16. If P = 100 W and V = 20 V, current is:

A) 5 A

B) 2000 A

C) 0.2 A

D) 2 A

Answer: A

Explanation: $P = IV \rightarrow I = P/V = 100/20 = 5$ A.

17. If P = 80 W and I = 4 A, resistance is:

A) 5 Ω

B) 20 Ω

C) 0.05 Ω

D) 16 Ω

Answer: A

Explanation: $P = I^2R \rightarrow 80 = 16R \rightarrow R = 5\ \Omega$.

18. If current is zero, power consumed is:

A) Infinite

B) Maximum

C) Zero

D) Constant

Answer: C

Explanation: $P = IV$, so if $I = 0 \rightarrow P = 0$.

19. Which formula is correct for calculating power?

A) $P = IV$

B) $P = I^2R$

C) $P = V^2/R$

D) All of these

Answer: D

Explanation: All three are valid forms.

20. If both voltage and current are doubled, power becomes:

A) Double

B) Four times

C) Eight times

D) Same

Answer: B

Explanation: $P = IV \rightarrow (2V)(2I) = 4VI$.

21. If energy consumed remains constant but time increases, power will:

A) Increase

B) Decrease

C) Remain same

D) Double

Answer: B

Explanation: $P = E/t$.

22. A 40 W bulb connected to 20 V draws current:

A) 2 A

B) 0.5 A

C) 800 A

D) 10 A

Answer: A

Explanation: $I = P/V = 40/20 = 2$ A.

23. If R = 4 Ω and V = 8 V, power is:

A) 16 W

B) 8 W

C) 4 W

D) 32 W

Answer: A

Explanation: $P = V^2/R = 64/4 = 16$ W.

24. Power depends directly on:

A) Time only

B) Voltage and current

C) Resistance only

D) Charge only

Answer: B

Explanation: $P = IV$.

25. If a circuit consumes 1 W power, it means:

A) 1 J energy per second

B) 1 C per second

C) 1 V per second

D) 1 Ω per second

Answer: A

Explanation: 1 W = 1 J/s

26. In an overheating alarm circuit, how does an NTC thermistor trigger the alarm?

A) By maintaining high resistance at high temperatures.

B) By breaking the circuit when it gets cold.

C) Resistance drops as temperature increases, allowing current to flow and trigger the alarm.

D) It generates its own electricity to ring a bell.

Answer: C

Explanation: NTC thermistors maintain high resistance at low temperatures to keep the alarm off; once the temperature of a motor or generator rises, the resistance drops enough for current to trigger the alarm.

27. In a street lighting system that turns on automatically when it gets dark, which component is most likely being used?

A) A PTC thermistor

B) A Varistor

C) An LDR (Light Dependent Resistor)

D) An NTC thermistor

Answer: C

Explanation: LDRs (or photo resistors) change their resistance based on light intensity. In low light, they have high resistance; as light increases, resistance decreases, making them ideal for automatic lighting controls.

28. Which wire carries the same amount of current as the live wire under normal operating conditions?

A) The Earth wire

B) The Neutral wire

C) The Grounding wire

D) None; the live wire carries the most current.

Answer: B

Explanation: This is a classic "trick" question. The neutral wire completes the circuit and provides the return path. According to the text, it carries the same current as the live wire but with opposite polarity. The Earth wire should carry zero current unless there is a fault.

29. In a parallel household circuit, if the coffee maker "burns out" (the internal circuit breaks), what happens to the kitchen lights on the same circuit?

A) They get brighter.

B) They turn off immediately.

C) They stay on and are unaffected.

D) They flicker because the resistance of the circuit increased.

