CHAPTER 3
CURRENT ELECTRICITY

1. Define electric current. Give its SI unit.

Ans: *Current is the rate of flow of electric charge.*

$I = \frac{dq}{dt}$ [or I = q/t]

SI unit is ampere (**A**), **1A=1C/s**

2. Define current density (j). Give its SI unit.

Ans: *It is the current flowing through unit area of cross section of a conductor.*

$J = \frac{I}{A}$ S.I unit is **A/m^2**

3. Define drift velocity (v_d).

Ans: In the absence of an external electric field, inside a conductor the free electrons are in random motion; and so their average velocity is zero.

When an electric field is applied the electrons move opposite to the electric field and get an average velocity.

The average velocity acquired by an electron in the presence of an external electric field is called drift velocity.

4. Define relaxation time.

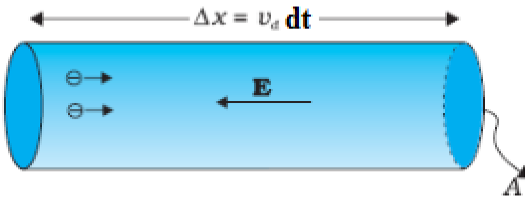
Ans: *Relaxation time is the average time interval between two successive collisions.*

5. Derive a relation between drift velocity and current.

Ans: Consider a conductor of length 'ℓ' and number density of electrons 'n'.

[n = number of electrons per volume]

The distance travelled by electron in dt time = $v_d dt$



The number of free electrons in the distance $v_d dt$

$= Av_d dt \times n$

The total charge crossing the area **A** in **dt** time

$dq = neAv_d dt$

$\therefore$ Current $I = \frac{dq}{dt}$

$$I = \frac{neAv_d dt}{dt} = neAv_d$$

$$\boxed{I = neAv_d}$$

$J = I / A$

$$J = \frac{neAv_d}{A}$$

$$\boxed{J = nev_d}$$

6. Derive a relation between drift velocity (v_d) and relaxation time (τ).

Ans: Let v_i be the initial velocity of an electron just after a collision. The velocity of the electron after the relaxation time 'τ' is given by,

$v_d = v_i + a\tau$

$$= v_i - \frac{eE\tau}{m}$$

But just after a collision electron can be taken at rest ie, $v_i = 0$

$$\therefore v_d = \frac{-eE\tau}{m} \qquad \vec{v}_d = \frac{-e\vec{E}\tau}{m}$$

7. Define mobility

Ans: Mobile charge carriers are responsible for conductivity.

In metals, electrons are the charge carriers.

In electrolytes both +ve and –ve ions are charge carriers.

In semiconductors, conduction is partially by electrons and partially by holes.

Mobility 'μ' is defined as the ratio of magnitude of the drift velocity to electric field strength.

$$\mu = \frac{|v_d|}{E} = \frac{eE\tau}{E} = \frac{e\tau}{m}$$

SI unit of mobility is $CmN^{-1}s^{-1}$ or $m^2V^{-1}S^{-1}$.

8. Distinguish between emf and potential difference.

Ans:

1. *Emf is the difference in potential between the terminals of a cell, when no current is drawn from it.*

Potential difference is the difference in potential between the terminals of a cell or between any two points in a circuit when current is drawn from the cell.

2. *Emf exists only between the terminals of the cell. But potential difference exists throughout the circuit.*
3. *Emf is the cause and potential difference is the after effect.*
4. *Emf is always greater than potential difference.*

9. State Ohm's law.

Ans: **Ohm's law states that 'at constant temperature the current flowing through a conductor is directly proportional to potential difference between the ends of the conductor'.**

Current α Potential difference.

$I \propto V \qquad I = \frac{1}{R} V$

R → Resistance of the conductor.

V = IR

10. What is meant by resistance?

Ans: It is the ability of a conductor to oppose electric current.

SI unit of resistance is **ohm.**

11. What are the factors which affect the resistance of a conductor?

Ans:

1. *Nature of the material of the conductor.*

2. *Length of the conductor 'ℓ' (directly proportional)*
3. *Area of cross-section 'A' (Inversely proportional)*
4. *Temperature (directly proportional)*

12. Write the equation for the resistance of a conductor in terms of its length and area of cross section.

Ans: $R \propto \ell$

$R \propto \frac{1}{A}$

$R \propto \frac{l}{A}$

$$\mathbf{R=\rho \frac{l}{A}}$$

ρ → The resistivity of the material of the conductor.

S.I. unit of Resistivity ohm-metre (**Ω - m**)

13. Define resistivity of the material of a conductor.

Ans: Resistivity,

$$\rho=\frac{RA}{l}$$

Put A = 1 m^2, ℓ = 1m

$$\rho = \frac{R.1}{1} = R$$

"***Resistivity of the material of a conductor is defined as the resistance of the conductor having unit length and unit area of cross section.***

14. Define conductance (C)

Ans: Conductance $C = \frac{1}{R}$

Conductance is the reciprocal of resistance.

