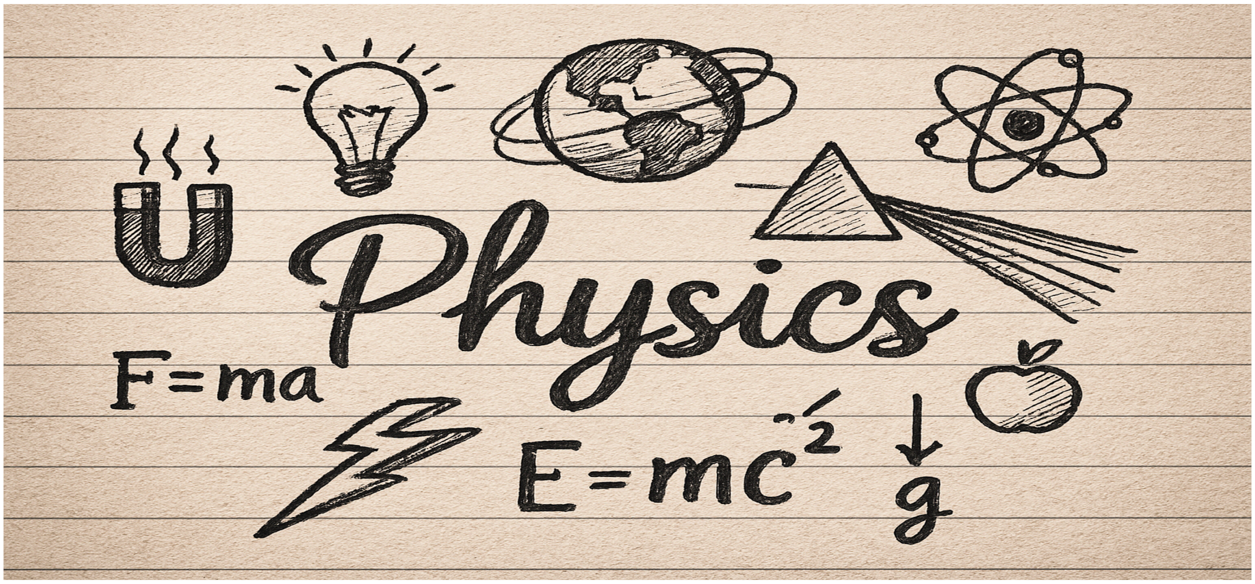


Class: 12th

Subject: Physics

Chapter 13: CURRENT ELECTRICITY

🩸 Important MCQs (Form Key points)