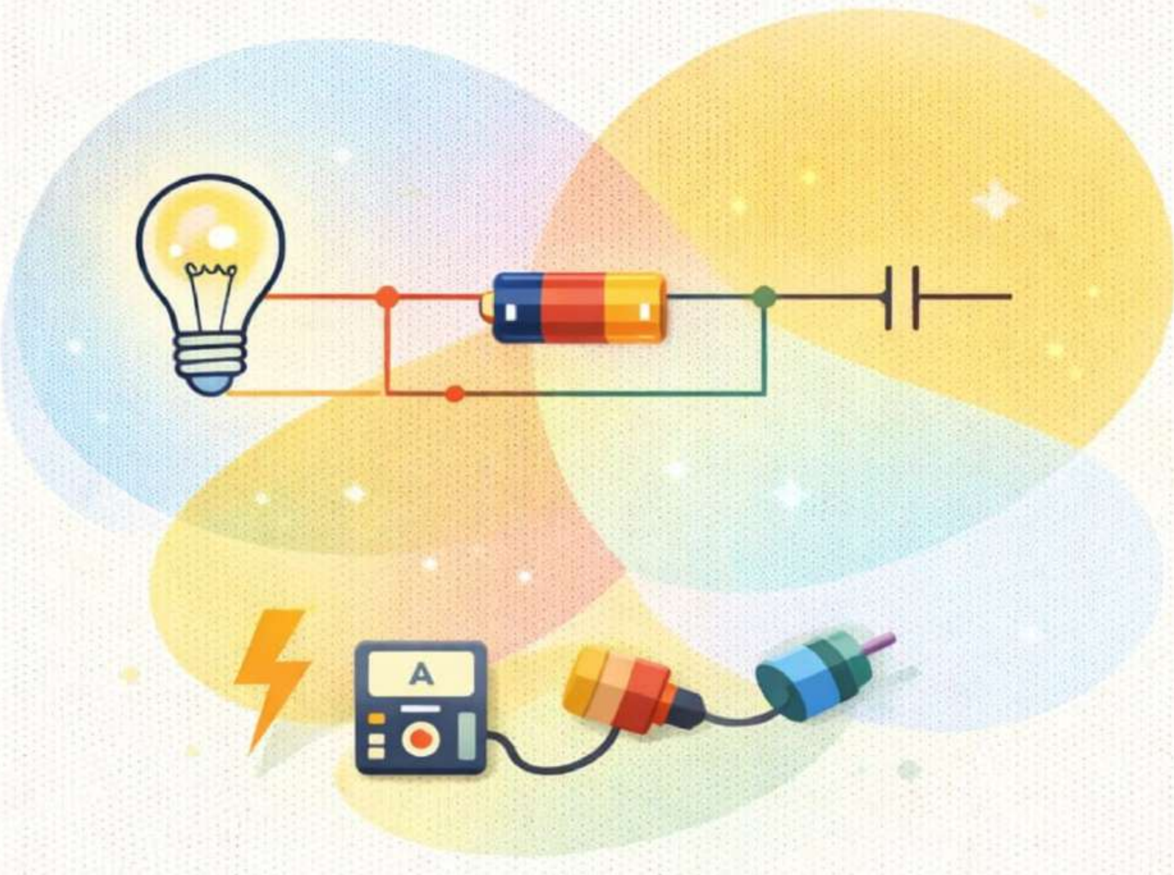
Answer: C

Explanation: This is the "beauty" of parallel circuits. Each appliance has its own independent path to the voltage source. A break in one path (the coffee maker) does not interrupt the flow of another path

CHAPTER 17

ELECTRIC CIRCUITS

Exercise MCQs



1. Two resistances of 4 Ω are connected in parallel and this combination is connected to another 6 Ω resistance in series. The equivalent resistance will be:

Options: A. 4 Ω, B. 6 Ω, C. 8 Ω, D. 10 Ω

Correct Answer: C. 8 Ω

Explanation: First, find the parallel resistance: Rp

= 4+4=8

4×4

=2 Ω.

Then add the series resistance: R total

=2 Ω+6 Ω=8 Ω.

2. In series connection of resistors, the current across each resistor:

Options:

A. increases,

B. decreases,

C. remain the same,

D. first increases then decreases

Correct Answer: C. remain the same

Explanation: In a series circuit, there is only one path for the flow of charge, so the current (I) is the same through every component.