SI unit = $\frac{1}{\Omega}$ = ohm^{-1} = **mho.**

15. Define conductivity (σ)

Ans:

Conductivity $\sigma = \frac{1}{\rho}$

Conductivity is the reciprocal of resistivity.

SI unit of conductivity is $\mathbf{\Omega^{-1} m^{-1}}$ or mho m^{-1}

16. What are the factors which affect resistivity?

Ans: *i. Nature of the material of the conductor.*

ii. Temperature

17. Derive the relation for resistivity in terms of relaxation time.

Ans:

We know, $I = neAv_d$

and $v_d = \frac{eE\tau}{m}$

$\therefore I = neA\frac{eE\tau}{m} = \frac{ne^2AE\tau}{m}$

But we have $E = \frac{V}{\ell}$

$\therefore I = \frac{ne^2AV\tau}{m\ell}$

$\Rightarrow \frac{V}{I} = \frac{m\ell}{ne^2A\tau}$

$\Rightarrow R = \frac{m\ell}{ne^2A\tau}$

$\Rightarrow \frac{\rho\ell}{A} = \frac{m\ell}{ne^2A\tau}$

Resistivity,

$$\rho = \frac{m}{ne^2\tau}$$

Conductivity,

$$\sigma = \frac{ne^2\tau}{m}$$

18. A wire of resistance 4Ω is drawn

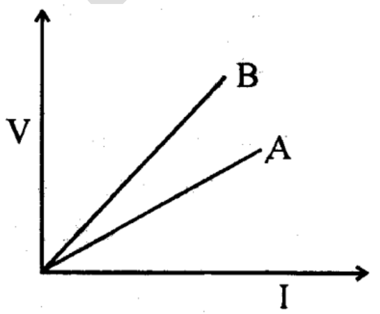
(a) to twice its original length

(b) to thrice its original length. Calculate the new resistance in each case

19[P]. A wire of resistance 4R is bent in to the form of a circle. What is the effective resistance between the ends of diameter?

20[P]. A copper wire is in the form of a cylinder and has a resistance R. It is stretched till its thickness reduces by half of its initial size. Find its new resistance in terms of R.

21[P].The voltage current graphs for two resistors of the same material and same radii with lengths L_1 and L_2 are shown in the figure. If $L_1 > L_2$, state with reason, which of these graphs represents voltage current change for L_1.



22[Q]. Two wires of equal lengths, one of copper and the other of manganin, have the same resistance. Which wire is thicker?

23. Why copper is used as for making connecting wires?

Ans: Copper has low resistivity.

24. Why Nichrome is used as heating element of electrical devices?

Ans: Nichrome has

i) High resistivity

ii) High melting point.

25. Why aluminium wires are preferred for overhead power cables?

Ans: Aluminium has low resistivity. It is cheaper and lighter.

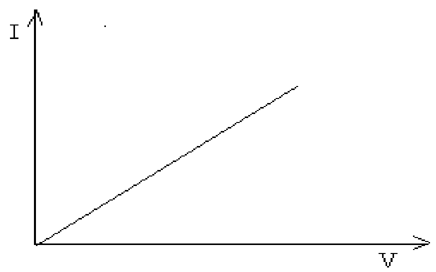
26. What are Ohmic and Non-ohmic substances.

Ans:

Ohmic substances

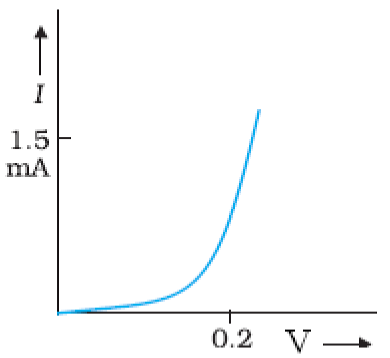
They are the substances which obey ohms law. For these substances V-I graph is linear.

Eg: Metals



Non - ohmic substances

They are the substances which do not obey ohm's law. For these substances V-I graph is nonlinear.



Characteristic curve of a diode.

Eg:-**Semiconductors, diodes, vacuum tubes, electrolytes** etc.

27. Ohm's law is not a universal law. Explain.

Ans: All materials do not obey Ohm's law. Metals obey ohms law while semiconductors, electrolytes, diodes etc. do not obey Ohm's law. So Ohm's law is not a universal law.

28. Explain how resistance depends on temperature.

Ans: When temperature increases, resistances of materials change.

$$R_2 = R_1[1 + \alpha (T_2 - T_1)]$$

R_1→ resistance at the reference temperature T_1.

R_2→ resistance at temperature T_2.

$\propto$ →Temperature coefficient of resistance.

