SAIVEERA ACADEMY
PHYSICS CENTUM GUIDE

UNIT – 2

CURRENT ELECTRICITY

UNIT -2 CURRENT ELECTRICITY

Important Questions

Two Marks	
Book Back	**Book inside**
1.Why current is a scalar? 2.Distinguish between drift velocity and mobility 3.State microscopic model of ohm's law 4.State macroscopic form of Ohm's law or State Ohm's law 5. Define temperature coefficient of resistance **PTA** 6.Define Joule's law of heating. 7. What is Seebeck effect? **Jul 22** 8.What is Thomson effect? 9.What is Peltier effect? **Jul 21** 10. State the Applications of Seebeck effect **Jul 22** 11.Define electrical resistivity Mar 22	1.Why circuit breaker is advantageous over fuse ? 2.Why repairing the electrical connection with the wet skin is always dangerous? 3.What is carbon resistor? 4.Define transition or critical temperature 5.Define Joule's heating effect.
Three Marks	
1.Obtain the macroscopic form of Ohm's law from its microscopic form and discuss its limitation Or Obtain the relation between current and drift velocity **Mar 22** 2. Explain the equivalent resistance of a series and parallel resistor network **Jul 21, PTA** 3. Explain the determination of the internal resistance of a cell using voltmeter **Mar 22** 4. State and explain Kirchhoff's rules **Jul 21, Sep 20** 5.How the emf of two cells are compared using potentiometer? **Mar 20, PTA**	1.Explain the determination of internal resistance of a cell by potentiometer **PTA** 2.
Five marks	
1.Describe the microscopic model of current and obtain general form of Ohm's law **PTA** 2.Obtain the condition for bridge balance in Wheatstone's bridge. **Sep 20, PTA**	

Important Formulae and Units

1. Instantaneous current $I = \frac{dq}{dt}$;
2. Amount of current $I = \frac{ne}{t}$
3. Acceleration of electron $a = \frac{eE}{m}$;
4. Drift velocity $v_d = \frac{eE}{m}\tau$ **Unit :** m/s
5. Mobility $\mu = \frac{e\tau}{m}$; **Unit :** $m^2V^{-1}s^{-1}$
6. Current density $J = nev_d$ **Unit :** Am^{-2}
7. Potential difference $V = IR$;
8. Resistance of the wire $R = \frac{\rho l}{A}$ **Unit :** Ω
9. Specific resistance $\rho = \frac{RA}{l}$; **Unit :** Ωm
10. Current through conductor $I = nAev_d$
11. Current through conductor $I = \frac{nAe^2}{mL}\tau V$
12. Conductivity $\sigma = \frac{1}{\rho} = \frac{1}{RA}\Omega^{-1}m^{-1}$ (mho m^{-1})
13. Ratio between resistance of the same material wires $\frac{R_2}{R_1} = \frac{(l_2 r_1^2)}{(l_1 r_2^2)}$
14. Conditions to balance Wheatstone's network $\frac{P}{Q} = \frac{R}{S}$
15. Colour code for carbon resistors

Colour	Number	Colour	Number
Black	0	Brown	1
Red	2	Orange	3
Yellow	4	Green	5
Blue	6	Violet	7
Grey	8	White	9

16. Tolerance

Silver: $\pm 10\%$ Gold: $\pm 5\%$

Red: $\pm 2\%$ Brown: $\pm 1\%$

17. **Resistors in series:** Current (I) is a same across each resistors R_1, R_2, R_3 Equivalent resistance $R_s = R_1 + R_2 + R_3$
18. **Resistors in parallel :** Potential difference (V) is a same across each resistors R_1, R_2, R_3 Equivalent resistance $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
19. Resistance of a conductor at a temperature t°C, $R_r = R_0[1 + \alpha(T - T_0)]$
20. Temperature coefficient of resistance $\alpha = \frac{R_T - R_0}{R_0.\Delta T} = \frac{\Delta R}{R_0 \Delta T}$ Unit : per°C
21. Metals- positive temperature coefficient of resistance.
    Insulators, semiconductors- negative temperature coefficient of resistance.

