TOPIC : CURRENT ELECTRICITY
EXERCISE # 1

SECTION (A)

1. The drift velocity of electrons in a conducting wire is of the order of 1mm/s. But electric field is set up in the wire very quickly, producing a current through each cross section, almost intantaneousty.

2. In the presence of an applied electric field ($\vec{E}$) in a metallic conductor. The electrons also move randomly but slowly drift in a direction opposite to $\vec{E}$.

3. n = $\frac{I}{e} = \frac{4.8}{1.6\times10^{-19}} = 3\times10^{19}$

SECTION (B)

1. Specific resistance depends only on the material of the wire.

2. Specific resistance depends only on the material of the wire.

3. R = $\frac{\rho\ell}{A} = \frac{\rho\times2\ell}{2A} = \frac{\rho\ell}{A}$ (unchanged)

4. V = IR
Equation of straight line

6. R = $\frac{\rho\ell}{A}$ ⇒ 0.1 = $\frac{3.14\times10^{-8}\times\ell}{\pi(1\times10^{-3})^2}$ ⇒ ℓ = 10 m

7. $R_1 = \frac{\rho\ell}{A}$, $R_2 = \frac{\rho\times2\ell}{A/2} = 4R_1$, $R_2 = \frac{\rho\ell/2}{2A} = \frac{R_1}{4}$

8. R = $\frac{\rho\ell}{a}$, R' = $\frac{\rho\times\ell}{4a} = \frac{R}{4}$

9. Volume will remain same so

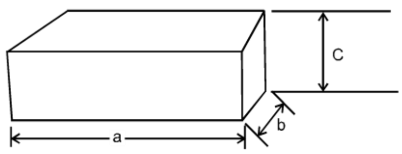
$V_1 = V_2$ ⇒ $\ell_1 A_1 = \ell_2 A_2$ ⇒ $\frac{A_1}{A_2} = \frac{\ell_2}{\ell_1}$

⇒ $\frac{r_1^2}{r_2^2} = \frac{\ell_2}{\ell_1}$ ⇒ $\frac{\ell_2}{\ell_1} = 4$ ⇒ $\ell_2 = 4\ell_1$ ⇒ R = $\frac{\rho\ell}{A}$, R' = $\frac{\rho4\ell}{A/4} = 16R$

10. If a same wire is stretched, its length increases but cross-sectional area decreases.

$R \propto l^2$ ∴ $\frac{R'}{R} = \left(\frac{l'}{l}\right)^2 = 4$ ⇒ R' = 4R

11.



a > b > c   Let and a = 2c

$R_{max} = \frac{\rho a}{bc}$ $\Rightarrow$ $R_{min} = \frac{\rho c}{ab}$ $\Rightarrow$ $\frac{R_{max}}{R_{min}} = \frac{a^2}{c^2} = 4$

12. In semiconductor resistance decrease with increase in the temperature. Therefore resistivity also decrease. In conducting solid resistance increase with increase the temperature because the rate of collisions between free electron and ions increases with increase of temperature both the statements are true.

13. $R = \frac{\rho \ell}{A}$

$R = \frac{2 \times 10^{-7} \times 1 \times 10^{-2}}{100 \times 1 \times 10^{-4}} = 2 \times 10^{-7}\,\Omega$

14. $X = \frac{\rho \times 4a}{a \times 2a} = 2\frac{\rho}{a}$

$Y = \frac{\rho \times a}{4a \times 2a} = \frac{1}{8}\frac{\rho}{a}$

$Z = \frac{\rho \times 2a}{4a \times a} = \frac{1}{2}\frac{\rho}{a}$ So, X > Z > Y

15. Wire is stretched, therefore its volume remains unchanged

$A_1 l_1 = A_2 l_2$

$A_1 l = A_2 \times 3l$

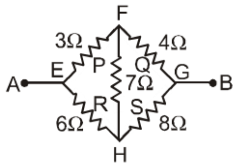
$A_2 = \frac{A_1}{3}$ Ratio of resistane $\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \frac{l}{3l} \times \frac{1}{3} = \frac{1}{9} = \frac{20}{R_2} = \frac{1}{9} \Rightarrow$ $R_2 = 180\ \Omega$

16. $\rho_{eq} \frac{2\ell}{A} = \rho_1 \frac{\ell}{A} + \rho_2 \frac{\ell}{A}$

$\rho_{eq} = 1/2\,(\rho_1 + \rho_2)$

17. $R_{AB} = 2 + 2 + 2 = 6\Omega$

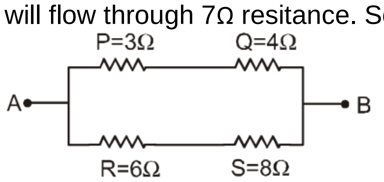
18. In the balance condition of bridge circuit, no current will flow through 7Ω resistance. The bridge circuit can be shown as :



The balanced condition of bridge circuit is given by

$\frac{P}{Q} = \frac{3}{4}$, $\frac{R}{S} = \frac{6}{8} = \frac{3}{4}$ $\therefore \frac{P}{Q} = \frac{R}{S}$

Thus, it is balanced Wheatstone's bridge, so potential at F is equal to potential at H. Therefore, no current will flow through 7Ω resitance. So, circuit can be redrawn as shown above.



P and Q are in series, so their equivalent resistance = 3 + 4 = 7Ω

R and S are also in series, the their equivalent resistance = 6 + 8 = 14Ω

Now, 7Ω and 14Ω resistance are in parallel, so $R_{AB} = \frac{7\times14}{7+14} = \frac{7\times14}{21} = \frac{14}{3}\Omega$.

NOTE: Normally, in wheastone's bridge in middle arm galvanometer must be connected. In wheatstone's bridge, cell and galvanometer arms are interchangeable.
In both the cases, condition of balanced bridge is

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

19. $A_1 l_1 = A_2 l_2$
$A_1 \times l = A_2 \times 2l$

$$\therefore \frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \frac{l}{2l} \times \frac{l}{2}$$

$$\frac{R_1}{R_2} = \frac{1}{4} \quad \Rightarrow \quad R_2 = 4R_1$$

Resistance becomes 4 times the initial resistance.

20. Resistivity of a metal is directly proportional to temperature and resistivity of semiconductor is inversely proportional to temperature.
Resistivity of metal ∝ Temperature

Resistivity fo semicondutor $\propto \frac{1}{\text{Temperature}}$

This implies that with decreases in temperature resistivity of metal decreases while that of emiconductor increases.
Here, Si is a semiconductor and Cu is a metal. So, resistivity of Si increases but that of Cu decreases.