Unit of $\propto$ is **$^0C^{-1}$ or K^{-1}**

The value of $\propto$ is positive for metals negative for semiconductors and nearly zero for insulators.

29. Why materials like constantan and manganin are used to make standard resistances?

Ans: The temperature coefficient of resistance of these materials is nearly zero. Therefore, their resistances do not change considerably with temperature. Moreover these materials have high resistivity.

30[P]. At room temperature (27.0^{0}C) the resistance of a heating element is 100 Ω. What is the temperature of the element if the resistance is found to be 117 Ω. Given that the temperature coefficient of the material of the resistor is 1.70 x 10^{-4} $^0C^{-1}$?

31[P]. A silver wire has a resistance of 2.1 Ω at 27.5^{0}C and a resistance of 2.7 Ω at 100^{0}C. Determine the temp coefficient of resistivity of silver.

32. Give the codes for different coloured rings of carbon resistors.

Ans:

<u>Colour coding of carbon resistors</u>

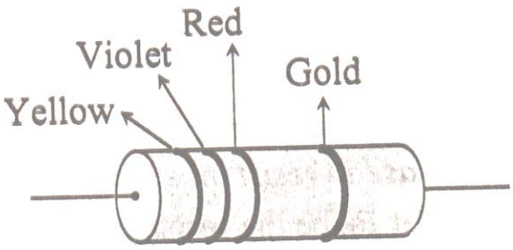
Colour	**Code**	**Tolerance**
Black	0	
Brown	1	
Red	2	
Orange	3	
Yellow	4	
Green	5	
Blue	6	
Violet	7	
Grey	8	
White	9	
Gold	-1	5%
Silver	-2	10%
No colour		20%

0 1 2 3 4 5 6
B B ROY of **G**reat **B**ritain

7 8 9
has a **V**ery **G**ood **W**ife

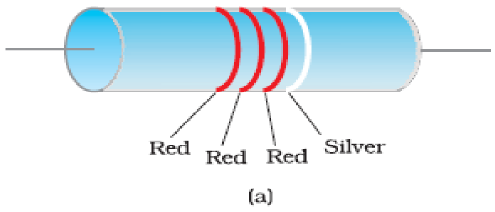
33. Determine the resistance of the carbon resistor in the following figure.

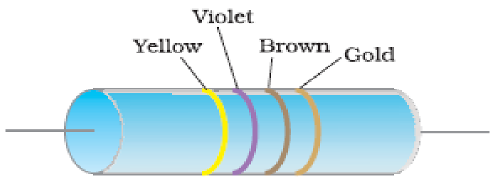
Ans:-



Resistance R = $(47\times10^2\pm5\%)\Omega$

34[P]. Determine the resistances of the following carbon resistors.





35. Determine the resistance of a resistor with the following colours for the rings: Blue, Grey, Black, No colour.

Ans:-R = $(68 \times 10^0 \pm 20\%)\Omega$

= $(68 \pm 20\%)\ \Omega$

36. What is the use of colour coding.

Ans: Colour coding of a carbon resistance is used to find the value of resistance.

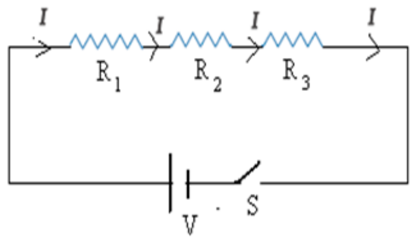
37. Derive expressions for the effective resistance when three resistors are connected in (i) series (ii) parallel

Ans:

(i) series

Consider resistances R_1, R_2 and R_3 connected in series with a voltage V.

In series circuit the current is the same, but the voltages across different resistors are different.



The applied voltage,

$V = V_1 + V_2 + V_3$ ---- (1)

But $V = IR_s$

$V_1 = IR_1$, $V_2 = IR_2$ and $V_3 = IR_3$

(1) → $IR_s = IR_1 + IR_2 + IR_3$

→$IR_s = I\,(R_1+R_2+R_3)$

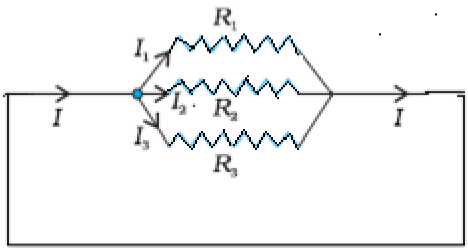
$R_s = R_1 + R_2 + R_3$

If there are 'n' resistors.

$R_s = R_1 + R_2 + R_3 + \ldots\ldots\ldots + R_n$

ii) parallel

Consider three resistances R_1, R_2 and R_3 connected in parallel.



In parallel circuit voltage across each resistor is the same but the currents are different.