3. A resistor's first three colours are brown, black and red, its value is: Options:

A. 10 Ω,

B. 10 kΩ,

C. 200 Ω,

D. 1000 Ω

Correct Answer: D. 1000 Ω

Explanation: Using the color code: Brown (1), Black (0), and Red (multiplier 10 2). This gives 10×10 2 =1000 Ω.

4. The relation for electric power in a circuit is $P = $:
Options:
A. IV,
B. I 2 R,
C. V 2 /R,
D. all of these
Correct Answer: D. all of these
Explanation: All three formulas are mathematically equivalent based on Ohm's Law (V=IR).

5. In the given figure, the current passing through 6 Ω resistor is: Options:
A. 0.40 A,
B. 0.48 A,
C. 0.72 A,
D. 0.80 A
Correct Answer: B. 0.48 A
Explanation: Using the current divider rule: I 1
=I total
× R 1
+R 2
R 2
. So, 1.2× 6+4 4
=1.2×0.4=0.48 A.

6. When four cells, each with an emf of 0.5 V, are connected in parallel, the net emf is:
Options:
A. 4.5 V,
B. 2.0 V,

C. 0.75 V,

D. 0.5 V

Correct Answer: D. 0.5 V

Explanation: In a parallel combination of identical cells, the total emf remains equal to the emf of a single cell.

7. The purpose of grounding electrical systems is to:

Options:

A. provide a path for current to flow,

B. protect against electric shocks,

C. reduce electrical resistance,

D. increase energy efficiency

Correct Answer: B. protect against electric shocks

Explanation: Grounding provides a low-resistance path to the Earth, directing dangerous fault currents away from people and equipment.

8. The purpose of a circuit breaker is to:

Options:

A. increase electrical resistance,

B. prevent electrical shock,

C. regulate voltage,

D. interrupt the flow of electricity in case of a fault

Correct Answer: D. interrupt the flow of electricity in case of a fault

Explanation: A circuit breaker automatically shuts off the circuit if the current becomes too high (due to an overload or short circuit) to prevent fire.

9. Which electrical element control the flow of the electric current in a circuit?

Options:

A. conductor,
B. insulator,
C. Resistor,
D. capacitor
Correct Answer: C. Resistor
Explanation: Resistance is the property of a material that opposes and regulates the flow of electric current.

10. A and B are two bulbs connected in parallel. A is glowing brighter than B, then the relation between R A
and R B
is: Options:
A. R A
R B
, B. R A
<R B
, C. R A
=R B
, D. R A
=0
Correct Answer: B. R A
<R B
Explanation: In parallel, P=V 2 /R. Since V is the same, the bulb with the lower resistance will consume more power and glow brighter.
11. The S.I unit for electrical power is: Options: A. watt, B. Joule, C. volt, D. kWh
Correct Answer: A. watt
Explanation: One Watt is defined as one Joule of energy consumed per second.

12. A wire of resistance R is divided in 10 equal parts. These parts

are connected in parallel, the equivalent resistance of such connection will be:

Options:

A. 10 R,

B. R,

C. 0.1 R,

D. 0.01 R

Correct Answer: D. 0.01 R

Explanation: Each part has resistance R/10. When 10 such parts are in parallel, R eq