1. Electric current is caused by:

(a) Motion of electrons only

(b) Motion of protons only

(c) Motion of electric charge ✅

(d) Motion of atoms

2. The heat energy produced by a current in a wire is given by:

(a) $H = I \times R \times t$

(b) $H = I^2 \times R \times t$ ✅

(c) $H = V \times I \times t$

(d) $H = R^2 \times I \times t$

3. The passage of electric current is always accompanied by:

(a) Heat only

(b) Magnetic field ✅

(c) Chemical reaction only

(d) Light

4. The study of liquids conducting electricity due to chemical reactions is called:

(a) Electrolysis ✅

(b) Electroplating

(c) Electromagnetism

(d) Thermodynamics

5. Ohm's law states that the potential difference across a conductor is:

(a) Inversely proportional to current

(b) Directly proportional to current ✅

(c) Independent of current

(d) Proportional to resistance only

6. The fractional change in resistance per kelvin is called:

(a) Resistivity

(b) Conductance

(c) Temperature coefficient of resistance ✅

(d) EMF

7. A thermistor is:

(a) A light-sensitive resistor

(b) A heat-sensitive resistor ✅

(c) A magnetic device

(d) A voltage source

8. Electrical power in a resistor is given by:

(a) P = VI ✅

(b) P = V/I

(c) P = I/V

(d) P = V + I

9. The EMF of a source is defined as:

(a) Voltage across a resistor

(b) Energy supplied to unit charge by the cell ✅

(c) Current multiplied by resistance

(d) Work done per unit time

10. Kirchhoff's first rule states that:

(a) Algebraic sum of potential changes in a loop is zero

(b) Sum of all currents meeting at a point is zero ✅

(c) Power in a resistor is V^2/R

(d) Current is proportional to potential difference

🩸 Important MCQs

1. Electric current is defined as the rate of flow of:

(a) Energy

(b) Mass

(c) Charge ✅

(d) Temperature

2. The SI unit of electric current is:

(a) Volt

(b) Coulomb

(c) Ampere ✅

(d) Ohm

3. One ampere is equal to one:

(a) Volt per second

(b) Coulomb per second ✅

(c) Ohm per second

(d) Joule per second

4. In metallic conductors, the charge carriers are:

(a) Protons

(b) Electrons ✅

(c) Positive ions

(d) Neutral atoms

5. Conventional current flows from:

(a) Negative to positive

(b) Lower potential to higher potential

(c) Positive to negative ✅

(d) Earth to neutral

6. Electronic current (electron flow) is in the direction:

(a) Same as conventional current

(b) Opposite to conventional current ✅

(c) Circular direction

(d) No fixed direction

7. Drift velocity of electrons is approximately of the order of:

(a) 10^6 m/s

(b) 10^3 m/s

(c) 10^0 m/s ✅

(d) 10^8 m/s

8. In the absence of an electric field, free electrons in a metal move:

(a) In one direction

(b) Very slowly

(c) Randomly with high speed ✅

(d) Toward the positive terminal

9. When an electric field is applied, electrons move:

(a) Along the field

(b) Opposite to the field direction ✅

(c) Upward

(d) Not at all

10. A steady current is established in a conductor when:

(a) Temperature becomes zero

(b) Electrons stop colliding

(c) Constant potential difference is applied across it ✅

(d) Electrons move only randomly

11. Current flows between two conductors as long as they have:

(a) Same potential

(b) Different potentials ✅

(c) Same resistance

(d) Same temperature

12. When two conductors reach the same potential, current becomes:

(a) Maximum

(b) Constant

(c) Zero ✅

(d) Infinite

13. To maintain a constant current in a wire, we must maintain a constant:

(a) Resistance

(b) Length

(c) Potential difference ✅

(d) Temperature

14. A device that maintains a constant potential difference is called a:

(a) Voltmeter

(b) Resistor

(c) Source of current ✅

(d) Rheostat

15. A cell converts which form of energy into electrical energy?

(a) Solar energy

(b) Heat energy

(c) Mechanical energy

(d) Chemical energy ✅

16. Electric generators convert:

(a) Heat energy into electrical energy

(b) Solar energy into electrical energy

(c) Mechanical energy into electrical energy ✅

(d) Magnetic energy into electrical energy

17. Thermo-couples convert:

(a) Light energy into electrical energy

(b) Heat energy into electrical energy ✅

(c) Sound energy into electrical energy

(d) Chemical energy into electrical energy

18. Solar cells convert:

(a) Heat energy into electrical energy

(b) Mechanical energy into electrical energy

(c) Solar energy into electrical energy ✅

(d) Chemical energy into electrical energy

19. The heating effect of current is due to:

(a) Voltage drop

(b) Collisions of electrons with metal atoms ✅

(c) Reduction of resistance

(d) Decrease in electron charge

20. The heat produced in a wire is given by the formula:

(a) H = IVt

(b) H = It/R

(c) H = IRt (as given in syllabus) ✅

(d) $H = V^2Rt$

21. Heating effect of current is used in:

(a) Electric kettles and irons ✅

(b) Electric motors

(c) Solar panels

(d) Transformers

22. Passage of current through a conductor always produces:

(a) Light

(b) Magnetic field around it ✅

(c) Chemical reaction only

(d) Sound waves

23. Magnetic effect of current is used in:

(a) Heaters

(b) Motors and measuring instruments ✅

(c) Solar cells

(d) Thermo-couples

24. A liquid that conducts current due to chemical reaction is called:

(a) Electrode

(b) Electrolyte ✅

(c) Resin

(d) Voltameter

25. During electrolysis of $CuSO_4$, copper is deposited on the:

(a) Anode

(b) Cathode ✅

(c) Both electrodes

(d) Nowhere

26. Ohm's law states that current is directly proportional to:

(a) Resistance

(b) Power

(c) Potential difference (voltage) ✅

(d) Charge

27. Ohm's law is valid only when:

(a) Resistance changes continuously

(b) Physical conditions such as temperature remain constant ✅

(c) Voltage is zero

(d) Current is alternating

28. Which equation correctly represents Ohm's law?

(a) I = VR

(b) R = VI

(c) V = IR ✅

(d) V = I/R

29. The unit of resistance (ohm) is equal to:

(a) 1 volt per coulomb

(b) 1 volt per ampere ✅

(c) 1 ampere per volt

(d) 1 watt per ampere

30. A conductor has resistance of 1 ohm when a current of 1 A flows under a potential difference of:

(a) 0.5 V

(b) 1 V ✅

(c) 2 V

(d) 10 V

31. A conductor obeys Ohm's law if:

(a) Its V–I graph is curved

(b) Its resistance changes with temperature

(c) Its V–I graph is a straight line ✅

(d) It produces heat

32. A filament bulb is an example of:

(a) Ohmic device

(b) Non-ohmic device ✅

(c) Superconductor

(d) Linear conductor

33. The V–I graph for a non-ohmic device (like filament bulb) is:

(a) Always a straight line

(b) Always zero

(c) Not a straight line due to changing resistance with temperature ✅

(d) A horizontal line

34. Semiconductor diodes are:

(a) Ohmic devices

(b) Non-ohmic devices ✅

(c) Devices with constant resistance

(d) Superconductors

35. In a series combination of resistors, the equivalent resistance is:

(a) Product of all resistances

(b) Sum of all resistances ✅

(c) Reciprocal of all resistances

(d) Least of all resistances

36. Resistivity of a material is defined as:

(a) Resistance of a 1 cm cube

(b) Resistance of a 1 m cube ✅

(c) Resistance of 1 m wire

(d) Resistance per ohm

37. Unit of resistivity is:

(a) ohm

(b) ohm-cm

(c) ohm-metre (Ωm) ✅

(d) ohm/m

38. Resistance of a wire is directly proportional to:

(a) Area

(b) Length L of the wire ✅

(c) Temperature only

(d) Conductivity

39. Resistance of a wire is inversely proportional to:

(a) Length

(b) Resistivity

(c) Area A of cross-section ✅

(d) Temperature

40. In formula , ρ represents:

(a) Conductance

(b) Conductivity

(c) Resistivity of the material ✅

(d) Temperature coefficient

41. Conductance is equal to:

(a) R

(b) 1/R ✅

(c) ρL/A

(d) V/I

42. SI unit of conductance is:

(a) ohm

(b) watt

(c) mho or siemen (S) ✅

(d) coulomb

43. Conductivity (σ) is equal to:

(a) 1/R

(b) 1/ρ ✅

(c) R/A

(d) L/R

44. Best electrical conductor among the following is:

(a) Iron

(b) Silver ✅

(c) Nichrome

(d) Carbon

45. Resistivity of a metal ______ when temperature increases:

(a) Decreases

(b) Remains constant

(c) Increases ✅

(d) Becomes zero

46. The increase in resistance with temperature is due to:

(a) Decrease in electron speed

(b) Less collisions

(c) More collisions between electrons and atoms ✅

(d) Temperature coefficient becomes zero

47. Temperature coefficient of resistance (α) is defined as:

(a) Fractional change in current per kelvin

(b) Fractional change in resistance per metre

(c) Fractional change in resistance per kelvin ✅

(d) Fractional change in voltage

48. Substances with negative temperature coefficient are:

(a) Copper and silver

(b) Nichrome and tungsten

(c) Germanium and silicon ✅

(d) Iron and aluminum

49. Equation for temperature coefficient is:

(a) alpha = (Vt − V0) / (V0 × t)

(b) alpha = (Rt − R0) / (R0 × t) ✅

(c) alpha = (It − I0) / t

(d) alpha = (rho0) / (rho t × t)

50. Resistivity of metals changes with temperature because:

(a) Number of electrons decreases

(b) Lattice atoms vibrate more at high temperature ✅

(c) Voltage becomes constant

(d) Length of wire increases

51. Carbon resistors indicate their resistance using:

(a) Numerical digits

(b) Colour bands ✅

(c) Letters

(d) Size of resistor

52. In a 4-band resistor, the first band indicates:

(a) Decimal multiplier

(b) Second digit

(c) First digit ✅

(d) Tolerance

53. The fourth band on a resistor indicates:

(a) Voltage rating

(b) Tolerance ✅

(c) Temperature coefficient

(d) First digit

54. Silver band on a resistor indicates tolerance of:

(a) ±5%

(b) ±10% ✅

(c) ±20%

(d) ±1%

55. A rheostat can be used as:

(a) Variable resistor ✅

(b) Fixed resistor

(c) Capacitor

(d) Thermistor

56. In a rheostat, moving the sliding contact towards terminal A:

(a) Decreases resistance ✅

(b) Increases resistance

(c) Has no effect

(d) Short-circuits the circuit

57. Potential divider provides:

(a) Constant current

(b) Variable voltage ✅

(c) Constant resistance

(d) Constant power

58. Thermistors are:

(a) Current-sensitive resistors

(b) Voltage-sensitive resistors

(c) Temperature-sensitive resistors ✅

(d) Light-sensitive resistors

59. Most thermistors have:

(a) Positive temperature coefficient

(b) Negative temperature coefficient ✅

(c) Zero temperature coefficient

(d) Variable coefficient

60. Power dissipated in a resistor can be calculated by:

(a) P = VI ✅

(b) P = I + V

(c) P = I/V

(d) P = V/I

61. Electromotive force (EMF) of a cell is defined as:

(a) Force on a charge

(b) Energy supplied per unit charge ✅

(c) Potential difference across a resistor

(d) Current per unit voltage

62. SI unit of EMF is:

(a) Ampere

(b) Joule

(c) Volt ✅

(d) Ohm

63. EMF is always present:

(a) Only when current flows

(b) Only in open circuit

(c) Even when no current flows ✅

(d) Only in short circuit

64. Internal resistance of a cell is due to:

(a) Wire connected to the cell

(b) Resistance of the electrolyte ✅

(c) External load

(d) Resistor in series

65. Terminal potential difference V of a cell is given by:

(a) V = IR

(b) V = E − Ir ✅

(c) V = E + Ir

(d) V = E/I

66. Maximum power is delivered to the load when:

(a) R = 0

(b) R >> r

(c) Load resistance R = internal resistance r ✅

(d) R << r

67. EMF is the "cause" and potential difference is the:

(a) Cause

(b) Effect ✅

(c) Resistance

(d) Current

68. Kirchhoff's first rule is also called:

(a) Loop rule

(b) Point rule ✅

(c) EMF rule

(d) Ohm's rule

69. Kirchhoff's first rule states:

(a) Sum of voltage changes in a loop is zero

(b) Sum of currents at a junction is zero ✅

(c) Current through a resistor is constant

(d) EMF equals terminal voltage

70. In Kirchhoff's first rule, current flowing towards a junction is taken as:

(a) Negative

(b) Zero

(c) Positive ✅

(d) Infinite

71. Kirchhoff's second rule is also known as:

(a) Point rule

(b) Loop rule ✅

(c) Ohm's law

(d) Power rule

72. Kirchhoff's second rule states:

(a) Sum of currents at a point is zero

(b) Algebraic sum of potential changes in a closed loop is zero ✅

(c) EMF equals I × R

(d) Voltage drop equals current squared

73. While applying Kirchhoff's loop rule, if a resistor is traversed in the direction of current, the potential change is:

(a) Positive

(b) Negative ✅

(c) Zero

(d) Infinite

74. While applying Kirchhoff's loop rule, if a cell is traversed from negative to positive terminal, the potential change is:

(a) Zero

(b) Negative

(c) Positive ✅

(d) Equal to current

75. Kirchhoff's rules are based on:

(a) Law of conservation of energy and charge ✅

(b) Ohm's law only

(c) Coulomb's law

(d) Joule's law

76. In a Wheatstone bridge, no current flows through the galvanometer when:

(a) R1 + R2 = R3 + R4

(b) R1/R2 = R3/R4 ✅

(c) R1 × R2 = R3 × R4

(d) R1 – R2 = R3 – R4

77. The Wheatstone bridge is primarily used to measure:

(a) Current

(b) Voltage

(c) Unknown resistance ✅

(d) Power

78. In a Wheatstone bridge, the galvanometer shows zero deflection when:

(a) Bridge is unbalanced

(b) Bridge is balanced ✅

(c) All resistances are equal

(d) Battery is disconnected

79. If three resistances in a Wheatstone bridge are known and the fourth is unknown, the unknown resistance can be determined using:

(a) Ohm's law

(b) Kirchhoff's rules ✅

(c) Power formula

(d) Coulomb's law

80. A potentiometer is used to measure:

(a) Current

(b) Potential difference or EMF ✅

(c) Resistance

(d) Power

81. The resistance of an ideal voltmeter should be:

(a) Zero

(b) Very high ✅

(c) Equal to circuit resistance

(d) Very low

82. In a potentiometer, no current flows through the galvanometer when:

(a) Circuit is open

(b) Sliding contact is at midpoint

(c) Null condition is achieved ✅

(d) EMF is zero

83. The EMF of a cell using potentiometer is measured by adjusting the sliding contact until:

(a) Maximum current flows

(b) Minimum resistance occurs

(c) Galvanometer shows no deflection ✅

(d) All resistances are equal

84. The ratio of EMFs of two cells can be measured using a potentiometer by:

(a) Measuring current through each cell

(b) Comparing voltage across a resistor

(c) Taking ratio of balancing lengths ✅

(d) Using Ohm's law

85. A potentiometer provides accurate EMF measurement because:

(a) It draws large current

(b) No current is drawn from the cell ✅

(c) Resistance is zero

(d) Battery voltage is ignored

86. EMF is the "cause" and potential difference is the:

(a) Cause

(b) Effect ✅

(c) Resistance

(d) Current

87. Condition for a Wheatstone bridge balance depends on:

(a) Voltage across resistances

(b) Ratio of resistances ✅

(c) Total current in the circuit

(d) Type of battery used

88. In a potentiometer wire of uniform cross-section, resistance is proportional to:

(a) Square of length

(b) Inverse of length

(c) Length ✅

(d) Cross-sectional area

89. Maximum potential that can be obtained from a potentiometer wire is:

(a) Zero

(b) Equal to battery EMF ✅

(c) Twice the battery EMF

(d) Half the battery EMF

90. Potentiometer can be used to compare EMFs of two cells by:

(a) Measuring currents through both

(b) Using Ohm's law

(c) Using balancing lengths of the wire ✅

(d) Measuring power delivered

🩸 Important Short Questions (From Key Points)

1. What causes electric current?

Answer:

👉 Electric current is caused by the motion of electric charge.

2. What is the formula for heat produced in a wire due to current?

Answer:

👉 $H = I^2 \times R \times t$

3. What accompanies the passage of electric current?

Answer:

👉 The passage of current is always accompanied by a magnetic field in the surrounding space.

4. What is electrolysis?

Answer:

👉 Electrolysis is the process in which certain liquids conduct electricity due to chemical reactions taking place within them.

5. State Ohm's law.

Answer:

👉 The potential difference V across the ends of a conductor is directly proportional to the current I flowing through it, provided the physical state such as temperature remains constant.

6. What is the temperature coefficient of resistance?

Answer:

👉 The fractional change in resistance per kelvin is known as the temperature coefficient of resistance.

7. What is a thermistor?

Answer:

👉 A thermistor is a heat-sensitive resistor. Most thermistors have a negative temperature coefficient of resistance.

8. Give the formulas for electrical power.

Answer:

👉 Electrical power $P = V \times I = I^2 \times R = V^2 \div R$

9. Define EMF of a source.

Answer:

👉 The EMF E of the source is the energy supplied to unit charge by the cell.

10. State Kirchhoff's rules.

Answer:

👉 **Kirchhoff's first rule:** The sum of all currents meeting at a point in a circuit is zero.

👉 **Kirchhoff's second rule:** The algebraic sum of potential changes in a closed circuit is zero.