21. Here: Thickness of first wire $r_1 = 2r$
The thickness of second wire $r_2 = r$
Using the relation for resistance of wire is,

$R = \frac{S\times l}{A} = S\times\frac{l}{\pi r^2} \propto \frac{1}{r^2}$ Hence $\frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^2 = \frac{(r)^2}{(2r)^2} = \frac{1}{4}$

22. $R_t = R_0 (1 + \alpha\Delta t)$
$5R = R_0 (1 + \alpha \times 50)$ ...(i)
and $6R = R_0 (1 + \alpha \times 100)$ ...(ii)
On dividing Eq. (i) by (ii) and solving it, we get

$$\alpha = \frac{1}{200}\Omega / 0°C$$

On putting in Eq. (i), we get

$$5R = R_0\left(1+\frac{1}{4}\right) \quad \Rightarrow \quad 5R = \frac{5}{4} R_0 \quad \Rightarrow \quad R_0 = 4R\Omega$$

23. The resistance of metallic wire at temperature t ° C is given by
$R_t = R_0 (1 + \alpha t)$ Where α is coefficient of expansion.

Hence, resistance of wire increases on increasing thetemperature. Also, from Ohm’s law, ratio of $\frac{V}{t}$ is equal to R ie, $\frac{V}{t} = R$

Hence, on increasing the temperature the ratio $\frac{V}{i}$ increases.

24. Given : l’ = l + 100% = 2l Initial volume = final volume ie, $\pi r^2 = pr'^2\, l$

$\Rightarrow \quad r'^2 = \frac{r^2 l}{l} = r^2 \times \frac{l}{2l} \quad \Rightarrow \quad r'^2 = \frac{r^2}{2} \quad \therefore \quad R' = \rho \frac{l}{A'} = \rho \frac{2l}{\pi r'^2} \left(\because R = \frac{\rho l}{A}\right) = \frac{\rho 4l}{\pi r^2}$

$\Delta R = R' - R = 4R - R = 3R \quad \therefore \quad \% \Delta R = \frac{3R}{R} \times 100\% = 300\%$

25. Conductane = $\frac{1}{\text{Resistance}}$

$\therefore$ Resistance (R) = $\frac{1}{8}\,\Omega$ $\quad \therefore$ Current flowing through the conductor

$I = \frac{V}{R} = \frac{20 \times 8}{1} = 160$ A

26. $V = \varepsilon - ir$ so y- intercept = ε = 1 V

slope = $-r = -\frac{1}{4}$

so $r = 0.25\ \Omega$

27. $R = \rho \frac{\ell}{A} = \rho \frac{\ell^2}{V} \quad \Rightarrow \quad R \propto \ell^2$ as $\ell \longrightarrow 2\ell$

$\Rightarrow R \longrightarrow 4R \quad \Rightarrow$ % change in R = 300 % **Ans.**

28. $H_1 = \frac{V^2}{R} t \quad \Rightarrow \quad H_2 = \frac{V^2}{R/2} t \quad \therefore \quad \frac{H_2}{H_1} = 2 \quad \Rightarrow \quad H_2 = 2H_1$ **Ans.**

29. $\rho_B = 2\rho_A$ $\quad r_B = 2r_A$

$R_A = R_B \quad \Rightarrow \quad \rho_A = \left(\frac{\ell_A}{\pi r_A^2}\right) \rho_B \left(\frac{\ell_B}{\pi r_B^2}\right) \quad \Rightarrow \quad \frac{\ell_A}{\ell_B} = \frac{1}{2}$ **Ans.**

30. Let $R = R_0$ at 0ºC

$5 = R_0 (1 + \alpha \times 50)$ ....(i)

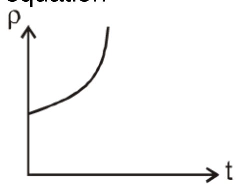
$6 = R_0 (1 + \alpha \times 100)$ ....(ii)

Solving (i) and (ii) $\Rightarrow$ $R_0 = 4\Omega$

31. $R = \frac{\rho l}{A}$

$R = \frac{\rho L}{tL} = \frac{\rho}{t}$. Independent of L.

32. The specific resistance (resistivity) of a metallic conductor nearly increases with increasing temperature as shown in figure. This is because, with the increases in temperature the ions of the conductor vibrate with greater amplitude, and the collision between electrons and ions become more frequent, over all small temperature range (up to 100ºC). The resistivity of a metal can be represented approximately by the equation



$\rho_t = \rho_0 (1 + \alpha t)$. The factor α is called the temperature cofficient of resistivity.

33. The electric fuse is a device which is used to limit the current in an electric circuit. Thus, the use of fuse safeguards the circuit and the applicanes connected in the circuit from being damaged. It is always connected with the live (or phase) wire. The fuse wire is a short piece of wire made of a material of high resistance and low melting point so that it may easily melt due to overheating when excessive current passes through it.

Note : A fuse wire is an alloy made of tin and lead.

34. The formula for resistance of wire is

$R = \frac{\rho \ell}{A}$

where ρ = specific resistance of the wire

$\Rightarrow R \propto \frac{\ell}{r^2}$ $(\because A = \pi r^2)$

$\therefore \frac{R_1}{R_2} = \frac{\ell_1}{\ell_2} \times \frac{r_2^2}{r_1^2}$ ....(i)

$\ell_1 = \ell$, $\ell_2 = 2\ell$,, $r_1 = r$, $r_2 = 2r$, $R_1 = R$

Substituting these values in Eq. (i), we have

$\frac{R_1}{R_2} = \frac{\ell}{2\ell} \times \frac{(2r)^2}{r^2}$

$\frac{R_1}{R_2} = \frac{\ell}{2\ell} \times \frac{(2r)^2}{r^2}$

$\frac{R_1}{R_2} = 2$

$R_2 = \frac{R}{2}$

Therefore, resistance will be halved. Now the specific resistance of the wire does not depend on the geometry of the wire hence, it remains unchanged.