22. Internal resistance r of a cell, $r = \left(\frac{\xi - V}{V}\right) R$

23. Internal resistance $r = R\left(\frac{l_1 - l_2}{l_2}\right)$ [l_2, l_1 - balancing length]

24. In Metre bridge: Unknown resistance $P = Q\frac{l_1}{l_2}$

25. Specific resistance $\rho = \frac{P\pi r^2}{L}$; potential difference across the wire = I r l

26. Potentiometer: $\varepsilon \alpha l \Longrightarrow \xi = Irl$

27. Unknown emf $\xi_2 = \xi_1 \frac{l_2}{l_1}$

28. Electric power, $P = VI = I^2R = \frac{V^2}{R}$

29. Current density $J = nev_d$ or σE

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

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

32.Conductivity is reciprocal of resistivity $\sigma = \frac{1}{\rho}$

33. Current density $J = \frac{I}{A}$ **Unit :** Am^{-2}

34. Electric energy $W = VIT = I^2RT$

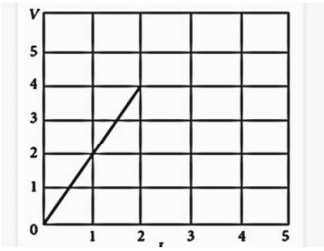
35. Cells in series connection $I = \frac{n\xi}{nr+R}$

36. Cells in parallel connection $I = \frac{n\xi}{r+nR}$

37.Heat produced $H = I^2RT$

Textbook One Mark Solved

1. The following graph shows current versus voltage values of some unknown conductor. What is the resistance of this conductor?



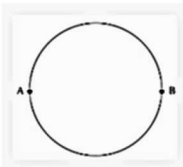
(a) 2 ohm (b) 4 ohm

(c) 8 ohm (d)1 ohm

Hint : $R = \frac{dV}{dI} = \frac{4-0}{2-0} = 2$

(a) 2 ohm

2. A wire of resistance 2 ohms per meter is bent to form a circle of radius 1m. The equivalent resistance between its two diametrically opposite points, A and B as shown in the figure is



(a) $\pi\ \Omega$ (b) $\pi/2\ \Omega$ (c) $2\pi\Omega$ (d) $\pi/4\ \Omega$

Hint : Circumference (L) = $2\pi R = 2\pi \times 1 = 2\pi$

Resistance $R = 2\pi \times 2 = 4\pi$

Equivalent resistance when connected in parallel $R_P = \frac{R}{n} = \frac{2\pi}{2} = \pi$ **(a) $\pi\ \Omega$**

3. A toaster operating at 240 V has a resistance of 120 Ω. The power is

a) 400 W b) 2 W c) 480 W d) 240 W

Hint : $P = \frac{V^2}{R} = \frac{240\times240}{120} = 480V$

c) 480 W

4. A carbon resistor of (47 ± 4.7) k Ω to be marked with rings of different colours for its identification. The colour code sequence will be

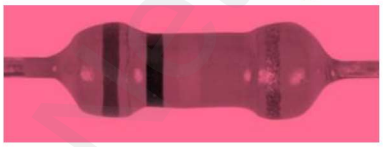
a) Yellow – Green – Violet – Gold b) Yellow – Violet – Orange – Silver

c) Violet – Yellow – Orange – Silver d) Green – Orange – Violet – Gold

Hint : Yellow – 4 , Violet – 7 , Orange - 10^3 – k Ω , Silver tolerance – 10 %

b) Yellow – Violet – Orange – Silver

5. What is the value of resistance of the following resistor?



(a)100 k Ω (b)10 k Ω (c) 1k Ω (d)1000 k Ω

Hint : Brown- 1 , Black – 0 , yellow - 10^4

Resistance value = 10×10^4

(a)100 k Ω

6. Two wires of A and B with circular cross section made up of the same material with equal lengths. Suppose $R_A = 3\ R_B$, then what is the ratio of radius of wire A to that of B?