🩸 Important Short Questions:

1. What is an electric current?

Answer:

👉 An electric current is caused by the motion of electric charge.

2. What is the SI unit of electric current?

Answer:

👉 The SI unit of current is ampere, which is the flow of one coulomb of charge per second.

3. Who are the charge carriers in metallic conductors, electrolytes, and gases?

Answer:

👉 In metallic conductors: electrons, in electrolytes: positive and negative ions, in gases: electrons and ions.

4. What is conventional current?

Answer:

👉 Conventional current is defined as the flow of positive charge from a point at higher potential to a point at lower potential.

5. What is drift velocity?

Answer:

👉 Drift velocity is the average velocity acquired by free electrons in a conductor due to an electric field, causing a net flow of charge.

6. Name some devices that use the heating effect of current.

Answer:

👉 Electric heaters, kettles, toasters, and electric irons.

7. What is the magnetic effect of current?

Answer:

👉 The passage of current produces a magnetic field around the conductor, the strength of which depends on the current and distance.

8. How is the magnetic effect of current utilized?

Answer:

👉 It is used in the detection and measurement of current and in machines like electric motors.

9. What is the chemical effect of current?

Answer:

👉 Certain liquids conduct electricity due to chemical reactions caused by the current, a process known as electrolysis.

10. What is an electrolyte?

Answer:

👉 An electrolyte is a liquid that conducts electricity by allowing ions to move through it.

11. Define anode and cathode.

Answer:

👉 **Anode**: electrode connected to the positive terminal of the current source; Cathode: electrode connected to the negative terminal.

12. What is a voltameter?

Answer:

👉 A voltameter is a vessel containing two electrodes immersed in an electrolyte used to study electrolysis.

13. What happens to Cu^{2+} ions during electrolysis of copper sulphate solution?

Answer:

👉 Cu^{2+} ions move towards the cathode and deposit as copper atoms.

14. What happens to the copper anode during electrolysis of copper sulphate?

Answer:

👉 Copper atoms from the anode dissolve into the solution as Cu^{2+} ions, keeping the solution's density constant.

15. How is electroplating related to electrolysis?

Answer:

👉 Electroplating uses the chemical effect of current to coat a thin layer of expensive metal (like gold or silver) onto a cheaper metal.

16. State Ohm's law.

Answer:

👉 The current flowing through a conductor is directly proportional to the potential difference across its ends provided the physical state of the conductor remains constant.

17. What is the formula for Ohm's law?

Answer:

👉 V = IR, where V is voltage, I is current, and R is resistance.

18. What is an ohmic and a non-ohmic device?

Answer:

👉 **Ohmic device**: A conductor whose resistance remains constant and obeys Ohm's law (e.g., metallic wire).

👉 **Non-ohmic device**: A device whose resistance changes with voltage or current and does not obey Ohm's law (e.g., filament bulb, semiconductor diode).

19. How is the resistance of a conductor defined?

Answer:

👉 Resistance is the opposition to the motion of electrons due to collisions with atoms. It is $R = V/I$ and is measured in ohms (Ω).

20. Write the formula for equivalent resistance of resistors in series and parallel.

Answer:

👉 **Series**: $R_e = R_1 + R_2 + R_3 + \ldots$

👉 **Parallel**: $1/R_e = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$

21. What is resistivity?

Answer:

👉 Resistivity (ρ) is the property of a material that determines how much it resists the flow of electric current. It is defined as $\rho = (R \times A)/L$.

22. What is the SI unit of resistivity?

Answer:

👉 The SI unit of resistivity is ohm-metre (Ω·m).

23. How is resistance of a wire related to its length and cross-sectional area?

Answer:

👉 Resistance R is directly proportional to length L and inversely proportional to cross-sectional area A: $R \propto L/A$.

24. What is the temperature coefficient of resistance?

Answer:

👉 It is the fractional change in resistance per kelvin: $\alpha = (R_t - R_0)/(R_0 \times t)$, where R_0 is resistance at 0°C and R_t is resistance at t°C.

25. Name some materials with negative temperature coefficient of resistance.

Answer:

👉 Germanium, silicon, and some semiconductors have negative temperature coefficients; their resistance decreases as temperature increases.

26. What is a carbon resistor?

Answer:

👉 A carbon resistor is a resistor made of a ceramic rod coated with a thin resistive film of carbon. Its value is indicated by color bands.

27. How is the resistance value of a carbon resistor indicated?

Answer:

The resistance value is indicated by a color code consisting of four bands:

1. First digit

2. Second digit

3. Decimal multiplier

4. Tolerance

28. What is a rheostat and its use?

Answer:

👉 A rheostat is a wire-wound variable resistor. It is used to control current in a circuit or as a potential divider.

29. How does a rheostat work as a potential divider?

Answer:

The output voltage across a portion of the wire is given by:

$V_{BC} = (r / R) \times V$

Where:

r = resistance of portion BC

R = total resistance of the rheostat

V = applied voltage

30. What is a thermistor?

Answer:

👉 A thermistor is a heat-sensitive resistor. Its resistance decreases with increase in temperature (negative temperature coefficient) or increases (positive temperature coefficient).

31. Name two types of thermistors based on temperature coefficient.

Answer:

👉 Negative Temperature Coefficient (NTC) thermistor

👉 Positive Temperature Coefficient (PTC) thermistor

32. How are thermistors made?

Answer:

👉 Thermistors are made from semiconductor ceramics (mixtures of metallic oxides of Mn, Ni, Co, Cu, Fe), pressed under high pressure, and baked at high temperature.

33. What are the applications of thermistors?

Answer:

👉 Thermistors are used as temperature sensors, converting temperature changes into electrical voltage.

34. Write the general formula for electrical power supplied by a source.

Answer:

👉 $P = V \times I$

Where P = electrical power, V = potential difference, I = current.

35. Give three alternative formulas to calculate power dissipated in a resistor.

Answer:

1. $P = V \times I$

2. $P = I^2 \times R$

3. $P = V^2 / R$

36. What is electromotive force (EMF)?

Answer:

👉 EMF of a source is the energy supplied to unit charge by the cell.

$E = \Delta W / \Delta Q$

(Unit: Volt, V)

37. What is the internal resistance of a cell?

Answer:

Internal resistance r is the resistance offered by the electrolyte inside a cell. A cell with EMF E and internal resistance r is equivalent to a pure EMF E in series with resistance r.

38. Write the formula for terminal voltage of a cell.

Answer:

👉 $V = E - I \times r$

Where V = terminal potential difference, E = EMF, I = current, r = internal resistance.

39. When is the terminal voltage equal to EMF?

Answer:

👉 When no current flows through the external circuit (switch open), the terminal voltage equals EMF: $V = E$.

40. Write the formula for power delivered to an external resistor.

Answer:

👉 $P_{out} = V \times I = I^2 \times R = V^2 / R$

Where R = external resistance, I = current, V = potential difference across R.

41. When is the maximum power delivered to a load?

Answer:

👉 Maximum power is delivered when the load resistance equals the internal resistance of the source, $R = r$.

Maximum power: $P_{max} = E^2 / (4R)$

42. State Kirchhoff's first rule (Current Law).

Answer:

The sum of all currents meeting at a junction is zero:

$\Sigma I = 0$

Currents towards the junction are positive, away are negative.

43. State Kirchhoff's second rule (Voltage Law).

Answer:

The algebraic sum of potential changes in a closed circuit is zero:

$\Sigma \Delta V = 0$

It reflects the law of conservation of energy.

44. How do you determine potential changes across a source or resistor?

Answer:

👉 **Across a source (EMF):** positive if moving from -ve to +ve terminal, negative otherwise.

👉 **Across a resistor:** negative if traversed in direction of current, positive if opposite.

45. Give the basic procedure to solve a circuit using Kirchhoff's rules.

Answer:

1. Draw the circuit diagram.

2. Choose loops ensuring all resistances are included at least once.

3. Assume loop currents (clockwise or anticlockwise).

4. Write loop equations using potential changes.

5. Solve equations for unknown currents or voltages.

46. What is a Wheatstone bridge?

Answer:

👉 A Wheatstone bridge is a circuit of four resistances forming a mesh with a galvanometer connected between two points, used to measure unknown resistance.

47. State the condition for no current through the galvanometer in a Wheatstone bridge.

Answer:

👉 No current flows through the galvanometer when $R_1/R_2 = R_3/R_4$.

48. How can an unknown resistance be measured using a Wheatstone bridge?

Answer:

👉 Three known adjustable resistances (R_1, R_2, R_3) and a fourth unknown resistance R_4 are connected. R_1, R_2, R_3 are adjusted until the galvanometer shows no deflection. Then $R_4 = (R_3 \times R_2) / R_1$.

49. What is a potentiometer?

Answer:

👉 A potentiometer is an instrument used to measure and compare potential differences accurately without drawing current from the circuit. It consists of a uniform resistance wire with a sliding contact.

50. How is the emf of a cell measured using a potentiometer?

Answer:

👉 A source of emf E is applied across the potentiometer wire. The sliding contact is adjusted until the galvanometer shows no deflection. Then the unknown emf E_x is proportional to the length of wire:

$$E_x = E \times (l / L)$$

Where L = total wire length, l = balancing length corresponding to the unknown emf.

🩸 Important Long Questions:

🌟 Q1: Explain the source of current and its different types with examples.

❖ Answer:

1. Introduction to Electric Current:

- **Electric current** is the flow of electric charge (usually electrons) through a conductor.
- **Current flows** when two points in a conductor have different electric potentials.
- **Electrons move** from higher potential to lower potential.

- In a simple wire without a source, current flows only briefly until equilibrium is reached.

2. Need for a Source of Current:

- To maintain a continuous current, a source of current is required.
- A source supplies energy to the charges continuously, converting chemical, mechanical, heat, or light energy into electrical energy.

3. Types of Sources of Current:

A. Cells (Chemical Energy ⟶ Electrical Energy):

- Cells convert chemical energy into electrical energy.
- **Example:** Dry cell (AA, AAA, 9V), Lead-acid battery.
- Used in torches, toys, remote controls, cars, UPS systems.
- Cells can be connected in series (to increase voltage) or parallel (to increase current capacity).