35. Total current drawn from the battery

$i = \frac{E}{R+r} = \frac{6}{100+0} = 0.06\text{A}$

Resistance of 50 cm wire is

$R' = \frac{\rho \ell'}{A} = \left(\frac{\rho}{A}\right)\ell'$ $\left(\because R = \frac{\rho \ell}{A}\right) = \frac{100}{300} \times 50$

so, $R' = \frac{50}{3}\ \Omega$

Hence, the potential difference between two points on the wire separated by a distance ℓ' is

$V = iR' = 0.06 \times \frac{50}{3} = 1\text{V}$

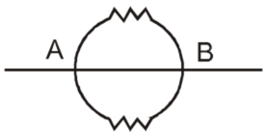
36. When wire is bent to form a complete circle then

$2\pi r = R$

$\Rightarrow r = \frac{R}{2\pi}$

Resistance of each semicirle

$= \pi r = \frac{\pi R}{2\pi} = \frac{R}{2}$



Thus, net resistance in parallel combination of two semicircular resistances

$$R' = \frac{\frac{R}{2} \times \frac{R}{2}}{\frac{R}{2} + \frac{R}{2}} = \frac{\frac{R^2}{4}}{R} = \frac{R}{4}$$

37. In stretching, specific resistance remains unchanged.
After stretching, specific resistance (ρ) will remain same.
Original resistance of the wire,

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

or $R \propto \frac{l}{A}$ or $R \propto \frac{l^2}{V}$ (as V = Al)

and $R \propto \frac{(l+10\%l)^2}{V}$

therefore, $$\frac{R'}{R} = \frac{\left(l+\frac{10}{100}l\right)^2}{l^2}$$

or $$\frac{R'}{R} = \frac{\left(\frac{11l}{10}\right)^2}{l^2} = \frac{121}{100}$$

or R' = 1.21 R

38. Heat evolved due to joule's effect is used up in boiling water.
As per key idea

$VIt = ms\Delta T$ or $t = \frac{ms\Delta T}{VI}$

Putting under given values
I = 4 A, V = 220 volt, m = 1 kg,
$\Delta T = (100 - 20)^o$ C, s = 4200 J/kg^{o}C

∴ $t = \frac{1 \times 4200 \times 80}{220 \times 4}$ = 6.3 min

SECTION (C)

1. In an electric circuit containing a battery, the positive charge inside the battery may go from the positive terminal to the negative terminal

2. (a) V = E – ir , V < E (b) V = E + ir , V > E (c) V = E (d) V = E

3. $\eta = \frac{E - Ir}{E}$ $1 - \frac{r}{r+R} = \frac{R}{r+R}$ = 0.6 ⇒ R = 0.6 r + 0.6 R

$r = \frac{4}{6}$ $R = \frac{2R}{3}$

$\eta = \frac{6R}{r+6R} = \frac{6R}{\frac{2R}{3}+6R} = \frac{18R}{2R+18R}$ = 0.9 = 90%

4. Power of electric bulb

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

So, resistance of electric bulb

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

Given, P_1 = 25W P_2 = 100W, $V_1 = V_2$ = 200V
Therefore, for same potential difference V,

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

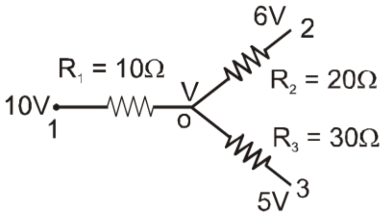
Thus, we observe that for minimum power, resistance will be maximum and vice-versa. Hence, resistance of 25W bulb is maximum and 100W bulb is minimum.

5. Power p = $\frac{V^2}{R}$

∴ p ∝ $\frac{1}{R}$

∴ $\frac{p_1}{p_2} = \frac{R_2}{R_1} = \frac{2}{1}$ ⇒ $p_1 : p_2 = 2 : 1$

7.

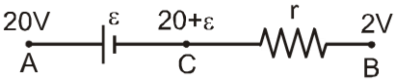


Apply KCL for circuit $\frac{V-10}{10} + \frac{V-6}{20} + \frac{V-5}{30} = 0$

6V – 60 + 3V – 18 + 2V – 10 = 0⇒ 11V = 88 ⇒ V = 8 V

current in resistance R_1 is = $\frac{10-8}{10}$ = 0.2 amp

8.



Potential at C point is greater than potential at point B. Therefore current flow in resistance from B to A.

10. Internal resistance of the cell is given by

r = $\left(\frac{E-V}{V}\right)$ R

Given, E = 1.5V, V = 1.0V, R = 2Ω

∴ r = $\left(\frac{1.5-1.0}{1.0}\right)$ × 2 = $\frac{0.5}{1.0}$ × = 1.0Ω

11. Power p = $\frac{V^2}{R}$

∴ p ∝ $\frac{1}{R}$

∴ $\frac{p_1}{p_2} = \frac{R_2}{R_1} = \frac{2}{1}$

$p_1 : p_2 = 2 : 1$

13. Power p = $\frac{V^2}{R}$

∴ p ∝ $\frac{1}{R}$

∴ $\frac{p_1}{p_2} = \frac{R_2}{R_1} = \frac{1}{2}$

$p_1 : p_2 = 1 : 2$

14. Here : Resistance R = 80Ω

Voltage V = 200 V
Time t - 2 hr
The relation of power is given by
= power × time
= 500 × 2 = 1000 Wh

15. From Joule's law,

$H = i^2Rt$

H = 80 J, i = 2A, t = 10s

$\therefore \quad 80 = (2)^2 \times R \times 10 \quad \Rightarrow \quad R = \frac{80}{4 \times 10} = 2\ \Omega$

16. Given, R = 6 Ω, t = 10 min = 600 s
v = 120 volt

Energy liberated = $\frac{v^2}{R}.t$

$= \frac{120 \times 120 \times 600}{6}$

$= 144 \times 10^4$ J

$= 14.4 \times 10^5$ J

17. Using the formula $P = \frac{V^2}{R}$ ...(i)

Where R is resistance of wire, V is voltage across wire and P is power dissipation in wire and

$R = \frac{\rho\ell}{A}$ ...(ii)

From Eqs. (i) and (ii)

$P_1 = \frac{V^2}{\rho\ell / A} = \frac{V^2}{\rho\ell}.A$

$P_1 = \frac{V^2}{\rho\ell}.A$ ...(iii)

In 2nd case

Let R_2 is net resistance.

$R_2 = \frac{R \times R}{R + R} = \frac{R}{2}$

Where, R is the resistance of half wire.

$\therefore \quad R_2 = \frac{\rho.\left(\frac{\ell}{2}\right)}{A.2} = \frac{\rho\ell}{4A}$

$\therefore \quad P_2 = \frac{V^2}{\rho\ell}.4A$ ... (iv)

Hence, from Eqs. (iii) and (iv)

$\frac{P_1}{P_2} = \frac{1}{4} \quad \Rightarrow \quad \frac{P_2}{P_1} = \frac{4}{1}$ **Ans.**

18. $R = \frac{V^2}{P} = \frac{(220)^2}{1000}$

Where, V and P are denoting rated voltage and power respectively.