$I = I_1 + I_2 + I_3$ .... (2)

$I = \frac{V}{R_p}$

$I_1 = \frac{V}{R_1}$ $\qquad$ $I_2 = \frac{V}{R_2}$ $\qquad$ $I_3 = \frac{V}{R_3}$

$\therefore (2) \rightarrow \frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

$$\boxed{\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

If there are n resistors

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots\ldots\ldots\ldots + \frac{1}{R_n}$$

38[P]. (a) Three resistors $1\ \Omega, 2\Omega\ and\ 3\Omega$ are combined in series. What is the total resistance of the combination?

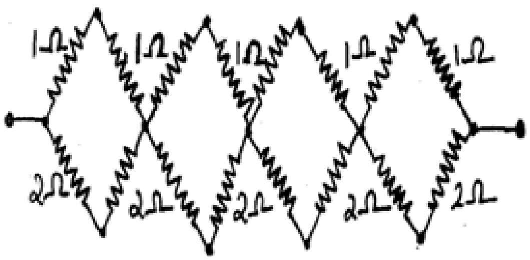
(b) If the combination is connected to a battery of emf 12V and negligible internal resistance, obtain the potential drop across each resistor.

39[P]. (a)Three resistors $2\ \Omega, 4\Omega\ and\ 5\Omega$ are combined in parallel. What is the total resistance of the combination?

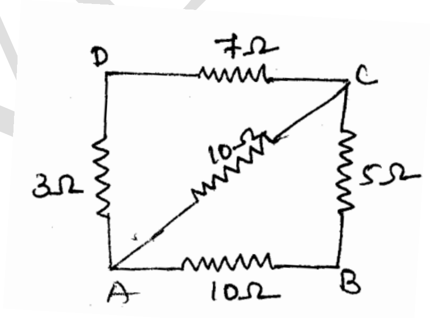
(b) If the combination is connected to a battery of emf 20V and negligible internal resistance, determine the current through each resistor and the total current drawn from the battery.

40[P]. Given n resistors each of resistance 'R'. How will you combine them to get the (i) maximum (ii) minimum effective resistance? What is the ratio of the maximum to minimum effective resistance?

41[P]. Determine the equivalent resistance of the network shown in figure.



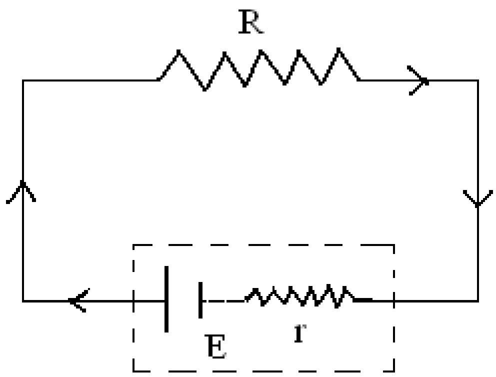
42[P]. Find the equivalent resistance between A and B.



43. Define internal resistance of a cell.

Ans: In the external circuit, the current flows from the positive terminal of the cell to the negative terminal. But inside the cell the current flows from –ve terminal to the +ve terminal.

"Internal resistance of a cell is the resistance offered by the electrolyte and electrodes of the cell".



Effective resistance = R + r

Current I = $\frac{E}{R+r}$

I(R + r) = E ⇨ IR + Ir = E

But IR = V V→ Terminal Voltage

V + Ir = E

Ir = E – V

$$r = \frac{E - V}{I}$$

44. What are the factors which affect the internal resistance of a cell?

Ans: *(i) The nature of the electrolyte and the electrodes.*

(ii) The distance between the electrodes.

(iii) Temperature

45. It is easier to start a car engine on a warm day than a chilly day. Why?

Ans: Internal resistance of a car battery decreases on a warm day due to increase in temperature. Therefore, more current flows to the spark plug.

46[P]. The storage battery of a car has an emf of 12V. If the internal resistance of a battery is 0.4*Ω*, what is the maximum current that can be drawn from the battery?

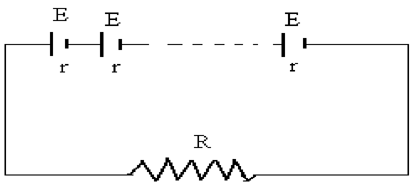
47[P]. A battery of emf 10V and internal resistance 3*Ω* is connected to a resistor. If the current in the circuit is 0.5A, what is the resistance of the resistor? What is the terminal voltage of the battery?

48. Derive expressions for the current due to a combination of cells.

Ans:

i) <u>Series</u>

Consider n cells connected in series with a resistor R.



Total emf= E + E + E + ……. + E = nE

Total Internal resistance

= r + r + r + ………….. + r = nr

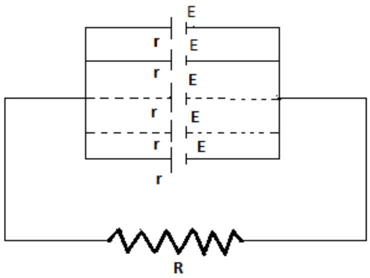
∴ Effective resistance = R + nr

Current I = $\frac{emf}{resistance} = \frac{nE}{R+nr}$

$$I = \frac{nE}{R+nr}$$

ii) <u>Parallel</u>

Consider n cells connected in parallel with an external resistance.