B. Electric Generators (Mechanical Energy ⟶ Electrical Energy):

- Generators convert mechanical energy into electrical energy using electromagnetic induction.
- A conductor moving in a magnetic field produces an emf and current.
- **Example:** Hydroelectric plants, diesel generators.
- Used to supply electricity to homes, industries, and hospitals.

C. Thermocouples (Heat Energy → Electrical Energy):

- Thermocouples convert heat directly into electrical energy.
- Made of two different metals joined together; a voltage is generated when there is a temperature difference.
- **Example:** Temperature sensors in ovens, industrial thermometers.

D. Solar Cells (Light Energy → Electrical Energy):

- Solar cells convert sunlight directly into electrical energy using semiconductors.
- **Example:** Solar panels for homes, solar street lights, calculators.

- Electrons are released when sunlight strikes the semiconductor, producing current.

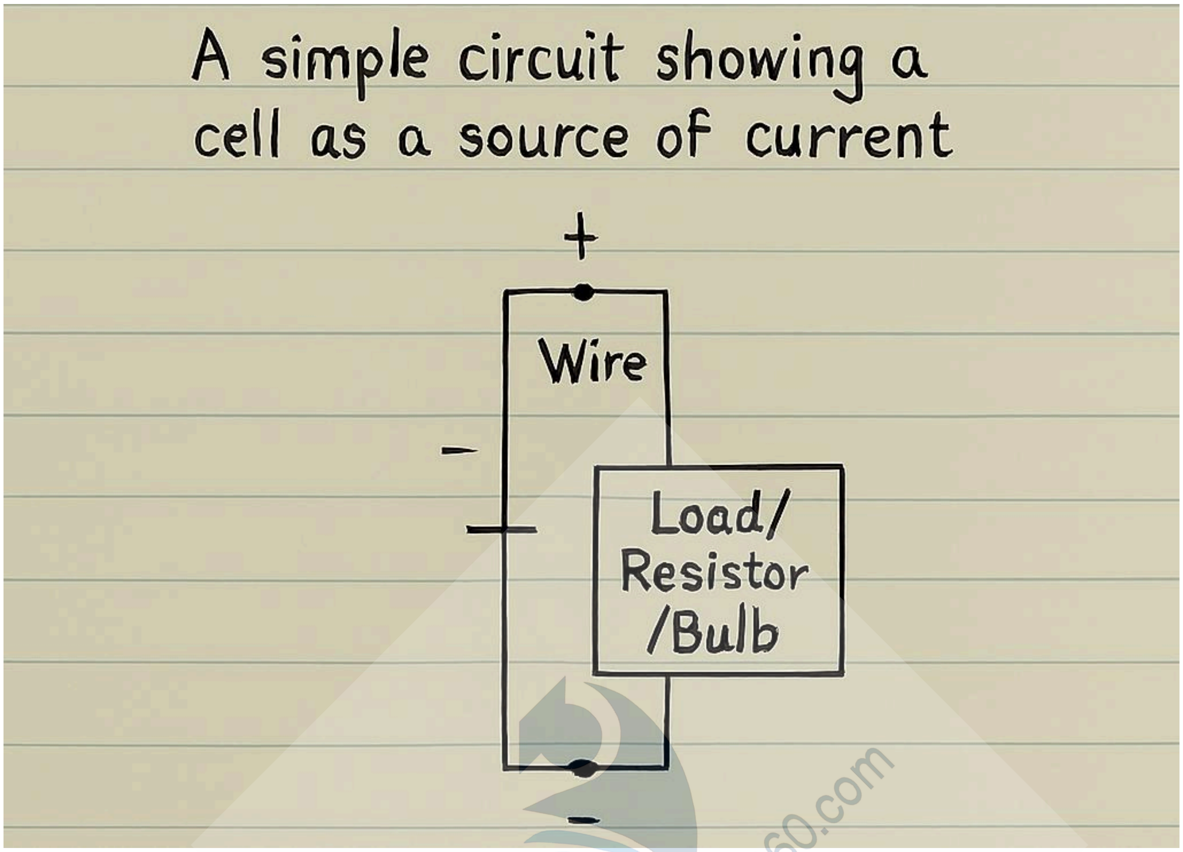
✦ **Summary:**

- A source of current is essential for continuous current flow.

Different sources convert different forms of energy into electrical energy:

- **Cells:** Chemical $\longrightarrow$ Electrical
- **Generators:** Mechanical $\longrightarrow$ Electrical
- **Thermocouples:** Heat $\longrightarrow$ Electrical
- **Solar Cells:** Light $\longrightarrow$ Electrical

✦ **Digram:**



Explanation of Diagram Concept:

1. The cell provides the potential difference.

2. Current flows from the positive terminal to the negative terminal through the external circuit.

3. The load (like a bulb or resistor) consumes electrical energy.

4. This simple diagram can also be adapted to show other sources:

Replace the cell with a generator (mechanical energy source).

Replace with solar cell (light energy source).

🌟 **Q2: Describe the effects of electric current with suitable examples.**

❖ **Answer:**

1. Heating Effect of Current

Jab current conductor se guzarta hai, to electrons atoms se takraate hain aur heat generate hoti hai.

Formula for heat produced:

$H = I^2 \times R \times t$

Where:

- H = Heat produced
- I = Current (amperes)
- R = Resistance (ohms)
- t = Time (seconds)

Applications: Electric heaters, kettles, toasters, irons.

2. Magnetic Effect of Current

- Current conductors around the magnetic field produce karta hai.
- Direction pata chalane ke liye Right-Hand Thumb Rule use hota hai.

Applications: Electric motors, galvanometers, magnetic detectors

3. Chemical Effect of Current (Electrolysis)

- Kuch liquids (electrolytes) current conduct karte hain aur chemical change hota hai.

Example: Electrolysis of copper sulfate ($CuSO_4$) solution:

- Cu^{2+} ions move to cathode ⟶ deposited as Cu metal
- Cu from anode dissolves ⟶ becomes Cu^{2+} ions

Applications: Electroplating (gold/silver coating), electrorefining of metals

🌟 **Q3: Explain the concept of a source of current and give examples of different types of sources.**

❖ **Definition:**

A source of current is a device that maintains a nearly constant potential difference across the ends of a conductor, ensuring continuous flow of current.

Need for a Source:

- When two conductors at different potentials are connected by a wire, current flows from higher potential to lower potential.
- The flow continues only until both ends reach the same potential.

Without a source, the current stops after potential equalization.

Energy Conversion:

A source converts non-electrical energy into electrical energy:

- Chemical $\longrightarrow$ Electrical
- Mechanical $\longrightarrow$ Electrical
- Heat $\longrightarrow$ Electrical
- Solar $\longrightarrow$ Electrical

Types of Sources with Examples:

1. Cells (Primary & Secondary): Convert chemical energy to electrical energy.

- **Example:** Dry cell, Lead-acid battery.

2. Electric Generators: Convert mechanical energy to electrical energy.

- **Example:** Hydro-electric generator, Diesel generator.

3. Thermocouples: Convert heat energy to electrical energy.

- **Example:** Thermoelectric devices.

4. Solar Cells: Convert sunlight directly into electrical energy.

- **Example:** Solar panels for homes or calculators.

🌟 **Q4: What are the effects of electric current? Describe its three main types with examples.**

❖ **Answer:**

Electric current is the flow of electrons through a conductor. Its presence is detected by the effects it produces. The three main effects are:

1. Heating Effect of Current

- Current through a conductor makes electrons collide with atoms, producing heat.

Heat produced by a current I in a wire of resistance R for time t is:

$H = I \times I \times R \times t$ (or $H = I^2 \times R \times t$)

Applications: Electric heaters, kettles, toasters, irons.

2. Magnetic Effect of Current

- A current-carrying conductor creates a magnetic field around it.
- Field strength depends on current and distance from wire.

Applications: Electric motors, galvanometers, magnetic detectors, loudspeakers.

3. Chemical Effect of Current

- Certain liquids (electrolytes) like copper sulphate solution conduct electricity and undergo chemical changes.

Electrolysis: Passing current through electrolyte causes reactions at electrodes:

- **At cathode:** $Cu^{2+} + 2\,e^- \longrightarrow Cu$ (deposited)
- **At anode:** $Cu \longrightarrow Cu^{2+} + 2\,e^-$ (dissolves)

Applications: Electroplating gold, silver on cheaper metals.

✦ **Summary:**

1. Heating Effect: Generates heat; used in heaters and irons.

2. Magnetic Effect: Produces magnetic field; used in motors, galvanometers.

3. Chemical Effect: Causes chemical changes in electrolytes; used in electroplating.

🌟 **Q5: Explain Ohm's law and define resistance. Give the SI unit of resistance with its definition.**

❖ **Answer:**

1. Concept of Current and Potential Difference

Electric current (I): The flow of electric charges (electrons) through a conductor per unit time.

Potential difference (V): The work done to move a unit charge between two points in a conductor. It is the driving force for current.

2. Ohm's Law

Ohm's law states:

> "The current flowing through a conductor is directly proportional to the potential difference across its ends, provided the physical conditions (such as temperature) of the conductor remain constant."

Mathematical form:

V = I \ R

Where:

- **V =** potential difference across the conductor (volts, V)
- **I =** current through the conductor (amperes, A)
- **R =** resistance of the conductor (ohms, Ω)

3. Resistance

Resistance is the opposition offered by a conductor to the flow of electric current.

Factors affecting resistance:

- Nature of material
- Length of the conductor (directly proportional)
- Cross-sectional area (inversely proportional)
- Temperature

SI Unit: Ohm (Ω)

> A conductor has a resistance of 1 ohm if a current of 1 ampere flows through it when a potential difference of 1 volt is applied.

4. Ohmic and Non-Ohmic Devices

Ohmic Devices:

- A conductor is ohmic if it strictly obeys Ohm’s law.
- Current is directly proportional to potential difference.

Examples: Metallic wires, resistors.

V-I Graph: Straight line passing through the origin.