$\therefore \qquad P_{consumed} = \frac{V^2}{R} = \frac{110 \times 110}{220 \times 220} \times 1000 = 250$ watt **Ans.**

19. Let time taken in boiling the water by the heater is t sec. Then

$Q = ms\Delta T \qquad \Rightarrow \qquad \frac{Pt}{J} = ms\Delta T \qquad \Rightarrow \qquad \frac{836}{4.2} t = 1 \times 1000\ (40^o - 10^o)$

$\frac{836}{4.2} t = 1000 \times 30 \qquad \Rightarrow \qquad t = \frac{1000 \times 30 \times 4.2}{836} = 150$ second **Ans.**

20. $P = \frac{V^2}{R} \qquad \therefore \qquad R_{hot} = \frac{V^2}{P} = \frac{200 \times 200}{100} = 400\ \Omega$

$R_{cold} = \frac{400}{10} = 40\ \Omega$ **Ans.**

21. $P = V^2/R$, putting values we get $R = (22)^2$ ohm
When operated at 110 V, $P' = (110)^2/R = 25$ watt

22. KCL is based on conservation of charge
and KVL is based on conservation of energy

23. Let R_1 and R_2 be the resistances of the coils, V the supply voltage, H the heat required to boil the water.

For first coil, $H = \frac{V^2 t_1}{R_1}$ ....(i)

For second coil, $H = \frac{V^2 t_2}{R_2}$ ....(ii)

Equating Eqs. (i) and (ii), we get

$\frac{t_1}{R_1} = \frac{t_2}{R_2}$ i.e., $\frac{R_2}{R_1} = \frac{t_2}{t_1} = \frac{40}{10} = 4 \qquad \Rightarrow \qquad R_2 = 4R_1$ ....(iii)

when the two heating coils are in parallel,

$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{R_1 \times 4R_1}{R_1 + 4R_1} = \frac{4R_1}{5}$

and $H = \frac{V_t^2}{R}$ ....(iv)

Comparing Eqs. (i) and (iv) we get

$\frac{V^2 t_1}{R_1} = \frac{V^2 t}{R}$

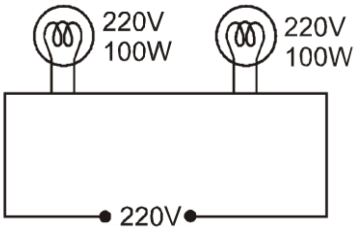
$\Rightarrow t = \frac{R}{R_1} \times t_1 = \frac{4}{5} \times 10 = 8$ min.

24. Let, $P_1 = 100W$, $P_2 = 100W$, $V = 220$ volt

$P_1 = \frac{V^2}{R_1}$ and $P_2 = \frac{V^2}{R_2}$

$\therefore R_1 = \frac{V^2}{P_1} = \frac{(220)^2}{100} = \frac{220 \times 220}{100} \Omega$ and $R_2 = \frac{V^2}{P_2} = \frac{(220)^2}{100} = \frac{220 \times 220}{100}\ \Omega$

Case I : When two bulbs are connected in series.

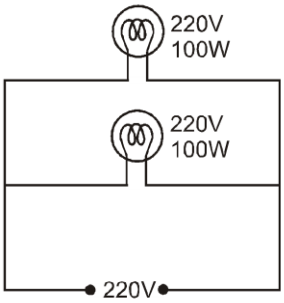


In series, $R_{eq} = R_1 + R_2$

$= \left(\frac{220 \times 220}{100}\right) \times 2$

Hence, $P_{eq} = \frac{V^2}{R_{eq}} = \frac{220 \times 220}{\left(\frac{220 \times 220}{100} \times 2\right)} = \frac{100}{2} = 50W$

Case II : When two bulbs are connected in parallel.



In parallel,

$R_{eq} = \frac{R_1R_2}{R_1 + R_2} = \frac{\left(\frac{220 \times 220}{100}\right)^2}{\frac{220 \times 220}{100} \times 2} \Rightarrow R_{eq} = \frac{220 \times 220}{100} \times \frac{1}{2}$

Hence, $P_{eq} = \frac{V^2}{R_{eq}} = \frac{220 \times 220}{\frac{220 \times 220}{100} \times \frac{1}{2}} = 220W$

Alternative :

For series $P_{eq} = \frac{P_1P_2}{P_1 + P_2} = \frac{100 \times 100}{200} = 50W$

For parallel $P_{eq} = P_1 + P_2 = 100 + 100 = 200W$

25. Watt-hour efficiency of a battery is the ratio of output energy to the input energy. Input energy when the battery is charged

= Vit

= 15 × 10 × 8 = 1200 W–h

Energy released when the battery is discharged

= 14 × 5 × 15 = 1050 W–h

Hence, W-h efficiency of battery is given by

$= \frac{\text{energy output}}{\text{energy input}} = \frac{1050}{1200} = 0.875 = 87.5\%$

26. Since, power rating of bulb in both the countries India and USA should be same, so

$\frac{V_1^2}{R_1} = \frac{V_2^2}{R_2} \Rightarrow \frac{220 \times 220}{R_1} = \frac{110 \times 110}{R_2}$

$\Rightarrow \frac{R_2}{R_1} = \frac{110 \times 110}{220 \times 220} \Rightarrow R_2 = \frac{R}{4}$ ($\because R_1 = R$)

27. Power $P = i^2R$

$\Rightarrow R = \frac{P}{i^2}$

Given, P = 1 W, i = 5A

$\therefore R = \frac{1}{(5)^2} = 0.04\Omega$

28. Kirchhoff' first law is junction rule, according to which the algebraic sum of the currents into any junction is zero. The junction rule is based on conservation of electric charge. No charge can accumulate at a junction, so the total charge entering the junction per unit time must equal to charge leaving per unit time. Kirchhoff's second law is loop rule according to which the algebraic sum of the potential difference in any loop including those associated emf's and those of resistive elements, must equal to zero.
This law is basically the law of conservation of energy.

29. In series order, the resistance of three bulbs must be added to give resultant resistance of the circuit.
Let R_1, R_2 and R_3 are the resistances of three bulbs respectively.
In series order
$R = R_1 + R_2 + R_3$

but $R = \frac{V^2}{P}$ and supply voltage in series order is the same as the rated voltage.