(a) 3 (b) $\sqrt{3}$ (c) $1/\sqrt{3}$ (d) 1/3

Hint : $R \propto \frac{l}{a}$ where l is common

$\frac{R_A}{R_B} = \frac{\pi r_2^2}{\pi r_1^2}$; $\frac{r_1}{r_2} = \sqrt{\frac{R_B}{R_A}}$ where $R_A = 3\ R_B$

(c) $1/\sqrt{3}$

7. A wire connected to a power supply of 230 V has power dissipation P_1. Suppose the wire is cut into two equal pieces and connected parallel to the same power supply. In this case power dissipation is P_2 The ratio $\frac{P_2}{P_1}$ is

(a)1 (b) 2 (c) 3 (d) 4

Hint : Resistance before cutting the wire R , Resistance after cutting the wire $\frac{R}{2}$

Wire are connected in parallel $\frac{1}{R_p} = \frac{R_1R_2}{R_1+R_2} = \frac{R}{4}$

$P = \frac{V^2}{R}$ Ratio $\frac{P_2}{P_1} = \frac{R}{R_p} = \frac{4R}{R} = 4$

(d) 4

8. In India electricity is supplied for domestic use at 220 V. It is supplied at 110 V in USA. If the resistance of a 60W bulb for use in India is R, the resistance of a 60W bulb for use in USA will be

(a) R (b) 2R (c) R/4 (d) R/2

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

For India : $P_1 = \frac{V_1^2}{R_1}$ For USA $P_2 = \frac{V_2^2}{R_2}$

14. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of

a) each of them increases b) each of them decreases

c) copper increases and germanium decreases d) copper decreases and germanium increases

Hint : For conductors (copper) $\rho \propto T$

For semiconductors (germanium) $\rho \propto \frac{1}{T}$

d) copper decreases and germanium increases

15. In Joule's heating law, when R and t are constant, if the H is taken along the y axis and I^2 along the x axis, the graph is

a) straight line b) parabola c) circle d) ellipse

Hint : Since R and t are constant $H \propto I^2$ On plotting we will get straight line

a) straight line

Additional One Marks Solved

1. If the resistance of a coil is 3 ohm at 20°C and $\alpha = 0.004/°C$ then its resistance at 100°C is

a) 1.98 Ω **b) 3.96 Ω** c) 7.92 Ω d) 39.6 Ω

Solution:

$$R_{100} = 3[1 + 0.004(100 - 20)]$$
$$= 3[1 + 0.004 \times 80]$$
$$= 3[1 + 0.32] = 3 \times 1.32$$
$$R_{100} = 3.96\ \Omega$$

2. Two wires have the same length. But, area of cross – section of one is 9 times that of the other. If the resistance of thinner wire be 300 Ω, then resistance of the thicker wire is

a) 66.6 Ω **b) 33.3 Ω** c) 100 Ω d) 600 Ω

Solution:

$R \propto \frac{1}{A}$ $\frac{R_1}{R_2} = \frac{A_2}{A_1}$

$A_2 = 9\,A_1$, $R_1 = 300\ \Omega$, $R_2 = ?$

$$\frac{300}{R_2} = \frac{9A_1}{A_1}$$

$$\frac{300}{R_2} = 9$$

$$R_2 = \frac{300}{9} = \frac{100}{3} = \mathbf{33.3\ \Omega}$$

3. The equivalent resistance of the following combination is $\frac{6}{5}$ ohm then the value of resistance R_2 is

a) 3 Ω b) 6 Ω c) $\frac{5}{6}$ Ω d) 1.5 Ω

Solution:

c) has high resistance d) has high melting point

55. The temperature co-efficient of resistance for alloys is

(a) low **(b) very low** (c) high (d) very high

Short Answers Questions - Book Back

1.Why current is a scalar?