Total internal resistance

$$\frac{1}{r_p}=\frac{1}{r}+\frac{1}{r}+\dots\dots\dots+\frac{1}{r}$$

$$\frac{1}{r_p}=\frac{n}{r} \quad \Rightarrow \quad r_p=\frac{r}{n}$$

$$\text{Effective resistance}=R+\frac{r}{n}$$

$$\text{Current } I=\frac{E}{R+\frac{r}{n}}=\frac{E}{\frac{nR+r}{n}}=\frac{nE}{nR+r}$$

$$\boxed{I=\frac{nE}{nR+r}}$$

49. State Kirchhoff's rules.

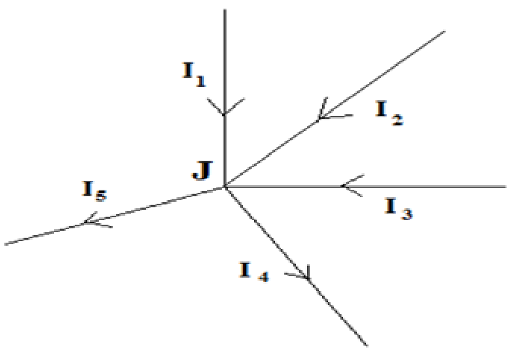
Ans:

<u>1st rule (Current rule or Junction rule)</u>

Kirchhoff's first rule states that "In a closed circuit the algebraic sum of the currents meeting at a junction is zero"

In other words,

The total current entering a junction is equal to the total current leaving the junction.



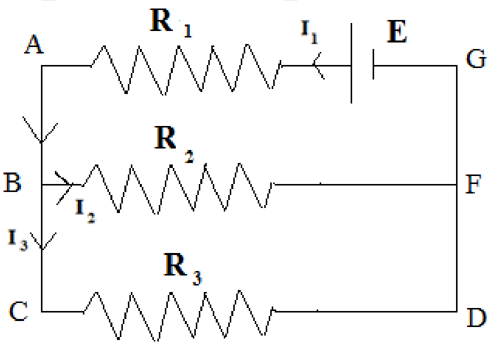
$$I_1+I_2+I_3-I_4-I_5=0$$

Or $$I_1+I_2+I_3=I_4+I_5$$

Kirchhoff's Ist rule is a statement of law of conservation of charge.

<u>2nd rule [Voltage Rule or Loop rule or mesh rule]</u>

Kirchhoff's second rule states that 'In a closed circuit the algebraic sum of the voltages is zero'.



In the closed circuit ABFGA

$$I_2R_2+I_1R_1=E$$

Similarly for the mesh [closed circuit] BCDFB,

$$I_3R_3-I_2R_2=0$$

Kirchhoff's second rule is a statement of law of conservation of energy.

<u>Wheatstone's Bridge</u>

50. What is the use of a Wheatstone's bridge?

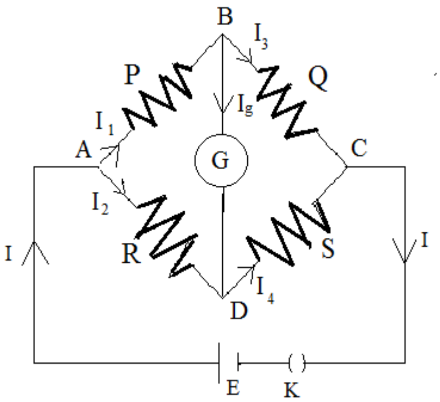
Ans: It is used to find the resistance of a given wire.

51. Derive the balancing condition of Wheatstone's bridge. Explain how the unknown resistance can be determined.

Ans:

Circuit Details

Consider 4 resistances **P, Q, R** and **S** connected in the form of a bridge. A cell of emf 'E' is connected between the terminals A and C. A galvanometer is connected between the terminals B and D.