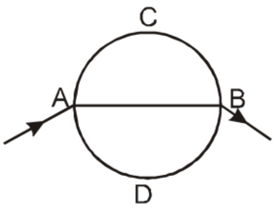
$\therefore \frac{V^2}{P} = \frac{V^2}{P_1} + \frac{V^2}{P_2} + \frac{V^2}{P_3}$

or $\frac{1}{P} = \frac{1}{60} + \frac{1}{60} + \frac{1}{60}$ or $P = \frac{60}{3} = 20$ W

SECTION (D)

1. (1) $R_1 = R_{01}(1 + \alpha_1 \Delta\theta) = 600(1 + 0.001 \times 30) = 618\ \Omega$
$R_2 = R_{02}(1 + \alpha_2 \Delta\theta) = 300(1 + 0.004 \times 30) = 336\ \Omega$
$R_{eq} = R_1 + R_2 = 618 + 336 = 954\ \Omega$

(b) $R_{eq} = R_{0eq}(1 + \alpha_{eq}\Delta\theta)$ $954 = 900(1 + \alpha\, 30)$ $\alpha = \frac{54}{900 \times 30} = \frac{1}{500}$ degree^{-1}



2.

$$\frac{1}{R_{eq.}} = \frac{1}{R_{ACB}} + \frac{1}{R_{ADB}}$$

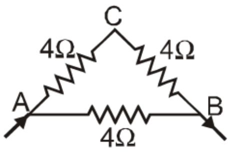
$2\pi r = L$

$ACB = \pi r$

$\pi r = \frac{L}{2} = \frac{12}{2} = 6$

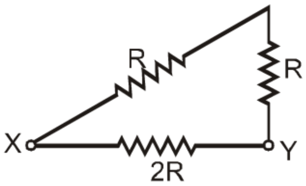
$$\frac{1}{R_{eq.}} = \frac{1}{6} + \frac{1}{6}$$

$R_{eq} = 3$

3. 

$R_{eq.} = \frac{8\times 4}{8+4} = \frac{8}{3}$

4. $R = \frac{1}{3} + 2 = \frac{7}{3}\ \Omega$

5. 

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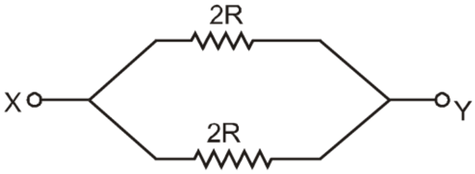
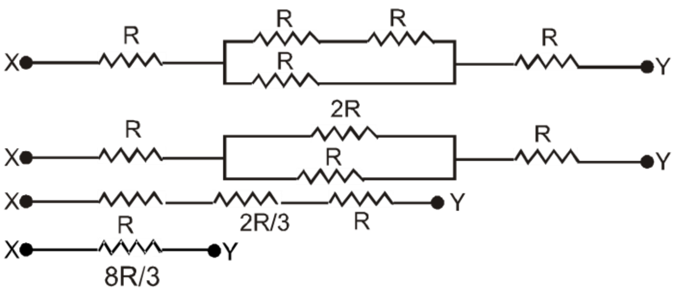


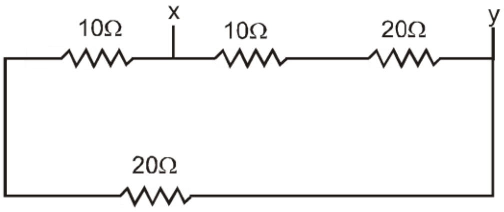
$R_{eq} = 2R$

6. 

7. Balanced wheatstone bridge so $R_{xy} = \frac{2R\times 2R}{2R+2R} = R$

8. $R = \frac{20\times 20}{20+20} = 10\Omega$

9. $R = \frac{30\times 15}{30+15} = 10\Omega$

10. 

$R = \frac{30\times 30}{30+30} = 15\Omega$

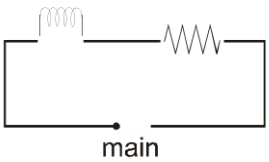
12. $R_{2.5\,W} = \frac{(110)^2}{2.5}\ \Omega$, $R_{100W} = \frac{(110)^2}{100}$ $\Rightarrow$ $R_{2.5} > R_{100}$.

In series current passes through both bulb are same

$P_{2.5} = i_2 R_{2.5}$, $P_{100} = i_2 R_{100}$

$P_{2.5} > P_{100}$ due to $R_{2.5} > R_{100}$

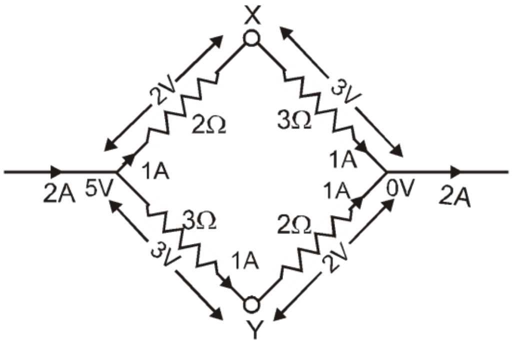
Therefore 2.5 W bulb will fuse first.

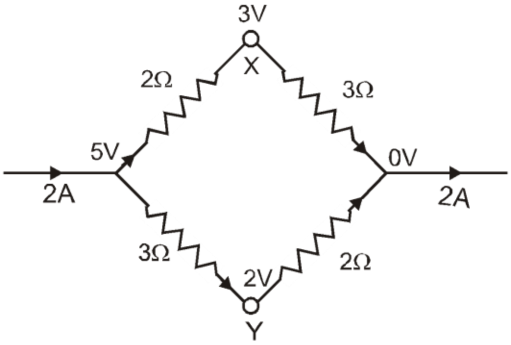
13.


For power across heater is maximum resistance of bulb should be minimum

$P_{heater} = \left(\frac{V}{R_H + R_b}\right)^2 R_H$

R_{bulb} is minimum for 200 W.

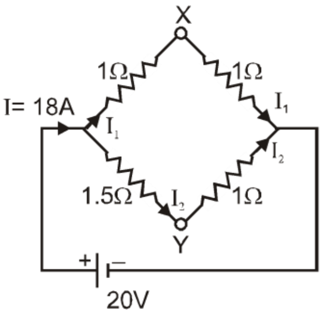
14.