Current I is defined as the scalar product of the current density and area vector in which the charges cross.

$$I = \vec{J}.\vec{A}$$

- ✓ The dot product of two vector quantity is a scalar form.
- ✓ Hence current is a scalar quantity

2.Define Current Density

It is defined as the current per unit area of cross section of the conductor.

$J = \frac{I}{A}$ **Unit** : A/m^2 **Quantity :** Vector

3. Distinguish between drift velocity and mobility

Drift velocity	Mobility
It is average velocity acquired by the electrons inside the conductor when it is subjected to an electric field	It is defined as the magnitude of the drift velocity per unit electric field
$v_d = a\tau$	$\mu = \frac{v_d}{E}$
Unit : m/s	**Unit :** $m^2V^{-1}s^{-1}$

4.State microscopic model of ohm's law

$$\vec{J} = \sigma\vec{E}$$

$\vec{J}$ Current density σ – conductivity $\vec{E}$ – Electric field

It operates on a microscopic level relating the current density J to the conductivity σ and electric field E

5.State macroscopic form of Ohm's law or State Ohm's law

At constant temperature,steady current flowing through the conductor is directly proportional to potential difference between two ends

$$V \alpha I \qquad V = IR$$

6.What are ohmic and non ohmic devices

- ✓ Materials for which the current against voltage graph is a straight line through the origin, are said to obey Ohm's law and their behaviour is said to be ohmic.
- ✓ Materials or devices that do not follow Ohm's law are said to be non-ohmic

16.What do you meant by internal resistance of a cell

The resistance offered by electrolyte of a cell to the flow of current between its electrodes is called internal resistance of a cell

17. Define Joule's law of heating.

It states that the heat developed in an electrical circuit due to the flow of current varies directly as

(i) the square of the current

(ii) the resistance of the circuit and

(iii) the time of flow.

$$H = I^2Rt$$

18.What is Seebeck effect?

Seebeck discovered that in a closed circuit consisting of two dissimilar metals, when the junctions are maintained at different temperatures an emf (potential difference) is developed.

19.What is Thomson effect?

Thomson showed that if two points in a conductor are at different temperatures, the density of electrons at these points will differ and as a result the potential difference is created between these points. Thomson effect is also reversible.

20. What is Peltier effect?

Peltier discovered that when an electric current is passed through a circuit of a thermocouple, heat is evolved at one junction and absorbed at the other junction

21.State the Applications of Seebeck effect

- ✓ It is used in thermoelectric generators to convert waste heat into electricity in power plan.
- ✓ This effect is utilized in automobiles as automotive thermoelectric generators for increasing fuel efficiency.
- ✓ Seebeck effect is used in thermocouples and thermopiles to measure the temperature difference between the two objects.

Short Answer Question - Book Inside

1. Why nickel is used as heating element

It has high specific resistance and can be heated to very high temperature without oxidation

Long Answers Questions-Book Back

1. Describe the microscopic model of current and obtain general form of Ohm's law

- ✓ Consider a conductor with area of cross section A and an electric field $\vec{E}$ applied from right to left.
- ✓ There are n electrons per unit volume in the conductor which are moving with the same drift velocity $\vec{v}_d$
- ✓ The electrons move through a distance dx within a small interval of dt

$v_d = \frac{dx}{dt}$ $\quad dx = v_d dt$ **.....(1)**

The electrons available in the volume of length dx = volume × number per unit volume

$= Adx \times n$ **.....(2)**

Sub (1) in (2)

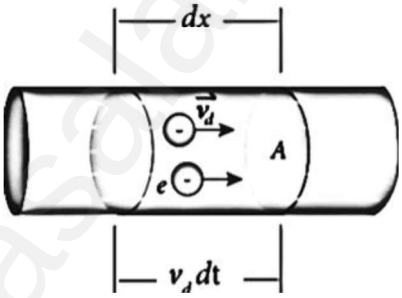
$= A\, v_d dt \times n$

Total charge in volume element

dQ = charge × number of electrons in the volume element

$dQ = e\, A\, v_d\, dt \times n$**.....(3)**

$I = \frac{dQ}{dt}$ **.....(4)**



Sub (3) in (4)