Balancing Condition

Applying Kirchhoff's 2nd rule in the loop ABDA,

$I_1P + I_gG - I_2R = 0$ …. (1)

Again in the mesh BCDB,

$I_3Q - I_4S - I_gG = 0$ …………. (2)

The resistance '**S**' is adjusted so that current through the galvanometer is made zero. ie., $I_g = 0$

Then, $I_1 = I_3$ and $I_2 = I_4$

∴ (1) → $I_1P - I_2R = 0$;

$I_1P = I_2R$ ………… (3)

(2) → $I_3Q - I_4S = 0$;

$I_3Q = I_4S$ ……….. (4)

(3)/(4) → $\frac{I_1P}{I_3Q} = \frac{I_2R}{I_4S}$

But when the bridge is balanced, $I_1 = I_3$ and $I_2 = I_4$

∴ $\frac{P}{Q} = \frac{R}{S}$

$$\boxed{\frac{P}{Q} = \frac{R}{S}}$$

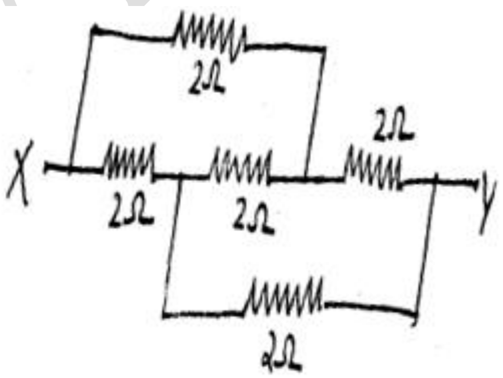
This is the balancing condition of Wheatstone's bridge.

Procedure

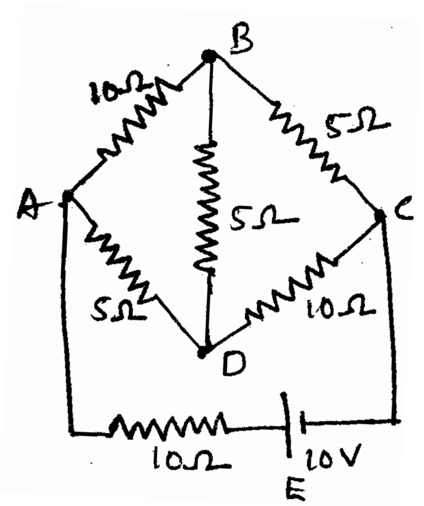
The wire whose resistance is to be determined (**Q**) is connected across **B** and **C**. The value of resistance **S** is adjusted so that the current through the galvanometer is zero. Now the bridge is balanced and we have $\frac{P}{Q} = \frac{R}{S}$

Since the values of P, Q, R and S are known, we can calculate the value of Q using the equation $Q = \frac{PS}{R}$

52[P]. Calculate the equivalent resistance between X and Y of the following network.



53[P]. Determine the current in each branch of the network shown in figure



Meter Bridge

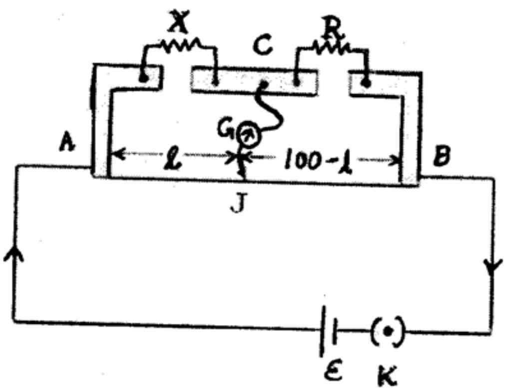
54. What is the use of a meter bridge?

Ans: It is used to find the resistance of a given wire.

55. Using a neat circuit diagram explain the circuit details, principle of a meter bridge. And give the procedure to find an unknown resistance.

Ans:

Circuit Diagram



Circuit Details

Meter bridge consist of a one meter long resistance wire (made of constantan or manganin) fixed on a wooden board. A cell of emf E and a key are connected between the terminals A and B. A jockey is connected to the terminal 'C' through a galvanometer. The unknown resistance is connected in the left gap and a resistance box is connected in the right gap.

Principle

It works on the Wheatstone's bridge principle. At the balancing condition $\frac{P}{Q}=\frac{R}{S}$, no current flows through the galvanometer.

$$\frac{X}{R}=\frac{\ell r}{(100-\ell)r}$$

$$\frac{X}{R}=\frac{\ell}{100-\ell}$$

$$X=\frac{Rl}{(100-l)}$$

$$\boxed{X=\frac{R\ell}{100-\ell}}$$

Procedure

The key is closed. A suitable resistance (say 1Ω) is taken from the resistance box. The jockey is moved from A towards B, until the galvanometer shows the zero deflection. The balancing length (AJ = ℓ) is measured. Unknown resistance X is determined using the equation

$$X=\frac{R\ell}{100-\ell}.$$

X is determined for different values of R (say 2Ω, 3Ω, -----). Now the experiment is repeated after interchanging X and R.

Resistivity

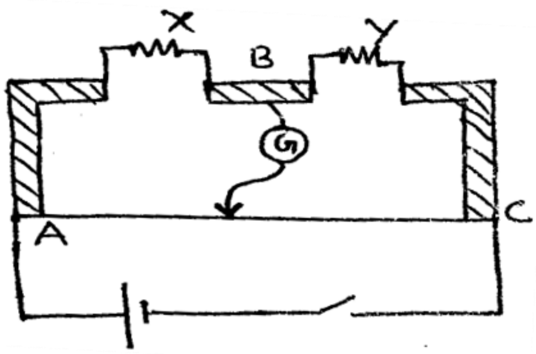
Resistivity $\rho=\frac{RA}{L}$,

Here, R = X, A = πr^2

$$\rho=\frac{X\pi r^2}{L}$$

L is the length and r is the radius of the given wire whose resistance is to be determined.