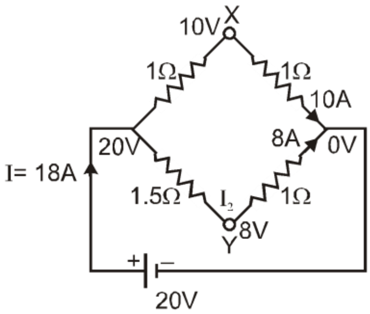
$\Rightarrow\ V_x - V_y = 3 - 2 = 1V$

15. $R_{eq} = \frac{6\times3}{6+3} = 2\Omega$

$V_{xy} = IR_{eq} = 2 \times 1 = 2V$

17.


⇒

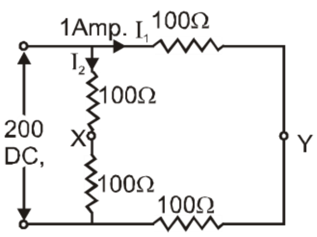


$R_{eq} = \frac{2\times2.5}{2+2.5} = \frac{10}{9}$

Net current $I = \frac{20}{10/9} = 18$ Amp.

$I_1 = \frac{2.5}{4.5}\times18 = 10$ Amp.

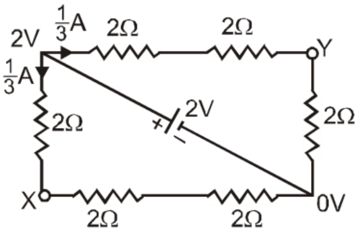
$I_2 = 18 - 10 = 8$ Amp. $\Rightarrow\ V_x - V_y = 10 - 8 = 2V$

18.


$R_{eq} = \frac{200\times200}{200+200} = 100\Omega$

Net current I = $\frac{200}{100}$ = 2 Amp.
$I_2 = I_1 = = 1$ Amp.
So $V_x - V_y = 100 - 100 = 0$

19. $R_{eq} = \frac{6 \times 6}{6+6} = 3\Omega$



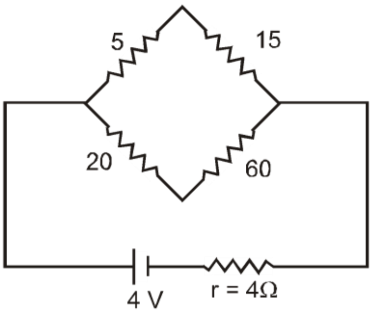
Net current I = $\frac{2}{3}$ Amp.

distributed current $I_1 = I_2 = \frac{1}{3}$ Amp.

$V_x = 4 \times \frac{1}{3} = \frac{4}{3}$ V $\qquad V_y = 2 \times \frac{1}{3} = \frac{2}{3}$ V

$V_x - V_y = \frac{4}{3} - \frac{2}{3} = \frac{2}{3}$

20.



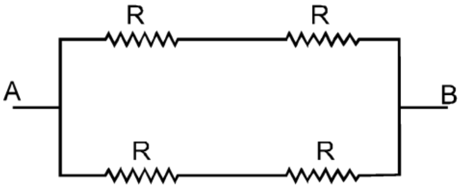
$\Rightarrow \quad R_{eq} = \frac{80 \times 20}{80+20} + 4 = 20\Omega$

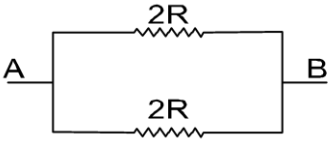
$\Rightarrow \quad I = \frac{V}{R} = \frac{4}{20} = \frac{1}{5}A$

21. The given circuit (between A and B) is a balanced Wheatstone's bridge.Therefore, resistance between C and D is ineffective.
The resistances 2R and 2R are in parallel, so, effective resistance

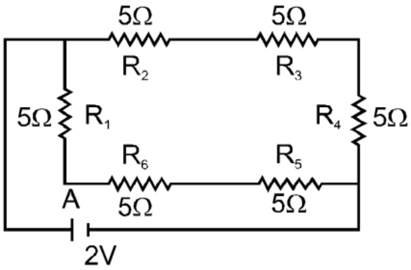
$R_{eff} = \frac{R_1 R_2}{R_1 + R_2}$

$= \frac{2R \times 2R}{2R + 2R} = R$





22. The figure can be shown as equivalent resistance of R_1, R_2 and R_3



$R' = R_1 + R_2 + R_3 = 5 + 5 + 5 = 15\ \Omega$

$R_{AB} = \frac{R'R''}{R'+R''} = \frac{15\times15}{15+15} = \frac{15}{2}$ = 7.5 ohm

23. Resistance $R = \frac{V^2}{P}$

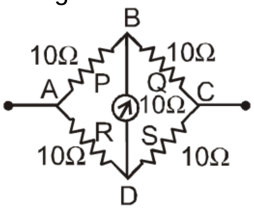
$R \propto \frac{1}{P}$

So, the resistance of 40 watt is maximum, heat produced $H \propto R$

∴ heat produced in 40 watt bulb will be maximum, so it will gllow more.

24. In a Wheatstone's bridge, if $\frac{P}{Q} = \frac{R}{S}$, then resistance of galvanometer will be inaffective.

The given circuit can be shown as,



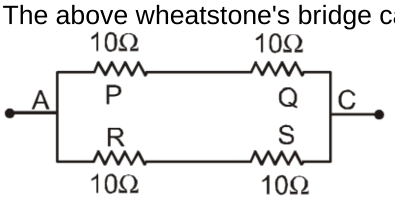
From figure, $\frac{P}{Q} = \frac{10}{10} = 1$

$\frac{R}{S} = \frac{10}{10} = 1$

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

Therefore, the galvanometer will be ineffective.

The above wheatstone's bridge can be redrawn as.



Resistances P and Q are in series, so

$R' = 10 + 10 = 20\ \Omega$

Resistances R and S are in series, to

$R'' = 10 + 10 = 20\Omega$

Now, R' and R'' are in parallel hence, net resistance of the circuit

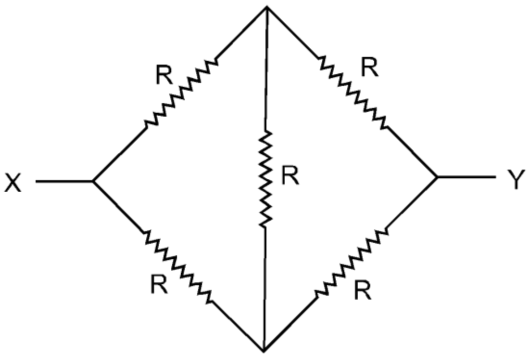
$= \frac{R'\times R''}{R'+R''} = \frac{20\times20}{20+20} = 10\Omega$

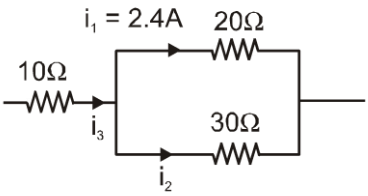
25. As there is no change in the reading of galvanometer with switch S open or closed. It implies that bridge is balanced. Current through S is zero and $I_R, = I_G$, $I_P = I_Q$.