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

$I = neAv_d$

Since current density $J = I/A$

$J = nev_d$ **.....(4)**

Sub $v_d = \frac{e\tau}{m}E$ in (4)

$\vec{J} = -\frac{n\tau e^2}{m}\vec{E}$

$\vec{J} = -\sigma\vec{E}$

J = σE (microscopic form's of ohm's law)

2. Obtain the macroscopic form of Ohm's law from its microscopic form and discuss its limitation

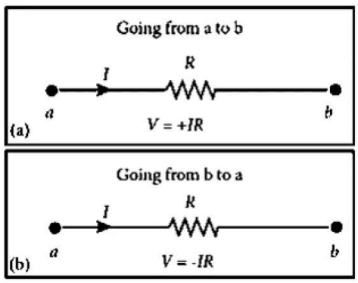
J = σE. .....(1)

- ✓ Consider a segment of wire of length l and cross sectional area A.
- ✓ When a potential difference V is applied across the wire, a net electric field is created in the wire which constitutes the current.
- ✓ Assuming electric field is uniform in the entire length of the wire, the potential difference (voltage V) can be written as

$V = El$ $\quad$ **E** $= \frac{V}{l}$ **..... (2)**

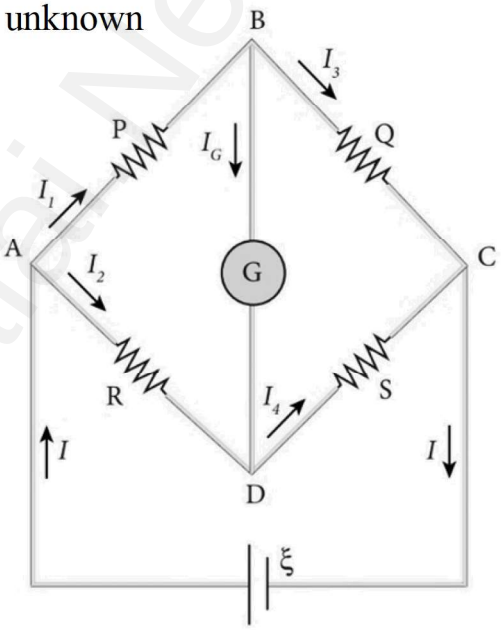
Sub (2) in (1)

- ✓ The product of current and resistance is taken as positive when the direction of the current is followed. Suppose if the direction of current is opposite to the direction of the loop, then product of current and voltage across the resistor is negative. It is shown in (a) and (b). The emf is considered positive when proceeding from the negative to the positive terminal of the cell. It is shown in (c) and (d).



6. Obtain the condition for bridge balance in Wheatstone's bridge.

- ✓ An important application of Kirchhoff 's rules is the Wheatstone's bridge. It is used to compare resistances and also helps in determining the unknown resistance in electrical network.
- ✓ The bridge consists of four resistances P, Q, R and S connected .
- ✓ A galvanometer G is connected between the points B and D.
- ✓ The battery is connected between the points A and C. The current through the galvanometer is I_G and its resistance is G.



Applying Kirchhoff 's current rule to junction B

$I_1 - I_G - I_3 = 0$ ……..(1)

Applying Kirchhoff 's current rule to junction D,

$I_2 + I_G - I_4 = 0$ ……..(2)

Applying Kirchhoff 's voltage rule to loop ABDA,

$I_1P + I_GG - I_2R = 0$ ……..(3)

Applying Kirchhoff 's voltage rule to loop ABCDA,

$I_1P + I_3Q - I_2R - I_4S = 0$ ……..(4)

When the points B and D are at the same potential, the bridge is said to be balanced , no current flows through galvanometer

$I_G = 0$.