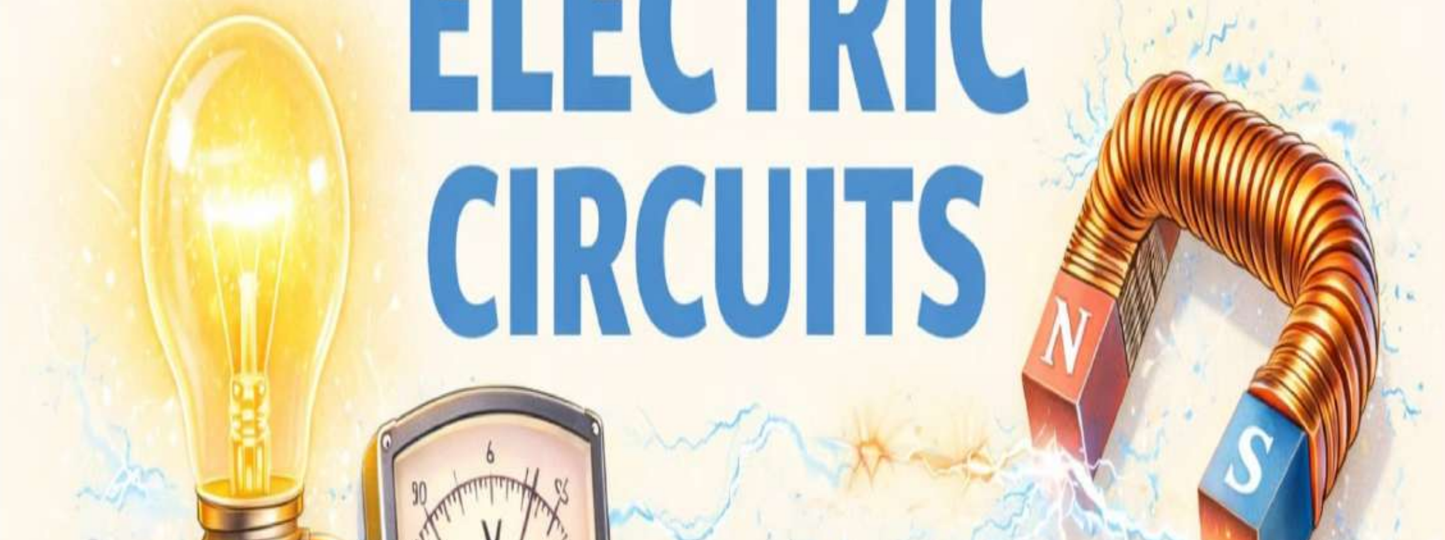
= 10 R/10

= 100 R

=0.01 R.

CHAPTER 17

ELECTRIC CIRCUITS



Exercise – Short Questions

CHAPTER 17:

ELECTRIC CIRCUITS

SHORT RESPONSE QUESTIONS :

Question 1 :

How does the color code on a carbon resistor provide information about its properties and why is this method chosen over labelling techniques?

Answer:

The color bands on a resistor indicate its resistance value, multiplier, and tolerance. Each color represents a specific number or factor. This method is used because it is compact, durable, easy to read, and suitable for small resistor.

Question 2:

Why are electrical devices in a home connected in parallel rather than in series? How would household functionality be impacted if they were connected in series?

Answer:

Devices connected in parallel:

- Each device receives full voltage.
- Devices work independently.
- Turning one device on/off does not affect others.

Devices connected in series:

- Voltage is shared among devices.
- Devices work weakly.
- If one device fails, the whole circuit stops.
- Household use becomes inconvenient and unreliable.

Question 3 :

When resistors are connected in parallel, why does the total resistance decrease? How does this principle relate to the

efficiency of electrical systems?

Answer:

When resistors are connected in parallel, total resistance decreases because the current has multiple paths to flow. This allows devices to receive full voltage and operate properly, reducing energy loss and making the electrical system more efficient.

Question 4:

How can connecting an ammeter in parallel damage a circuit? Suggest ways to prevent this.

Answer:

Connecting an ammeter in parallel can cause a short circuit, damaging the ammeter and circuit. To prevent this, always connect it in series, use fuses, and ensure the ammeter has the proper current rating.

Question 5:

Why is it unsafe to touch electrical switches with wet hands? What principles of conductivity and human safety does this advice rely on?

Answer:

Touching switches with wet hands is unsafe because water increases skin conductivity, allowing current to pass through the body. This can cause electric shock. It relies on the principle that the human body conducts electricity, so keeping hands dry ensures safety.

Question 6:

Why is touching a live wire with feet on the ground particularly dangerous? How do the factors involved influence the severity of an electrical shock?

Answer:

Touching a live wire while standing on the ground is dangerous because the body completes the circuit, allowing current to flow. The severity depends on voltage, current, body resistance, and contact duration; lower resistance or higher voltage causes a stronger shock.

Question 7:

How does a circuit breaker protect a household's electrical system? What might happen in the absence of a circuit breaker during a power surge or overload?