26. The given circuit can be shown in the following way. No current will be flown in the middle resistane.
Equivalent resistance of R and R' = 2R

Total resistance $\frac{1}{R'} = \frac{1}{2R} + \frac{1}{2R}$

$R' = R$

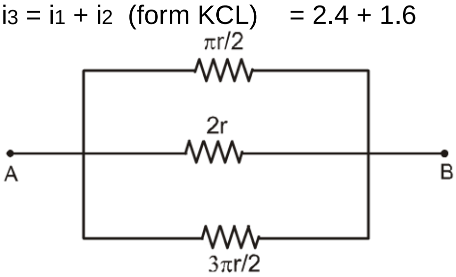




27.

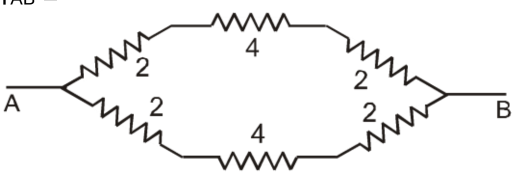
In parallel 2.4 × 20 = 30 i_2 ⇒ $i_2 = \frac{2.4 \times 20}{30}$ = 1.6 amp

28. $i_3 = i_1 + i_2$ (form KCL) = 2.4 + 1.6 = 4 amp



29.

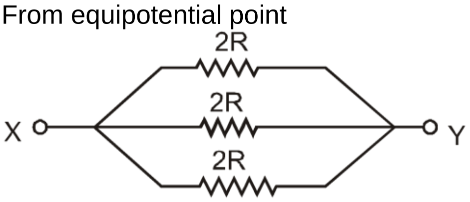
$r_{AB} = \frac{6\pi r}{16 + 3\pi}$



30.

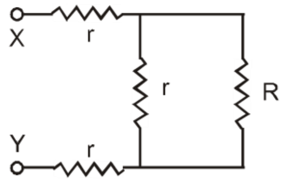
$R_{AB} = \frac{8 \times 8}{8 + 8} = 4\Omega$

From equipotential point



31.

$R_{eq.} = \frac{2R}{3}$

32. 

$\Rightarrow \qquad R = 2r + \frac{rR}{r+R} \qquad \Rightarrow \qquad R_2 - 2rR - 2r_2 = 0$

$\Rightarrow \qquad R = (1 + \sqrt{3})R$

33. Due to equi potentional points R = R + R = 2R

34. $P = i_2R$

current is same, so $P \propto R$

In the first case it is 3r, in second case it is $\frac{2}{3}$ r, in third case it is $\frac{r}{3}$ and in fourth case the net resistance is $\frac{3r}{2}$.

$R_3 < R_2 < R_4 < R_1 \qquad \therefore \qquad P_3 < P_2 < P_4 < P_1$

35. $P = \frac{V^2}{R} \qquad$ so $R = \frac{V^2}{P}$

$\therefore \qquad R_1 = \frac{V^2}{100}$ and $R_2 = R_3 = \frac{V^2}{60}$

Now $\qquad W_1 = \frac{(250)^2}{(R_1+R_2)^2} \cdot R_1$

$W_2 = \frac{(250)^2}{(R_1+R_2)^2} \cdot R_2$

and $\qquad W_3 = \frac{(250)^2}{R_3}$

$W_1 : W_2 : W_3 = 15 : 25 : 64 \qquad$ or $\qquad W_1 < W_2 < W_3$

36. $\frac{R_1}{R_2} = \frac{A_2}{A_1} = \frac{4\pi r^2}{\pi r^2} = \frac{4}{1} \qquad \therefore \qquad \frac{V_1}{V_2} = \frac{R_1}{R_2} = \frac{4}{1} \qquad V_{BC} = 4V_{AB}$

37. Here: Resistance of arm PQ (R_1) = 100 Ω

Resistance of arm QR (R_2) = 100 Ω

Resistance of arm RS (R_3) = 100 Ω

Resistance of arm SP (R_4) = 100 Ω

Resistance of upper arm R_1 and R_2 are connected in series.

Hence, their resultant resistance

$R_U = R_1 + R_2 = 100 + 100 = 200\ \Omega$

Similarly the resistance of lower half R_3 and R_4 are also connected in series

Hence, their resultant resistance is

$R_L = R_3 + R_4 = 100 + 100 = 200\ \Omega$

So, equivalent resistance

$\frac{1}{R_{PR}} = \frac{1}{R_U} + \frac{1}{R_L} = \frac{1}{200} + \frac{1}{200} = \frac{2}{200} = \frac{1}{100} \qquad$ So, $R_{PR} = 100\ \Omega$

38. The equivalent resistance of the circuit

$R = \left(\frac{4\times 2}{4+2}\right) + 2 = \frac{8}{6} + 2 = \frac{20}{6}$

$= \frac{10}{3}\ \Omega$

$\therefore$ Current through the circuit

$i = \frac{V}{R} = \frac{2}{10/3} = \frac{6}{10} = \frac{3}{5}$ A

Therefore, potential difference across BC

$V = \frac{3}{5}\left(\frac{4\times 2}{4+2}\right) = 0.8$ volt

39. Let R_1 and R_2 be the resistances of two wires . In parallel combination,

$\frac{R_1R_2}{R_1+R_2} = \frac{6}{5}$ … (i)

If one of the wires breaks, then effective resistance becomes 2Ω, that is , $R_1 = 2\Omega$

Substituting in Eq. (i), we have

$\frac{2R_2}{2+R_2} = \frac{6}{5} \Rightarrow 10R_2 = 12 + 6R_2 \Rightarrow 4R_2 = 12$

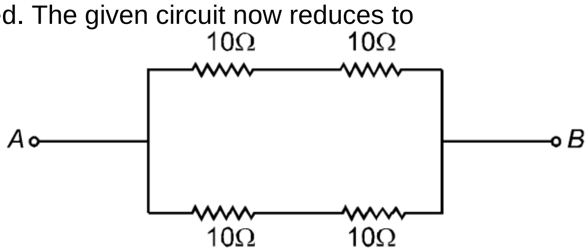
$\therefore$ $R_2 = \frac{12}{4} = 3\ \Omega$