Non-Ohmic Devices:

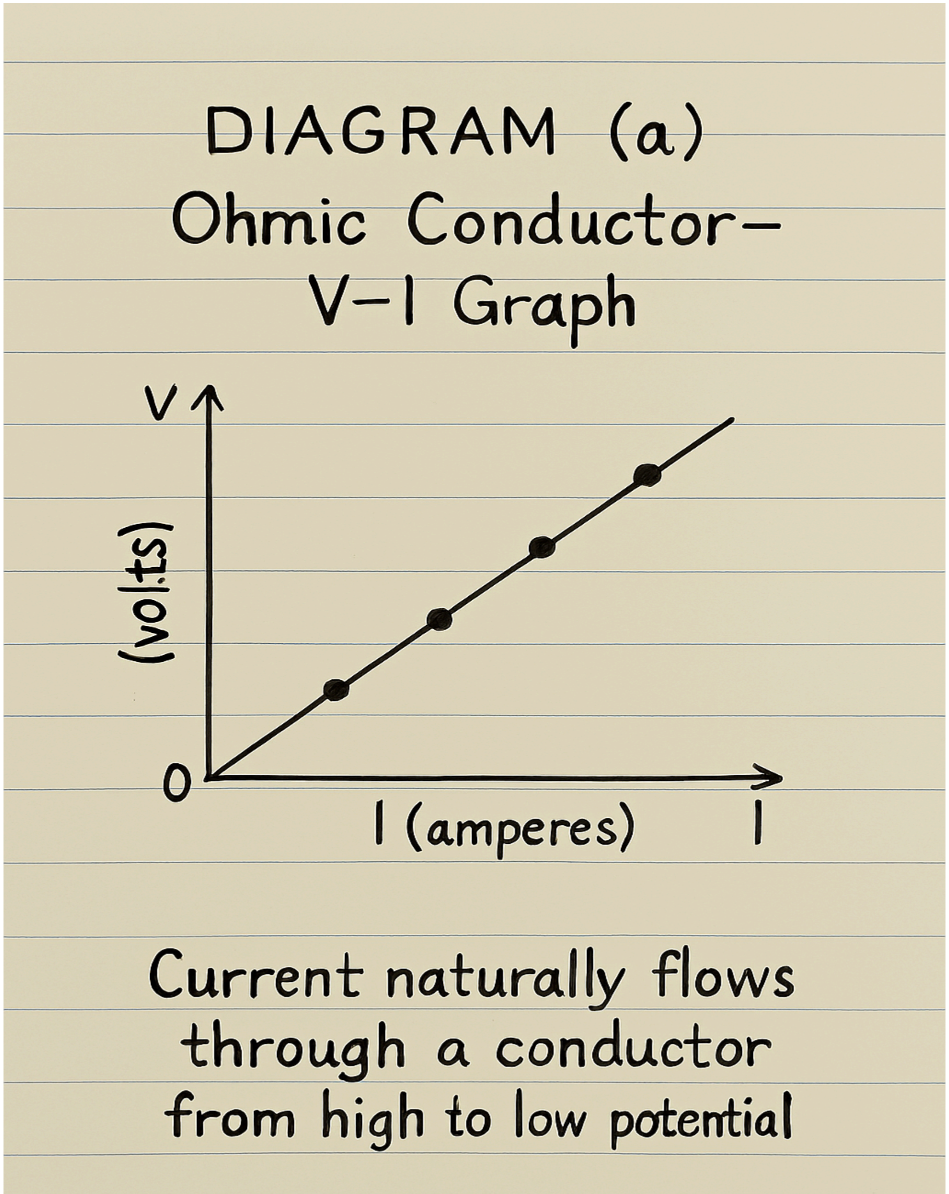
- A device is non-ohmic if it does not obey Ohm’s law.
- Current is not directly proportional to potential difference.

Examples: Filament bulbs, semiconductor diodes.

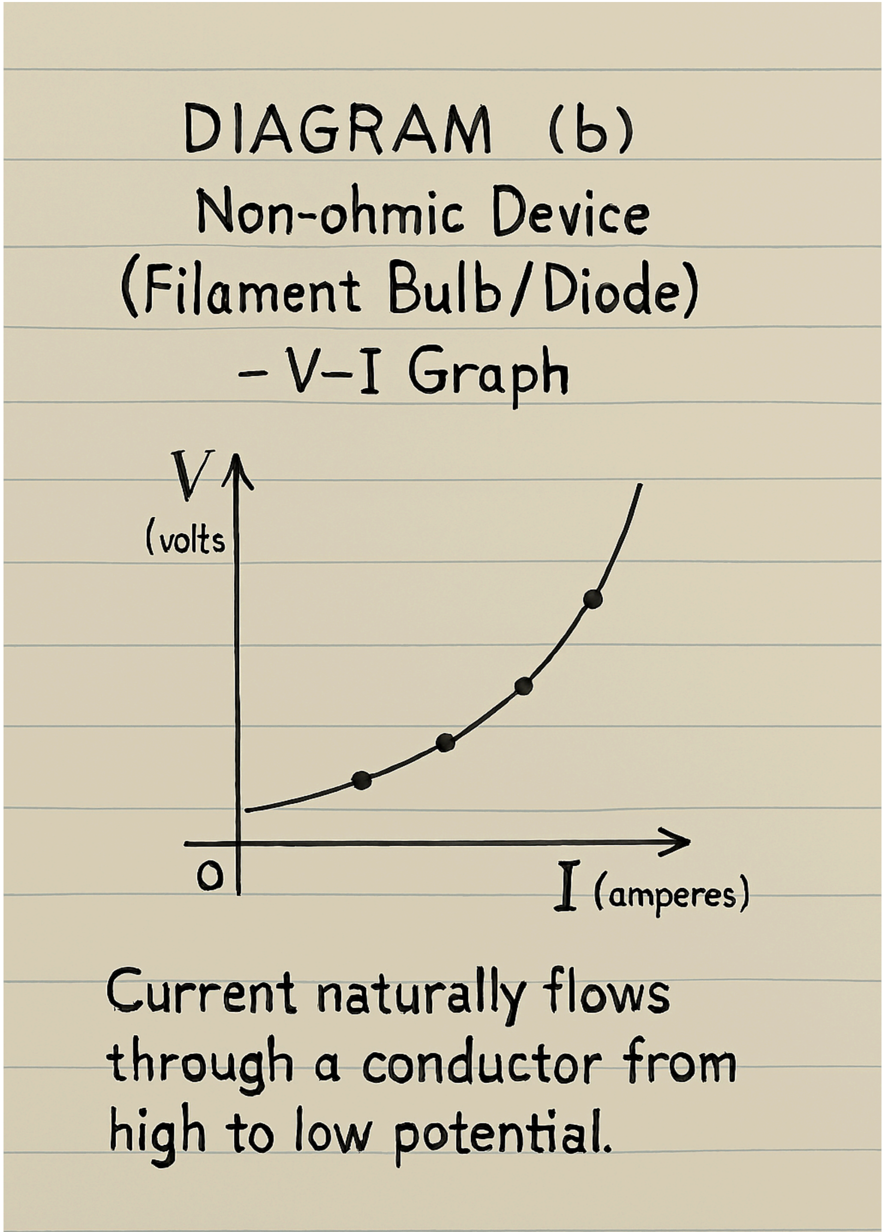
V-I Graph: Curved, not straight, due to resistance changing with temperature (filament) or non-linear current-voltage relationship (diode).

✦ Diagrams:

(a) Ohmic conductor – V-I graph (straight line)



(b) Non-ohmic device (filament bulb/diode) – V-I graph (curved line)



🌟 **Q6: What is a thermistor? Explain its types and applications.**

❖ **Answer:**

A thermistor is a special type of resistor whose resistance changes with temperature. It is a heat-sensitive resistor used in circuits to detect or respond to temperature changes.

Construction:

- Thermistors are made from metallic oxide ceramics such as manganese, nickel, cobalt, copper, iron, etc.
- These oxides are pressed into desired shapes like beads, rods, or washers and then baked at high temperatures to form a stable, temperature-sensitive resistor.

Types of Thermistors:

1. Negative Temperature Coefficient (NTC) Thermistors:

- Resistance decreases as temperature increases.
- Most common type.
- Useful for measuring low temperatures accurately because high resistance at low temperatures gives more precise readings.

2. Positive Temperature Coefficient (PTC) Thermistors:

- Resistance increases as temperature increases.
- Often used in overcurrent protection and self-regulating heating devices.

Applications:

- **Temperature sensors:** Detect changes in temperature and convert them into electrical signals.
- **Accurate low-temperature measurement:** Especially useful near 10 K for scientific instruments.
- **Voltage regulation based on temperature:** Thermistors can control voltage or current depending on temperature in a circuit.
- **Other uses:** Overcurrent protection (PTC) and devices that automatically switch off at high temperatures.

🌟 Q7: Define electromotive force (EMF) and potential difference. Explain the difference between them with examples.

❖ Answer:

1. Electromotive Force (EMF):

- EMF is the total energy supplied per unit charge by a cell or battery.
- This energy comes from chemical reactions inside the cell.
- **Its unit is volt.**
- EMF is the maximum possible voltage of a cell when no current is flowing in the circuit.

2. Potential Difference (P.D):

- Potential difference is the energy used per unit charge in the external circuit (e.g., across a resistor).
- When current flows, some voltage is lost inside the cell due to internal resistance, and the remaining appears across the external circuit.
- This is also called terminal potential difference.

3. Internal Resistance of a Cell:

- Every cell has some internal resistance (r).
- When current (I) flows, a voltage drop equal to I × r occurs inside the cell.
- **Therefore**, the terminal potential difference becomes less than EMF.

4. Difference Between EMF and Potential Difference:

EMF = total energy supplied per unit charge by the source (no current flowing).

Potential Difference = useful energy per unit charge delivered to the external circuit

(current flowing).

Hence EMF is always greater than the terminal potential difference when current is flowing.

5. Example:

- EMF of a battery = 6 V
- Internal resistance = 1 Ω
- Current = 1 A
- Internal drop = 1 × 1 = 1 V
- Terminal P.D = 6 − 1 = 5 V

Meaning:

- The battery supplies 6 V in total, but the external circuit receives only 5 V.