56. (a) In a meter bridge the balance point is found to be at 39.5cm from



the end A, when the resistor Y is of 12.5Ω. Determine the resistance of X. Why are the connections between resistors in a meter or Wheatstone bridge made of thick copper strips?

(b) Determine the balance point of the bridge if X and Y are interchanged.

(c) What happens if the galvanometer and cell are interchanged at the balancing point of the bridge? Would the galvanometer show any current?

57. What are the uses of a potentiometer?

Ans:

Potentiometer is used

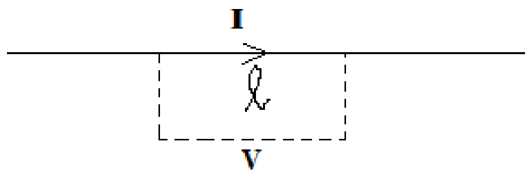
(i) To compare the emf of two cells

(ii) To find the internal resistance of a cell

58. Explain the principle of a potentiometer.

Ans:

Consider a resistance wire of uniform area of cross section carrying a current I



The potential difference across ℓ length of the wire is given by,

$V = IR$

➔ $V = I\ell r$, r is the resistance per unit length of the wire

➔ $V = (Ir)\ell$ ➔ $V = k\ell$

➔ $V \alpha \ell$, where $k=Ir$

Principle

When a steady current (I) flows through a wire of uniform area of cross section, the potential difference between any two points of the wire is directly proportional to the length of the wire between the two points.

59. Using a neat connection diagram, explain how potentiometer can be used to compare the emf of two cells.

Ans:

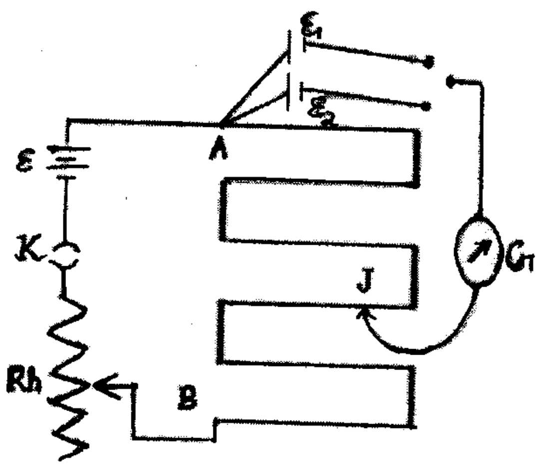
Circuit details

The primary circuit consists of potentiometer, cell of emf ε, key K and a rheostat.

The secondary circuit consists of two cells ε_1 and ε_2, two-way key, galvanometer, high resistance and Jockey.

Connection diagram

Procedure



The key K in the primary circuit is closed. The cell ϵ_1 is brought into the circuit by putting the key. Jockey is moved from A towards B until the galvanometer shows zero deflection. The balancing length AJ= ℓ is found out. Now by the principle of potentiometer,

$\varepsilon_1 \alpha\, \ell_1$ ….. (1)

The cell ε_1 is replaced by the cell ε_2 by putting the key. Again balancing length ℓ_2 is found out.

Therefore, $\varepsilon_2 \alpha\, \ell_2$ …….. (2)

(1) ÷ (2) → $\frac{\varepsilon_1}{\varepsilon_2} = \frac{\ell_1}{\ell_2}$ If one of the cells is a standard cell (say ε_1), we can determine the emf of the other

$$\varepsilon_2 = \varepsilon_1 \frac{\ell_2}{\ell_1}$$

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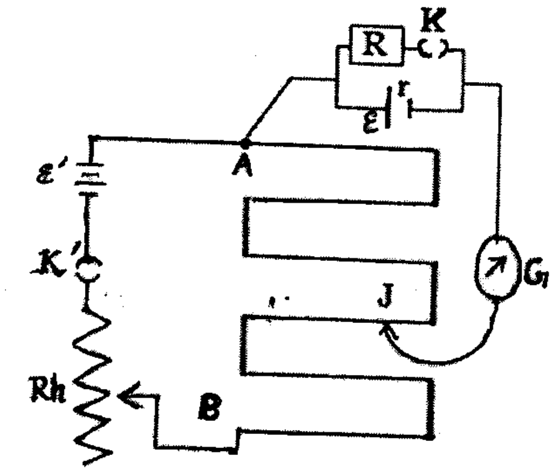
60. Using a neat connection diagram explain how potentiometer can be used to find the internal resistance of a cell.