Answer:

A circuit breaker protects a household by automatically cutting off electricity when there is an overload or short circuit, preventing damage to appliances and wiring. Without it, excess current can damage devices, overheat wires, and even cause a fire.

Question 8:

In what ways does grounding protect appliance cases and user safety? How does grounding mitigate potential electrical hazards?

Answer:

Grounding protects appliance cases by providing a safe path for excess current to flow into the earth. This prevents the metal case from becoming dangerous to touch and reduces the risk of electric shock to the user. It also prevents short circuits, fires, and other electrical hazards, ensuring overall safety.

Question 9:

How does an appliance's wattage influence its energy consumption and operation cost? How can understanding this relationship help in making energy-efficient choices?

Answer:

An appliance with higher wattage consumes more energy and increases electricity costs. Understanding this helps people choose energy-efficient or lower-wattage appliances. This reduces energy consumption and saves money.

Question 10:

In what ways do electrical energy and electrical power differ in function and application? How do the differences impact our understanding and measurement of electricity?

Answer:

Electrical energy is the total electricity consumed over time, while electrical power is the rate of energy use at a given moment. The difference helps us understand how much electricity an appliance uses and how fast it uses it, allowing accurate measurement of consumption and electricity costs.

Question 11:

How does the kilowatt-hour relate to the unit of energy consumption, and how can you convert energy used from joules to kilowatt-hour?

Answer:

The kilowatt-hour is a unit of electrical energy commonly used to measure electricity consumption. To convert energy from joules to kilowatt-hour, use the relation: 1 kilowatt-hour = 3,600,000 joules.

So, **Energy in kilowatt-hour = Energy in joules ÷ 3,600,000.**

Question 12:

Describe a situation in your daily life where electrical energy is essential how does this energy transformed allow the device to perform its function?

Answer:

Using a **refrigerator** is an everyday example. The electrical energy is transformed into mechanical energy by the compressor, which moves the refrigerant, and this removes heat from inside, keeping the **food cold and fresh.**

Question 13:

What are three common sources of electrical energy and how do their advantages and disadvantages influence our choice of energy sources?

Answer:

Three common sources are fossil fuels, hydropower, and solar energy. Fossil fuels are reliable but polluting, hydropower is clean but needs large dams, and solar energy is renewable but depends on sunlight. These factors affect our choice based on cost, reliability, and environmental impact.

Question 14:

Examine the ways and risks of connecting different EMF sources in parallel and suggest safe ways to combine power sources.

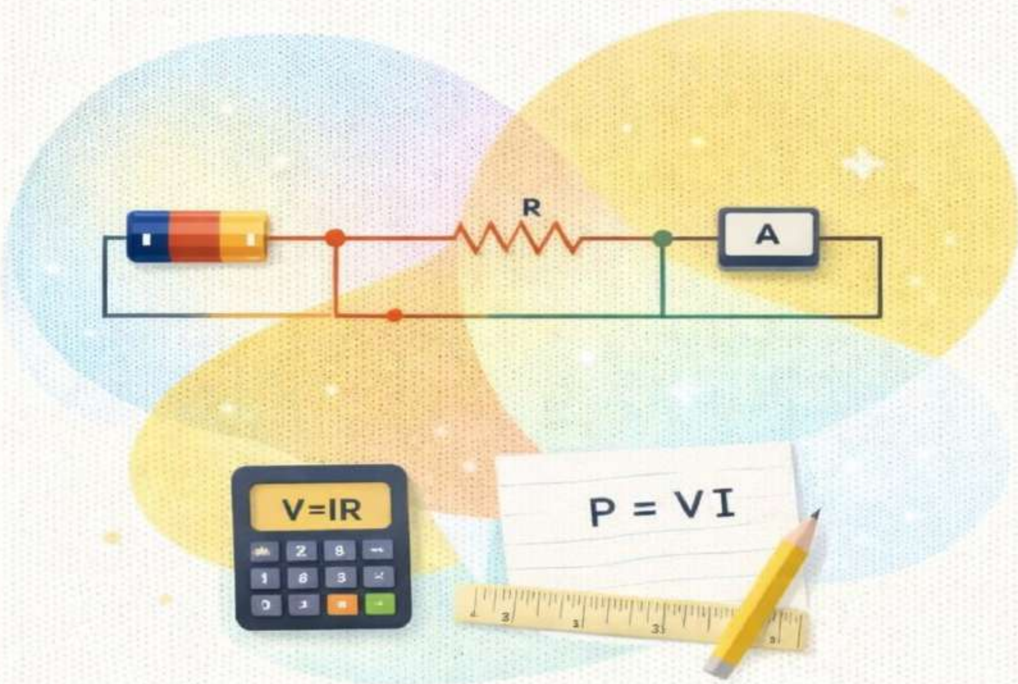
Answer:

Connecting EMF sources in parallel increases the total current. If the voltages are different, current can flow the wrong way, which may damage the sources or cause a short circuit. To be safe, use sources with the same voltage, add diodes to stop backflow, and include fuses.

CHAPTER 17

ELECTRIC CIRCUITS

Numericals

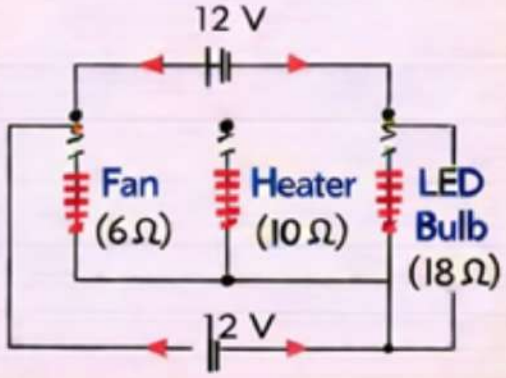


Q1.

A fan, a heater and an LED bulb are connected to a battery as shown in the figure.

(a) Find equivalent resistance.

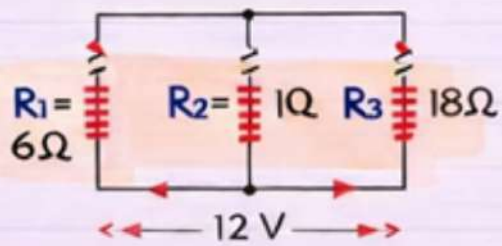
(b) Calculate the current passing through each device.



SOLUTION:

(a) Equivalent Resistance (R_{eq}):

→ Circuit Analysis:



For resistors in parallel,

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{10} + \frac{1}{18}$$

$$= \frac{(30 + 18 + 10}{180}$$

$$= \frac{58}{180}$$

$$R_{eq} = 90/29\ \Omega \qquad \approx 3.10\ \Omega$$

(b) Current through each device:

→ Total Current (I):

$$I = \frac{V}{R_{eq}} = \frac{12}{3.10}$$

$$I = 3.87\text{ A}$$

Current through each resistor

(Voltage same = 12 V)

$$I_1 = \frac{V}{R_1} = \frac{12}{6} = 2.00\text{ A}$$

$$I_2 = \frac{V}{R_2} = \frac{12}{10} = 1.20\text{ A}$$

$$I_3 = \frac{V}{R_3} = \frac{12}{18} \approx 0.67\text{ A}$$

ANSWER:

- Equivalent Resistance, $R_{eq} = 90/29\ \Omega \approx 3.10\ \Omega$
- Current through Fan (I_1) = 2.00 A
- Current through Heater (I_2) = 1.20 A
- Current through LED Bulb (I_3) ≈ 0.67 A

Q2.

Three resistors $R_1 = 8\Omega$, $R_2 = 12\Omega$, and $R_3 = 18\Omega$ are connected in parallel. Calculate the total resistance of the combination.