🌟 **Q8: State and explain Kirchhoff's first rule (junction rule) with an example.**

❖ **Answer: Kirchhoff's First Rule (Junction Rule)**

1. Statement of Kirchhoff's First Rule:

- Kirchhoff's first rule is called the junction rule. It states that:

"The algebraic sum of currents entering a junction is equal to the sum of currents leaving the junction."

In simple words,

total current entering a point = total current leaving that point.

2. Reason / Explanation:

- This rule is based on the law of conservation of charge.
- Charge cannot be created or destroyed in an electrical circuit.

Therefore, the amount of charge (and hence current) coming into a junction must equal the amount leaving it.

3. Sign Convention:

- Current entering the junction is taken as positive (+).

- Current leaving the junction is taken as negative (−).
- **Using this,** the total current at the junction becomes zero:
- (+ currents entering) + (− currents leaving) = 0

4. Example:

Suppose three wires meet at a junction.

- Current I_1 = 4 A enters the junction.
- Current I_2 = 3 A enters the junction.
- Current I_3 leaves the junction.

According to the junction rule:

$4\ A + 3\ A = I_3$

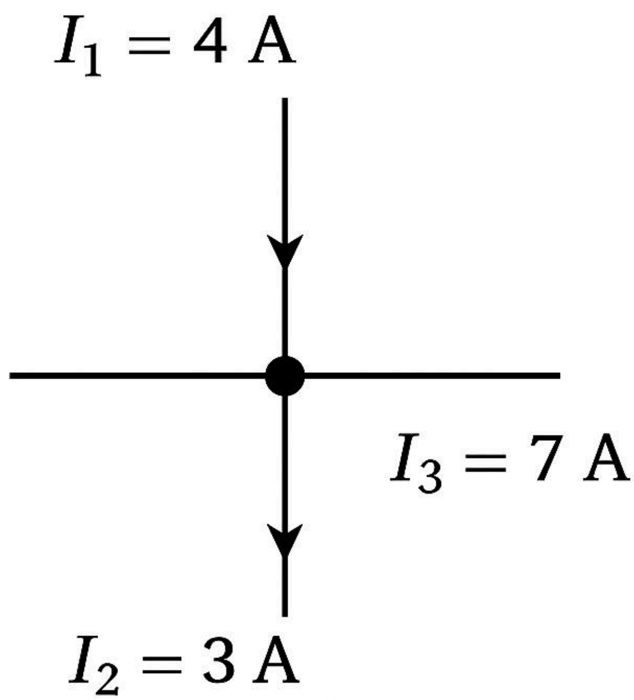
So,

$I_3 = 7\ A$

Meaning:

Total 7 A current enters the junction, so 7 A must leave it.

✦ **Digram:**



- Two currents enter (4 A and 3 A).
- One current (7 A) leaves.
- Rule satisfied: 4 + 3 = 7

🌟 **Q9: State and explain Kirchhoff's second rule (loop rule) with an example.**

❖ **Answer: Kirchhoff's Second Rule (Loop Rule)**

1. Statement of Kirchhoff's Second Rule (Loop Rule):

Kirchhoff's second rule states:

"The algebraic sum of all potential differences (voltage rises and drops) around a closed loop is zero."

In simple words:

Total voltage gained = Total voltage lost in a loop.

2. Reason / Explanation:

- This rule is based on the law of conservation of energy.
- When a charge completes a loop, the net energy change must be zero.
- A battery gives energy (voltage rise).
- Resistors consume energy (voltage drop).
- So both must balance.

3. Sign Convention:

To apply the loop rule, we follow signs:

- When moving from negative (−) to positive (+) terminal of a battery → voltage rise (+E)

- When moving from positive (+) to negative (−) terminal → voltage drop (−E)
- When moving in direction of current through a resistor → voltage drop (−IR)
- Against the current → voltage rise (+IR)

4. Example: A loop with one battery and two resistors

Consider a loop:

- Battery = E
- Resistors = R_1 and R_2
- Current = I

Applying Loop Rule:

Start from battery negative terminal and go around the loop:

- Voltage rise across battery = +E
- Voltage drop across R_1 = $-\ I R_1$
- Voltage drop across R_2 = $-\ I R_2$

According to loop rule:

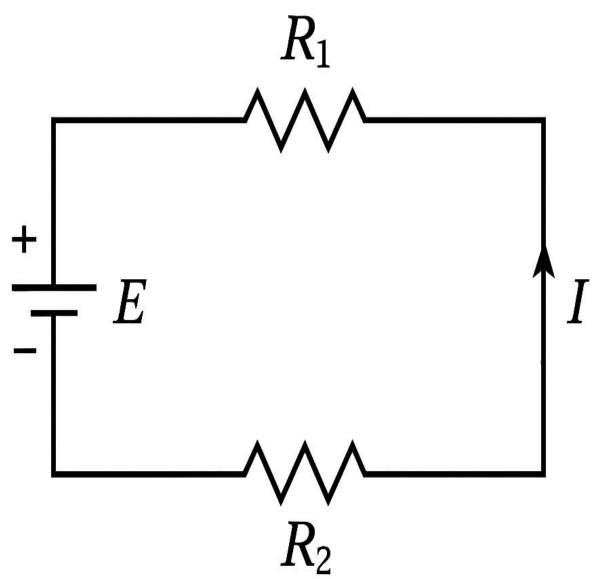
$E - I R_1 - I R_2 = 0$

Rearranging:

$E = I (R_1 + R_2)$

This shows that the energy supplied by the battery equals the energy used in resistors.

✦ **Digram:**



- The battery gives energy.
- R_1 and R_2 consume energy.
- Net gain = net loss ⟶ loop rule satisfied.

🌟 Q10: Explain the Wheatstone Bridge and derive the condition for no current through the galvanometer. How can it be used to determine an unknown resistance?

❖ **Answer:**

1. Concept (what is a Wheatstone bridge):

A Wheatstone bridge is a four-resistor circuit arranged in a diamond (or bridge) shape. The four resistors are labelled R_1, R_2, R_3, R_4. A battery (or emf source) is connected across two opposite corners (A and C). A sensitive galvanometer is connected between the other two corners (B and D). The arrangement is used to compare resistances and to measure an unknown resistance precisely.

2. Function (how it works):

When the bridge is supplied from the battery, currents flow through the two branches (left branch A⟶B⟶C and right branch A⟶D⟶C).

If the resistor values are such that the potential at point B equals the potential at point D, no current flows through the galvanometer (it shows zero deflection).

This situation is called the balanced condition of the bridge.

3. Derivation of the balance (no-current) condition — step by step (text formulas for easy copying):

Assume, at balance, the current in the left branch (through R_1 and R_2) is I_1 and the current in the right branch (through R_3 and R_4) is I_2. Because the galvanometer current is zero, these two branch currents are independent of each other.

- Voltage drop from A to B along the left branch = $I_1 \times R_1$.
- Voltage drop from A to D along the right branch = $I_2 \times R_3$.

At balance the potentials at B and D are equal, so the drops from A to these points are equal:

- $I_1 \times R_1 = I_2 \times R_3$. (Equation 1)

Also, voltage drop from B to C along the left branch = $I_1 \times R_2$, and from D to C along the right branch = $I_2 \times R_4$. Since B and D have the same potential at balance, the drops to C must be equal:

- $I_1 \times R_2 = I_2 \times R_4$. (Equation 2)

Now divide Equation 1 by Equation 2 (the currents I_1 and I_2 cancel):

- $(R_1 / R_2) = (R_3 / R_4)$.

This is the balance condition of the Wheatstone bridge.

Text form of the balance condition (copyable):

- $R_1 / R_2 = R_3 / R_4$

From this you can solve for an unknown resistance. For example, if R_4 is unknown:

- $R_4 = R_3 \times (R_2 / R_1)$

(again in plain text: R4 = R3 * (R2 / R1))

4. How to determine an unknown resistance in practice:

1. Place the unknown resistor in one arm of the bridge (say R_4). Make R_1, R_2 and R_3 known and adjustable (one or two of them variable).

2. Connect the battery across A and C and the galvanometer between B and D.

3. Adjust the known resistances (or a variable ratio arm) until the galvanometer shows zero deflection (no current through the galvanometer).

4. At that balance point use the relation $R_4 = R_3 \times (R_2 / R_1)$ to compute the unknown resistance.

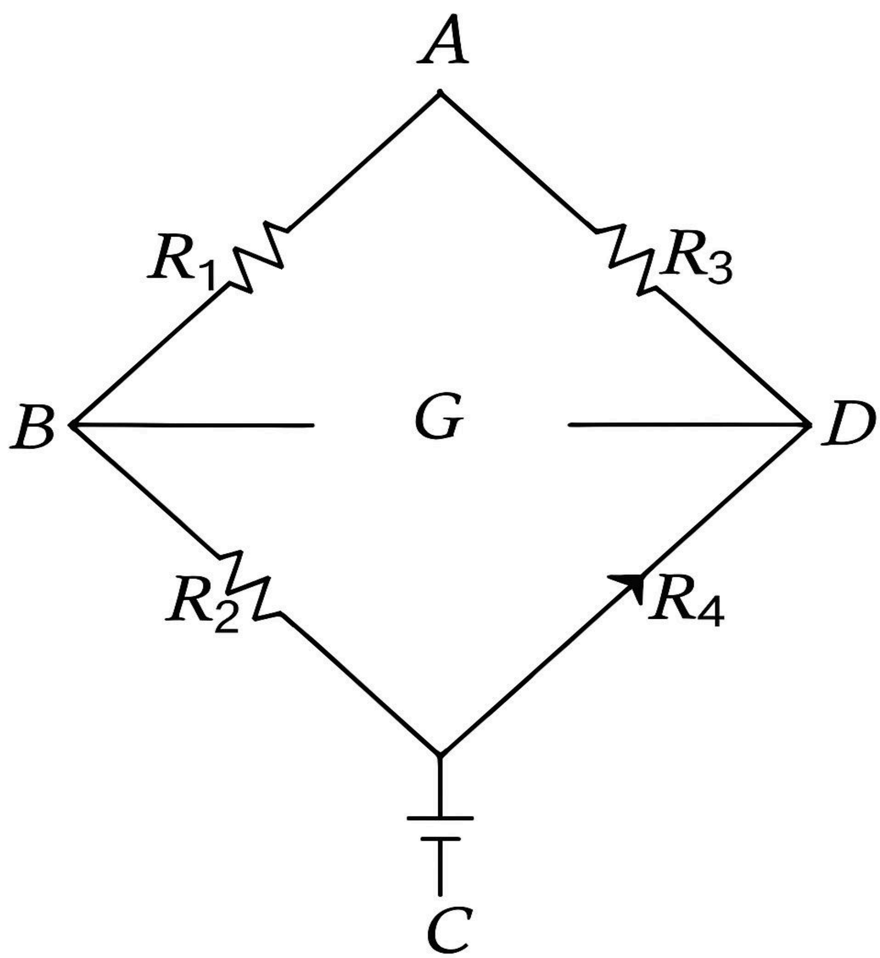
Note: The balance condition is independent of the battery voltage, so readings are not affected by exact battery emf (only by the ratios of resistances).