Substituting $\mathbf{I_G = 0}$ in (1) , (2) , (3) , (4)

$I_1 = I_3$ ……..(5)

$I_2 = I_4$ ……..(6)

$I_1P = I_2R$ ……..(7)

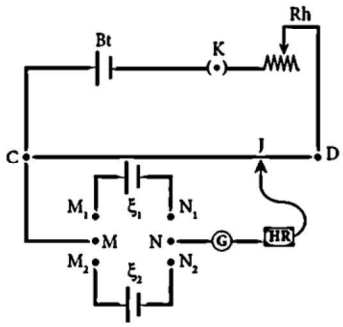
Sub (5) & (6) in (4)

$I_1P + I_1Q - I_2R - I_2S = 0$

$I_1(P + Q) = I_2(R + S)$ **……(8)**

Dividing (8) by (7)

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



3) The positive terminals of Bt, ε_1 and ε_2 should be connected to the same end C.
4) The DPDT switch is pressed towards M_1, N_1 so that cell ε_1 is included in the secondary circuit and the balancing length l_1 is found by adjusting the jockey for zero deflection.
5) Then the second cell ε_2 is included in the circuit and the balancing length l_2 is determined.
6) Let r be the resistance per unit length of the potentiometer wire and I be the current flowing through the wire.

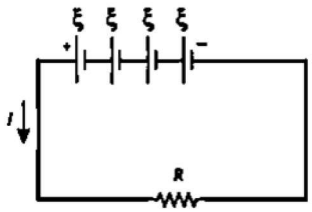
$\varepsilon_1 = Irl_1$ … **(1)** , $\varepsilon_2 = Irl_2$**….(2)**

Dividing (1) by (2)

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$$

Long Answers - Book Inside

1. Derive an expression for the current flowing in a circuit in which cells are connected in series



Cells in series (circuit diagram)

- ✓ In series connection, the negative terminal of one cell is connected to the positive terminal of the second cell, the negative terminal of second cell is connected to the positive terminal of the third cell and so on.
- ✓ The free positive terminal of the first cell and the free negative terminal of the last cell become the terminals of the battery.
- ✓ Suppose n cells, each of emf ε volts and internal resistance r ohms are connected in series with an external resistance R

The total emf of the battery = n ε

The total resistance in the circuit = nr + R

By Ohm's law, the current in the circuit is

$$I = \frac{\text{total emf}}{\text{total resistance}} = \frac{n\varepsilon}{nr + R} \quad \text{.....(1)}$$

Case (a) If $r << R$, then,

$$I = \frac{n\varepsilon}{R} \approx nI_1$$

I_1 - Current due to single cell

Case (b) If $r >> R$,

$$I = \frac{n\varepsilon}{nr} \approx \frac{\varepsilon}{r}$$

1. Current due to the whole battery is the same as that due to a single cell and hence there is no advantage in connecting several cells
2. Thus series connection of cells is advantageous only when the effective internal resistance of the cells is negligibly small compared with R.

Negative Thomson effect

- ✓ When the copper bar is replaced by an iron bar, heat is evolved along CA and absorbed along BC.
- ✓ Thus heat is transferred due to the current flow in the direction opposite to the direction of current.
- ✓ It is called negative Thomson effect
- ✓ Similar effect is observed in metals like **platinum, nickel, cobalt, and mercury.**

7.Explain seeback effect and its application

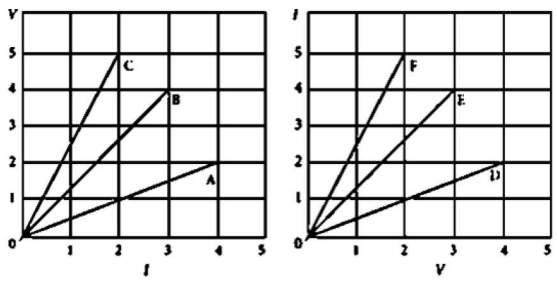
- ✓ Seebeck discovered that in a closed circuit consisting of two dissimilar metals, when the junctions are maintained at different temperatures an emf (potential difference) is developed.
- ✓ The current that flows due to the emf developed is called thermoelectric current. The two dissimilar metals connected to form two junctions is known as thermocouple
- ✓ If the hot and cold junctions are interchanged, the direction of current also reverses. Hence the effect is reversible.
- ✓ The magnitude of the emf developed in a thermocouple depends on (i) the nature of the metals forming the couple and (ii) the temperature difference between the junctions.