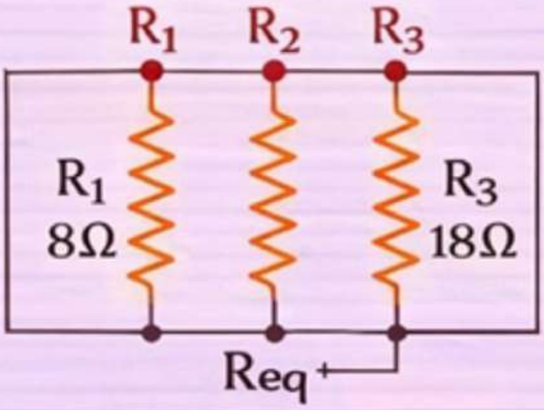
SOLUTION:

(a) **Equivalent Resistance (R_{eq}):**

→ **Circuit Analysis:**

For resistors in parallel:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$



For resistors in parallel:

$$\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{12} + \frac{1}{18}$$

$$\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{12} = \frac{152}{576}$$

$$R_{eq} = \frac{576}{152} = 3.789\ \Omega$$

ANSWER:

$$R_{eq} = 3.789\ \Omega$$

Q3.

A device with a resistance of 10 Ω is connected to a 120 V power source. Calculate the power consumed by the device.

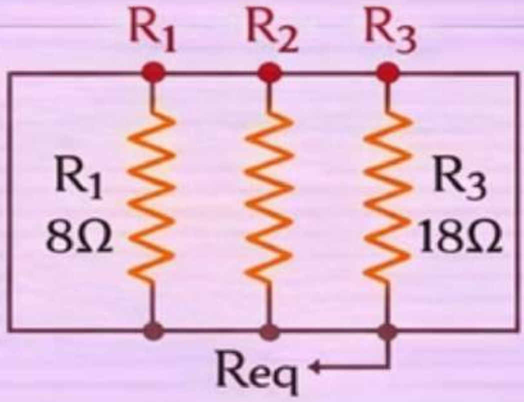
SOLUTION:

(a) Power Consumed by the Device (P):

→ Circuit Analysis:

Using the formula,

$$P = \frac{V^2}{R}$$



Using the formula,

$$P = \frac{120^2}{10} = \frac{14400^2}{10} = \frac{14400}{10}$$

$$P = 1440\ W$$

ANSWER:

$$P = 1440\ W$$

Q4.

A light bulb with a power rating of 60 W is switched on for 5 hours. Calculate the electrical energy consumed by the light bulb.

SOLUTION:

(a) Electrical Energy Consumed (E):

→ Circuit Analysis:

Using the formula,

$$E = P \times t$$

$$E = P \times t$$

$$E = (60\,W) \times (5\,hrs)$$

$$E = 300\,Wh$$

ANSWER:

$$E = 300\,Wh$$

Q5.

One hundred identical cells are connected in series, each of emf 0.2 V. What will the resultant emf when these identical cells are connected in parallel? When connected in parallel?

SOLUTION:

(a) Resultant EMF When Connected in Series:

→ Circuit Analysis:

Using information:

$n = 100$

$\varepsilon = 0.2V$

$$\varepsilon_{series} = \varepsilon_1 + \varepsilon_2 + \varepsilon_3 \cdots + \varepsilon_n$$

$$\varepsilon_{series} = 100\varepsilon = 100(0.2)$$

$$\varepsilon_{series} = 20\ V$$

(b) Resultant EMF When Connected in Parallel:

→ Circuit Analysis:

$$\varepsilon_{parallel} = \varepsilon_1 == \varepsilon_2 = \varepsilon_3 = \cdots = \varepsilon_n$$

$$\varepsilon_{parallel} = \varepsilon$$

$$E_{parallel} = 0.2\ V$$

ANSWER:

1. $E_{series} = 20\ V$ 2. $E_{parallel} = 0.2\ V$

Q6.

In the circuit shown, what is the value of the total resistance between points A and B?