For high precision, one arm is often a slide-wire or a standard decade resistance box so that precise ratios can be set.

5. Practical notes / applications:

- Wheatstone bridge is widely used in laboratories for accurate resistance measurement.
- Sensitive galvanometer (or null detector) improves precision because one measures a null (zero) rather than a small value.
- The method is particularly good for medium resistances; for very small or very large resistances other techniques are preferred or bridge modified.

✦ **Diagram:**



- Battery across A–C, galvanometer G across B–D.
- **At balance:** potential at B = potential at D ⟶ no current through G ⟶ R1/R2 = R3/R4.

✦ **Summary:**

A Wheatstone bridge balances when $R_1/R_2 = R_3/R_4$.

If three resistances are known and the bridge is balanced, the fourth (unknown) resistance is found by $R_4 = R_3 \times (R_2 / R_1)$.

The method measures unknown resistances accurately because it uses a null (zero) reading on a sensitive galvanometer.

🌟 **Q11: Explain Ohm's Law and define resistance. Include ohmic and non-ohmic devices.**

❖ **Answer:**

1. Concept of Current and Potential Difference

- Electric current is the flow of electrons through a conductor.
- Potential difference (voltage) is the energy supplied per unit charge to move electrons from one point to another.
- When a voltage is applied across a conductor, electrons start drifting and current flows.

2. Ohm's Law (statement and meaning)

Ohm's Law states:

The current flowing through a conductor is directly proportional to the potential difference across it, provided the temperature remains constant.

Formula:

V = I × R

Where:

V = voltage

I = current

R = resistance

This means:

- If voltage increases ⟶ current increases.
- If voltage decreases ⟶ current decreases.
- The ratio V/I remains constant for an ohmic conductor.

3. Resistance (definition + SI unit)

- Resistance is the opposition offered by a conductor to the flow of electric current.

SI unit: ohm (Ω)

Definition of 1 ohm:

A conductor has a resistance of 1 ohm if 1 volt produces a current of 1 ampere through it.

(Text 1 ohm = 1 volt / 1 ampere)

Factors affecting resistance:

- Length of conductor
- Area of cross-section
- Material
- Temperature

4. Ohmic Devices (obey Ohm's law)

These devices follow $V \propto I$ and maintain constant resistance.

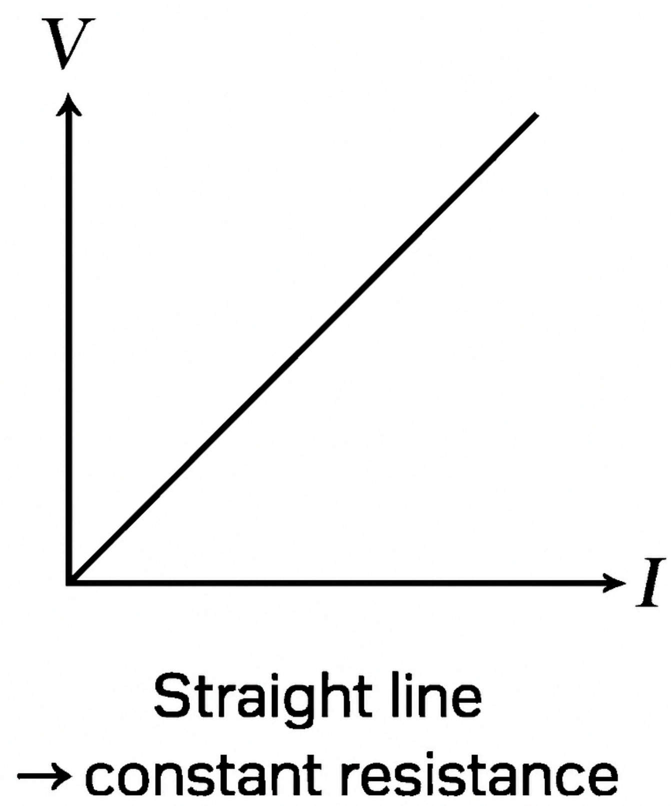
Characteristics:

- V–I graph is a straight line.
- Resistance does not change with current or voltage.

Examples:

- Metallic wires (copper, iron, nichrome)
- Resistors used in circuits

Graph (ohmic):



5. Non-Ohmic Devices (do not obey Ohm's law)

These devices do not follow a constant V/I ratio. Their resistance changes with temperature or current.

Characteristics:

- V–I graph is curved.
- Resistance varies as voltage or current changes.

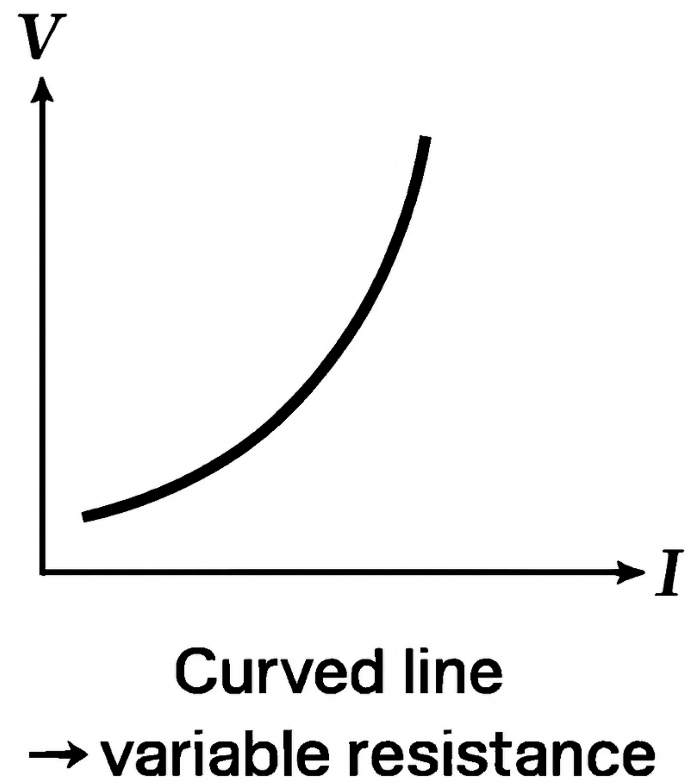
Examples:

- Filament bulb (resistance increases as filament heats up)

Semiconductor diode (current flows mostly in one direction)

- LED
- Thermistor (NTC/PTC)

Graph (non-ohmic):



✦ **Summary:**

Ohm's Law: V = I × R, valid only if temperature is constant.

Resistance is the opposition to current; unit = ohm.

Ohmic devices: obey Ohm's law, straight-line V–I graph, example: metal wire.

Non-ohmic devices: do not obey Ohm's law, curved V–I graph, example: filament bulb, diode.

🩸Exercise Questions:

🌟 **Question 13.1 A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of free electrons by**

(i) increasing the potential difference,

(ii) decreasing the length and the temperature of the wire?

❖ **Answer:**

Drift Velocity (Concept)

Drift velocity is the average slow speed with which free electrons move through a conductor when an electric field is applied.

It depends on:

- potential difference (voltage),
- length of wire,
- temperature of conductor,
- resistance of material.

(i) Effect of Increasing the Potential Difference

When the applied potential difference is increased, the electric field inside the wire becomes stronger.

As a result:

- Electrons experience more force.
- They move faster towards the positive terminal.
- The drift velocity increases.

Summary:

- Increasing the potential difference increases the drift velocity of electrons.

(ii) Effect of Decreasing the Length and Temperature of the Wire

(a) Decreasing the Length of the Wire

- A shorter wire has less resistance.
- Less resistance $\longrightarrow$ electrons face fewer collisions $\longrightarrow$ move more easily.

Therefore:

Drift velocity increases in a shorter wire.

(b) Decreasing the Temperature of the Wire

At lower temperature:

- Atoms vibrate less.
- Electrons collide less with atoms.

- Resistance decreases.
- Lower resistance → electrons move more freely.

So:

Drift velocity increases when temperature decreases.

✦ Final Summary:

Increasing potential difference: drift velocity increases because the electric field becomes stronger.

Decreasing length: drift velocity increases because resistance becomes lower.

Decreasing temperature: drift velocity increases because atomic vibrations reduce and electrons face fewer collisions.

🌟 Question 13.2 Do bends in a wire affect its electrical resistance? Explain.

❖ Answer:

Main Idea

No, bends do not significantly affect the electrical resistance of a wire, as long as the wire is not stretched, thinned, or damaged.

Explanation

1. Resistance depends on four factors

The resistance R of a wire depends on:

- the material (resistivity),
- the length of the wire,
- the cross-sectional area,
- the temperature.

A bend in the wire does not change any of these physical properties.

2. Why bends do not matter?

When a wire is bent:

- its length stays the same,
- its thickness stays the same,
- its material remains the same,
- its temperature does not change.

So the overall resistance remains unchanged.

3. When can bends affect resistance? (Rare case)

Resistance may change only if:

- the wire is bent too sharply,
- the wire becomes stretched or cracked,
- the cross-section becomes narrow at the bend.
- In such cases, resistance can increase slightly.
- But in normal, smooth bends → no effect.

✦ **Final Answer:**

Bends in a wire do not normally affect its electrical resistance because the resistance depends on the material, length, cross-sectional area, and temperature—none of which change by bending the wire. Only very sharp bends that damage or thin the wire can cause a slight increase in resistance.