Ans:

<u>circuit details</u>

The primary circuit consists of a potentiometer, cell of emf ϵ', key K' and a rheostat. The secondary circuit consist of a cell of emf ϵ, a galvanometer, Jockey, a resistance box R and key K.

<u>Connection Diagram</u>



<u>Procedure</u>

The key 'K'' in primary circuit is closed. The balancing length ℓ_1 is found out.

$\varepsilon \;\alpha\; \ell_1$ ………… (1)

Now the key K in the secondary is closed. The balancing length ℓ_2 is found out. Then we can write,

$V \;\alpha\; \ell_2$

$\frac{\varepsilon R}{R+r} \alpha\, \ell_2$ ………. (2)

$I = \frac{V}{R} = \frac{E}{R+r}$

$V = IR = \frac{ER}{R+r}$

(1) ÷ (2) $\frac{\varepsilon}{\left[\frac{\varepsilon R}{R+r}\right]} = \frac{\ell_1}{\ell_2}$

$$\frac{R+r}{R} = \frac{\ell_1}{\ell_2}$$

$$R + r = \frac{R\ell_1}{\ell_2}$$

$$r = \frac{R\ell_1}{\ell_2} - R$$

$$r = \frac{R\ell_1 - R\ell_2}{\ell_2}$$

$$r = \frac{R(\ell_1 - \ell_2)}{\ell_2}$$

$$\boxed{r = \frac{R(\ell_1 - \ell_2)}{\ell_2}}$$

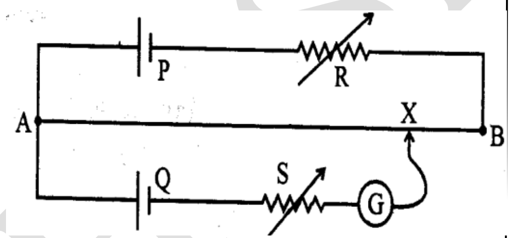
Using this equation we can calculate the internal resistance of the given cell.

61. Why potentiometer is preferred over voltmeter for measuring emf of a cell?

Ans: If we measure emf of a cell using a voltmeter, a small current is drawn by the voltmeter. So we will not get the actual emf of the cell. But if we measure the emf using a potentiometer, while measuring emf, since null deflection method is employed, no current flows from the cell. So we will get the actual emf of the cell.

62[P]. In a potentiometer arrangement, a cell of emf 12.5V gives a balance point at 35.0cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0cm, what is the emf of the 2nd cell?

63[P]. In the potentiometer circuit shown, the balance point is at X.



State with reason, where the balance point will be shifted, when

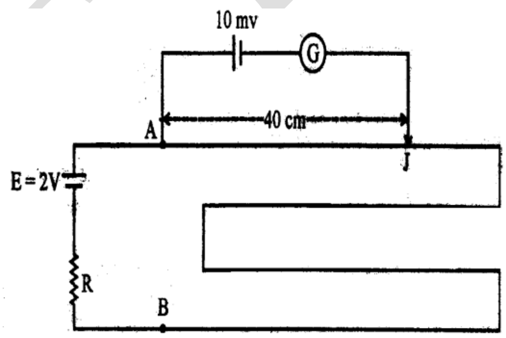
(a) Resistance R is increased, keeping all parameters unchanged.

(b) Resistance S is increased, keeping R constant.

(c) Cell P is replaced by another cell whose emf is lower than that of cell Q.

64[P]. A potentiometer wire of length 100cm has a resistance of 10 ohms.

It is connected in series with a resistance R and a cell of emf 2V and of negligible internal resistance. The circuit is as shown below:



(a) What is the resistance of 40cm length of the potentiometer wire?

(b) If a source of emf 10 millivolts is balanced by length of 40 cm of the potentiometer wire, find the value of the external resistance R.

(c) While performing an experiment on potentiometer what precautions (at least two) one must observe in the laboratory?

65. State Joule's law of heating.

Ans: Joule's Law states that **"the heat produced in a current carrying conductor is proportional to the square of the intensity of electric current, the resistance of the conductor and the time for which the current flows".**

$\mathbf{H = I^2Rt}$

S.I. unit of heat is joule (J)

$$H = I^2Rt$$
$$H = VIt$$
$$H = \frac{V^2t}{R}$$
$$H = Pt$$

66. Define electric power.

Ans: Electric power is defined as the electric energy consumed per second

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

SI unit of electric power is **watt** (W)

67P. A light bulb is rated at 125W for a 250 V a.c supply. Calculate the resistance of the bulb.

68P. Two electric bulbs one 25W and other 100W, which one has greater resistance?

69. Which is the commercial unit of electric energy? What is its relation with joule.

Ans: The commercial unit of electric energy is **kilo watt hour**.

$1kWh = 1000W \times 3600s = 3.6 \times 10^6 J$

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