SOLUTION:

(a) Finding Equivalent Resistance:

→ Given:

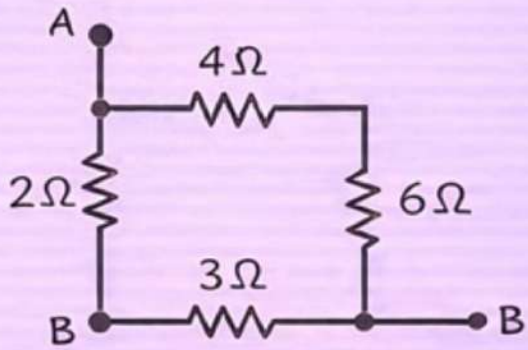
$R_1 = 4\Omega$

$R_2 = 6\Omega$

$R_3 = 2\Omega$

$R_4 = 3\Omega$

$R_{AB} = ?$



(a) Finding Equivalent Resistance:

→ Given:

$R_3 + R_4 = 2\Omega + 3\Omega$

$R_5 = 5\Omega$

(b) Parallel Combination:

→ $R_P = \frac{1}{R_P} = \frac{1}{6} + \frac{1}{5} = \frac{11}{30}$

$R_P = \frac{30/11}{11}$ $\quad R_P = 2.73\Omega$

$R_{AB} = R_1 + R_P$

$R_{AB} = 4 + 2.73$

$R_{AB} = 6.73\Omega$

$R_{AB} = 4 + 2.73 \longrightarrow R_{AB} = 6.73\Omega$

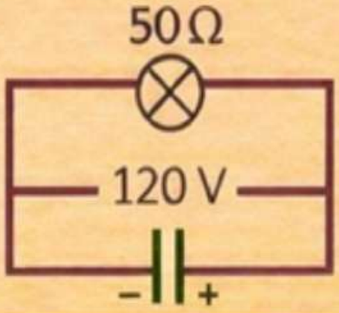
Q7.

Q7. Calculat the following:

(a) power consumed

(b) current flowing through

(c) electrical energy consumed
by the bulb in the given figure.



SOLUTION:

(a) Power Consumed:

→ Given:

$$P = \frac{V^2}{R}$$

$$P = \frac{(120)^2}{50} = \frac{14400}{50} = \underline{288\,W}$$

(b) Current Flowing Through:

→ $P = VI \rightarrow I = \frac{P}{V}$

$$I = \frac{288}{120} = 2.4\,A$$

(c) Electrical Energy Consumed:

→ $P = \frac{E}{t} \rightarrow E = P \cdot t$

$$E = 288\,t$$

Q8.

Q8. Calculate the total resistance of the circuit shown in the figure:

Given:

$R_1 = 4.5\,\Omega$

$R_2 = 12.5\,\Omega$

$R_3 = 12.5\,\Omega$

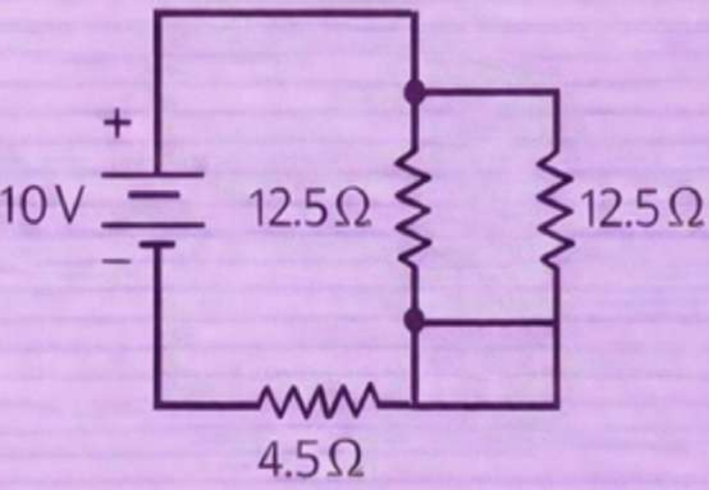
SOLUTION:

(a) Finding the Parallel Resistance:

→ $\frac{1}{R_P} = \frac{1}{12.5} + \frac{1}{12.5}$

$R_P = \frac{2}{12.5}$

$R_P = 6.25\,\Omega$



(b) Finding the Total Resistance:

→ $R_{eq} = R_1 + R_P$

$= 4.5\,\Omega + 6.25\,\Omega$

$R_{eq} = 10.75\,\Omega$

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