Applications of Seebeck effect

- ✓ Seebeck effect is used in thermoelectric generators (Seebeck generators).These thermoelectric generators are used in power plants to convert waste heat into electricity.
- ✓ This effect is utilized in automobiles as automotive thermoelectric generators for increasing fuel efficiency.
- ✓ Seebeck effect is used in thermocouples and thermopiles to measure the temperature difference between the two objects.

Numerical Problems Solved

1. The following graphs represent the current versus voltage and voltage versus current for the six conductors A,B,C,D,E and F. Which conductor has least resistance and which has maximum resistance?



To find :

$R_{Least} = ?$; $R_{max} = ?$

Solution:

According to ohm's law $V = IR$, $R = \frac{V}{I}$

$200\,I_1 + 1 = 15$

$200\,I_1 = 14$,

$I_1 = \frac{7}{100}$

$\mathbf{I_1 = 0.07\ A}$

(1) => $I_3 = I_1 - I_2$

$= 0.07 - (-0.01)$

$\mathbf{I_3 = 0.08\ A}$

10. A potentiometer wire has a length of 4 m and resistance of 20 Ω. It is connected in series with resistance of 2980 Ω and a cell of emf 4 V. Calculate the potential along the wire.

Given: $l = 4$ m, resistance, $r = 20\ \Omega$, $r' = 2980\ \Omega$, $\xi = 4V$, $E = ?$

Solution:

Effective resistance for two resistors in series combination

$R_s = r + r' = 20 + 2980\ \Omega$

$R_s = 3000\ \Omega$

$I = \frac{\varepsilon}{R} = \frac{4}{3000} A$

Potential drop across the wire,

$$V = Ir = \frac{4}{3000} \times 20 = \frac{4}{150} \text{ volt}$$

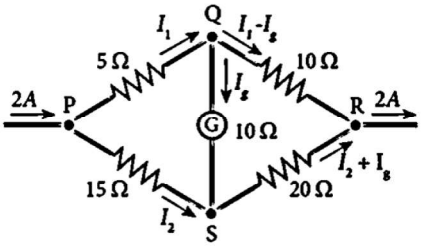
∴ Potential gradient,

$$E = \frac{V}{l} = \frac{4}{150} \times \frac{1}{4}$$

$$E = \frac{1}{15 \times 10} = \frac{10 \times 10^{-2}}{15} = 0.66 \times 10^{-2} Vm^{-1}$$

$$\mathbf{E = 0.66 \times 10^{-2}\ Vm^{-1}}$$

11. Determine the current flowing through the galvanometer (G) as shown in the figure.



Solution:

Apply Kirchoff's current rule at junction P,

$I - I_1 - I_2 = 0$

$$I - I_1 = I_2 \rightarrow (1)$$

Apply Kirchoff's voltage rule for closed path, PQSP,

$5\,I_1 + 10\,I_g - 15\,I_2 = 0$

From (1) $5\,I_1 + 10\,I_g - 15(I - I_1) = 0$

$5\,I_1 + 10\,I_g - 15\,I + 15\,I_1 = 0$

$I = 2A$,

$20\,I_1 + 10\,I_g - 15 \times 2 = 0$

$20\,I_1 + 10\,I_g = 30 \rightarrow (2)$

Apply Kirchoff's voltage rule for closed path, QRSP,

$$10(I_1 - I_g) - 20(I_2 + I_g) - 10\,I_g = 0$$

$$10\,I_1 - 10\,I_g - 20\,I_2 - 20\,I_g - 10\,I_g = 0$$

From (1) $10\,I_1 = 40\,I_g - 20(I - I_1) = 0$

$$10\,I_1 - 40\,I_g - 20\,I + 20\,I_1 = 0$$

$I = 2A,$

$30\,I_1 - 40\,I_g - 20 \times 2 = 0$

$30\,I_1 - 40\,I_g = 40 \rightarrow (3)$

$(2) \times 3 \quad 60\,I_1 + 30\,I_g = 90$

$(3) \times 2 \quad 60\,I_1 - 80\,I_g = 80$

$(-) \quad (+) \quad (-)$

$110\,I_g = 10$ $\qquad$ $\mathbf{I_g = \frac{1}{11} A}$

12. Two cells each of 5V are connected in series across a 8 Ω resistor and three parallel resistors of 4 Ω, 6 Ω and 12 Ω. Draw a circuit diagram for the above arrangement.

Calculate

i) the current drawn from the cell

(ii) current through each resistor

To find : I=?

Solution:

$R_1 = 4\,\Omega$, $R_2 = 6\Omega$, $R_3 = 12\,\Omega$ are connected in parallel,

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

$$= \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$$

$$\frac{1}{R_P} = \frac{3+2+1}{12} = \frac{6}{12} = \frac{1}{2}\Omega$$

$$\therefore\ \mathbf{R_P = 2\Omega}$$

Now, 8Ω and 2 Ω resistors are in series

$R_S = R + R_P = 8 + 2 = 10$

$$\therefore R_S = 10\Omega$$

Two cells are connected in series,

$\varepsilon = \xi_1 + \xi_2 = 5 + 5 = 10$ volt

Current drawn from each cell,

$$I = \frac{\xi}{R_S} = \frac{10}{10} = 1\ A$$

Potential difference through 8Ω resistor is, $V = IR$

$V = 1 \times 8 = 8$ volt.

Potential through 2Ω (net resistance in parallel)

$V = IR = 1 \times 2 = 2\ V$

(i) Current through 8Ω resistor,

$I = \frac{V}{R} = \frac{8}{8} = 1\ A; \quad I = 1A$

(ii) Current through 4Ω , 6 Ω, 12 Ω resistor,

$R = 4\ \Omega,\ \ I = \frac{V}{R} = \frac{2}{4} = 0.5\ A$

$R = 6\ \Omega,\ \ I = \frac{V}{R} = \frac{2}{6} = 0.33\ A$

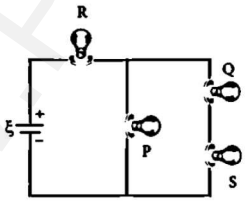
$R = 12\ \Omega,\ \ I = \frac{V}{R} = \frac{2}{12} = 0.166\ A$

13. Four light bulbs P, Q, R, S are connected in a circuit of unknown arrangement. When each bulb is removed one at a time and replaced, the following behavior is observed.

Given:

	P	Q	R	S
P removed	*	ON	ON	ON
Q removed	ON	*	ON	OFF
R removed	OFF	OFF	*	OFF
S removed	ON	ON	ON	*

Solution:



14. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63 cm, what is the emf of the second cell?

Given: $\xi_1 = 1.25\ V,\ \ \xi_2 = ?\ \ \ \xi = \frac{5}{4} V,\ \ \ l_1 = 35 \times 10^{-2} m,\ \ l_2 = 63 \times 10^{-2} m$

Solution : $\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1};$

$\varepsilon_2 = \varepsilon_1 \times \frac{l_2}{l_1}$

$\varepsilon_2 = \frac{5}{4} \times \frac{63 \times 10^{-2}}{35 \times 10^{-2}} = \frac{9}{4} = 2.25\ V \qquad \varepsilon_2 = \mathbf{2.25\ volt}$