🌟 **Question 13.3 What are the resistances of the resistors given in the figures A and B? What is the tolerance of each? Explain what is meant by the tolerance?**

❖ **Answer:**

🔹 **Resistor A (Brown, Green, Red, Gold)**

- First band (Brown) = 1
- Second band (Green) = 5
- Third band (Red multiplier) = ×100
- Fourth band (Gold tolerance) = ±5%

Resistance of A = 15 × 100 = 1500 ohms (1.5 kΩ)

Tolerance of A = ±5%

Range = 1425 ohms to 1575 ohms

🔹 Resistor B (Yellow, White, Orange, Silver)

- First band (Yellow) = 4
- Second band (White) = 9
- Third band (Orange multiplier) = ×1000
- Fourth band (Silver tolerance) = ±10%

Resistance of B = 49 × 1000 = 49000 ohms (49 kΩ)

Tolerance of B = ±10%

Range = 44100 ohms to 53900 ohms

📘 Explanation of Tolerance

- Tolerance means the maximum percentage error allowed in the actual resistance compared to the stated value.
- It shows the range of values within which the resistor's actual resistance may lie.

- **Example:**

- 1500 ohms ±5% ⟶ actual value between 1425 and 1575 ohms
- 49000 ohms ±10% ⟶ actual value between 44100 and 53900 ohms

🌟 **Question 13.4: Why does the resistance of a conductor rise with temperature?**

❖ **Answer:**

1. Concept of Resistance:

- Resistance is the opposition offered by a conductor to the flow of electric current.
- In metals, current is carried by free electrons moving through the lattice of metal atoms.

2. Effect of Temperature:

- As the temperature of a conductor increases, the metal atoms vibrate more intensely.
- Free electrons collide more frequently with these vibrating atoms.

- These frequent collisions oppose the flow of electrons, increasing resistance.

3. Temperature-Resistance Relationship:

- For most metals, resistance increases approximately linearly with temperature.
- Formulaically (conceptual, no need to copy formulas for exams if not allowed):

$R \propto \text{collisions} \propto \text{temperature}$

This is why, for example, wires get hotter and less efficient when current passes through them at high temperature.

4. Practical Implications:

- Electrical devices may heat up, leading to energy loss.
- Some devices (like filament bulbs) are non-ohmic because resistance increases significantly with temperature.

✦ **Summary:**

Higher temperature ⟶ more atomic vibrations ⟶ more collisions ⟶ higher resistance.

🌟 **Question 13.5: What are the difficulties in testing whether the filament of a lighted bulb obeys Ohm's law?**

❖ **Answer:**

1. Concept of Ohm's Law:

Ohm's law states that the current through a conductor is directly proportional to the potential difference across it, provided the physical conditions like temperature remain constant.

Mathematically: V = IR

2. Filament Bulb as a Conductor:

- The filament of a bulb is made of metal (usually tungsten).
- When the bulb is switched on, current flows and the filament heats up rapidly.

3. Difficulties in Testing:

(a) Change in Temperature:

- As the filament heats up, its resistance increases.
- Since Ohm's law requires constant resistance, this variation makes it difficult to test Ohm's law directly.

(b) Non-linear V-I Relationship:

- Due to temperature rise, the V-I graph is not a straight line.
- At low currents, it may appear linear, but at higher currents, the curve deviates.

(c) Measurement Challenges:

- Rapid heating makes it hard to take accurate readings of current and voltage simultaneously.
- Sensitive instruments may be required to detect small changes.

4. Conclusion:

- The filament is a non-ohmic device because its resistance depends on temperature.
- Ohm's law is strictly obeyed only at low currents where temperature change is negligible.

🌟 **Question 13.6: Is the filament resistance lower or higher in a 500 W, 220 V light bulb than in a 100 W, 220 V bulb?**

❖ **Answer:**

1. Given:

- Power (P) of bulb = 500 W and 100 W
- Voltage (V) = 220 V

2. Relation between Power, Voltage, and Resistance:

- Electrical power: $P = V^2 / R$
- Rearranging to find resistance: $R = V^2 / P$

3. Calculating Resistance:

(a) 500 W bulb:

- $R_1 = V^2 / P_1 = 220^2 / 500$
- $R_1 = 48400 / 500 = 96.8\ \Omega$

(b) 100 W bulb:

- $R_2 = V^2 / P_2 = 220^2 / 100$
- $R_2 = 48400 / 100 = 484\ \Omega$

4. Comparison:

- 500 W bulb → R = 96.8 Ω (lower)
- 100 W bulb → R = 484 Ω (higher)

Conclusion:

- The filament resistance of the 500 W bulb is lower than that of the 100 W bulb at the same voltage.
- Higher power bulbs allow more current, so they need lower resistance to draw higher current at the same voltage.

🌟 Question 13.7: Describe a circuit which will give a continuously varying potential.

❖ **Answer:**

1. Concept:

- A circuit that provides a continuously varying potential is known as a potential divider circuit.
- It can be made using a rheostat or a sliding contact on a resistor/wire.
- This arrangement allows the output voltage to be varied smoothly from zero to the maximum applied voltage.

2. Components:

- **Rheostat:** Wire wound variable resistor with two fixed terminals (A and B) and one sliding terminal (C).
- **Battery:** Provides a constant voltage across the rheostat.
- **Sliding Contact (C):** Moves along the wire to vary the resistance portion in the circuit.

3. Working:

- Let total resistance of wire AB be R and the resistance of portion BC be r.

- If voltage applied across AB is V, the current through the wire is:

$I = V / R$

The potential difference across BC is:

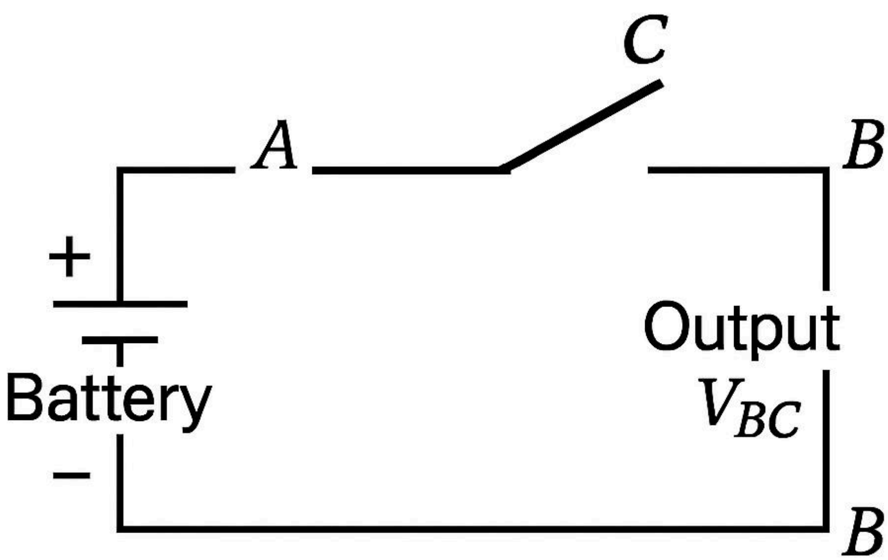
$V_{BC} = I \times r = (V / R) \times r$

By moving the sliding contact C, resistance r changes continuously, so V_{BC} varies continuously from 0 to V.

4. Applications:

- To provide variable voltage for experiments.
- Used in laboratory power supplies.
- Can be used to measure unknown EMFs when combined with a galvanometer (potentiometer principle).

✦ Diagram:



- Moving C towards A ⟶ V_BC increases
- Moving C towards B ⟶ V_BC decreases

✦ **Conclusion:**

The circuit provides a continuously varying potential proportional to the resistance between the sliding contact and one end of the resistor.

🌟 **Question 13.8: Explain why the terminal potential difference of a battery decreases when the current drawn from it is increased.**

❖ **Answer:**

1. Concept of EMF and Internal Resistance:

- A battery has an electromotive force (EMF, E) which is the energy supplied per unit charge by the battery.
- All batteries have some internal resistance (r) due to the electrolyte and the electrodes.
- When a current I flows through the battery, some energy is lost inside the battery itself because of this internal resistance.

2. Terminal Potential Difference (V):

- The terminal potential difference is the voltage measured across the battery terminals when current is drawn.

Formula:

$V = E - I \times r$

E = EMF of the battery, I = current, r = internal resistance

3. Explanation:

- When the current I increases, the term I × r becomes larger.
- This means more voltage is dropped inside the battery across its internal resistance.
- **As a result,** the terminal potential difference V decreases.

4. Special Case:

If no current is drawn ($I = 0$), the terminal voltage is equal to EMF:

$$V = E - 0 \times r = E$$

As current increases, $V < E$ due to the internal voltage drop.

✦ **Summary:**

- The terminal voltage decreases with increasing load current because the internal resistance of the battery consumes part of the EMF.
- This is why under heavy load, the battery voltage appears lower than its EMF.

🌟 **Question 13.9: What is Wheatstone Bridge? How can it be used to determine an unknown resistance?**

❖ **Answer:**

Wheatstone Bridge:

A Wheatstone bridge is an electrical circuit used to find the value of an unknown resistance very accurately. It consists of four resistors arranged in the form of a diamond. A galvanometer is connected between the two midpoints and a battery is connected across the other two points.

The four resistances are:

- R1 = known resistance
- R2 = known resistance
- R3 = known variable resistance
- Rx = unknown resistance

✔ Condition for Balanced Wheatstone Bridge

When no current flows through the galvanometer, the bridge is said to be balanced.

This condition gives the relation:

R1 / R2 = Rx / R3

From this, the unknown resistance Rx can be calculated:

Rx = R3 × (R1 / R2)

These equations are simple text — you can copy them anywhere.

✔ How the Bridge Determines Unknown Resistance

1. The resistors R1, R2, and R3 are connected in the bridge.

2. R3 is adjustable.

3. The value of R3 is changed until the galvanometer shows zero deflection.

4. At zero deflection, the bridge is balanced.

5. Now the ratio of the resistances becomes equal:

R1 / R2 = Rx / R3

6. Using this ratio, the unknown resistance Rx can be calculated.

✔ Final Point

The Wheatstone bridge is widely used because it gives very accurate results and is commonly used in laboratories to measure resistance.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.