40. In the given circuit, the ratio of resistances in the opposite arms is same

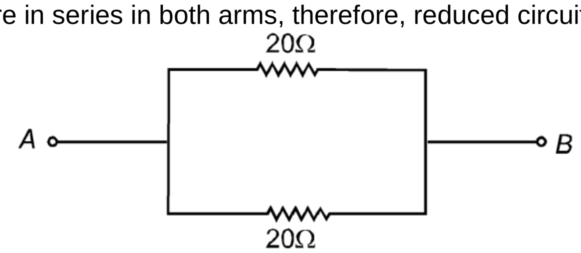
$\frac{P}{Q} = \frac{10}{10} = \frac{1}{1}$

$\frac{R}{S} = \frac{10}{10} = \frac{1}{1}$

Hence bridge is balanced. The given circuit now reduces to



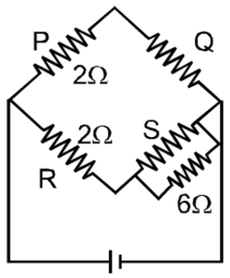
Here, 10Ω and 10 Ω resistors are in series in both arms, therefore, reduced circuit is shown



Now, the two 20 Ω resistors are connected in parallel, hence equivalent resistance is

$\frac{1}{R} = \frac{1}{20} + \frac{1}{20} = \frac{4}{20\times 20} = \frac{1}{10} \Rightarrow R = 10\ \Omega$

41. The bridge formed with given resistances is a balanced Wheatstone's bridge.
The situation can be depicted as shown in figure.
As resistances S and 6 Ω are in parallel their effective resistane is



$\frac{6S}{6+S}\,\Omega$ or $\frac{2}{2} = \frac{2(6+S)}{6S}$ or $3S = 6 + S$

or $S = 3\,\Omega$

42. In the given circuit,

$$\frac{R}{R} = \frac{R}{R} \qquad \left(\frac{P}{Q} = \frac{R}{S}\right)$$

Therefore, it is a balanced Wheatstone bridge, and no current will flow through resistance between B and D.

Resistance of arm ADC

$R' = R + R = 2R$

Resistance of arm ADC,

$R'' = R + R = 2R$

$\therefore$ Now, resistance R' and R" are in parallel.

Therefore, their resultant resistance

$$\frac{1}{R_{eq}} = \frac{1}{2R} + \frac{1}{2R} = \frac{1}{R} \quad \therefore R_{eq} = R$$

43. In series $R = R_1 + R_2$

$\Rightarrow \frac{2\ell}{\sigma A} = \frac{\ell}{\sigma_1 A} + \frac{\ell}{\sigma_2 A}$ $\quad\Rightarrow \frac{2}{\sigma} = \frac{1}{\sigma_1} + \frac{1}{\sigma_2}$

so. $\frac{2}{\sigma} = \frac{\sigma_1 + \sigma_2}{\sigma_1 \sigma_2}$ $\quad$ so $\sigma = \frac{2\sigma_1 \sigma_2}{\sigma_1 + \sigma_2}$

44. $\frac{15^2}{R_{eq}} = 150$ .....(i)

$R_{eq} = \frac{2R}{2+R}$ .....(ii)

Solving (i) and (ii), $R = 6\,\Omega$ **Ans.**

45. $i = \frac{3}{\left(\frac{6\times 3}{6+3}\right)} = \frac{3}{2} = 1.5$ A

46. $\therefore$ 2Ω and 6Ω are in parallel

$\Rightarrow R_{eq} = \frac{3\times(1.5+1.5)}{3+(1.5+1.5)} = \frac{3}{2}\Omega$ $\quad\Rightarrow\quad i = \frac{6}{R_{eq}} = 4A$ **Ans.**

47. $R_1 + R_2 = S$ $\quad \frac{R_1 R_2}{R_1 + R_2} = P$

$s = np \Rightarrow (R_1 + R_2)^2 = n R_1 R_2$

$\Rightarrow n = \left(\frac{R_1}{R_2} + \frac{R_2}{R_1} + 2\right)$ $\quad\Rightarrow\quad n_{min} = 2 + 2 = 4$ **Ans.**

$\therefore \quad \left(x+\frac{1}{x}\right)_{min} = 2$ for x > 0

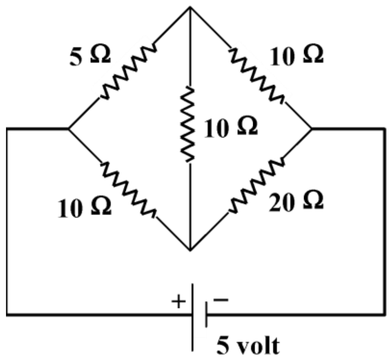
48. ρ : same

In parallel $\Rightarrow$ $i_1 R_1 = i_2 R_2$

$\Rightarrow \quad \frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{\rho \ell_2 / A_2}{\rho \ell_1 / A_1} = \frac{\ell_2}{\ell_1} \times \frac{r_1^2}{r_2^2}$

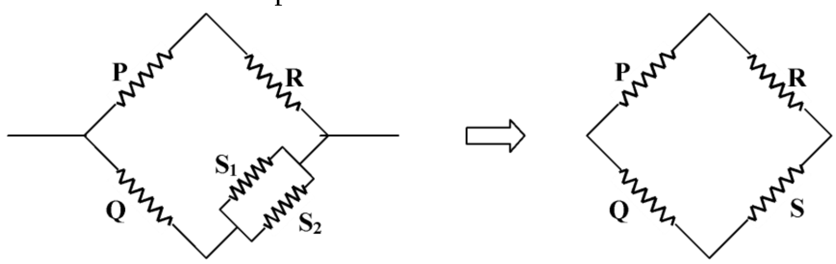
$\therefore \quad \frac{\ell_1}{\ell_2} = \frac{4}{3}$ and $\frac{r_1}{r_2} = \frac{2}{3}$

$\Rightarrow \quad \frac{i_1}{i_2} = \frac{1}{3}$ **Ans.**

49.


$$R_{eq} = \frac{15 \times 30}{15+30} = \frac{450}{45} = 10 \ \Omega$$

$$i = \frac{5}{10} = \frac{1}{2} = 0.5 \text{ amp}$$

50.


$\frac{P}{Q} = \frac{R}{S} \quad \Rightarrow \quad \frac{P}{Q} = \frac{R(S_1+S_2)}{S_1 S_2}$

51. In an open circuit, emf of cell

E = 2.2V

In a closed circuit, terminal potential difference

V = 1.8V

External resistance, R = 5Ω

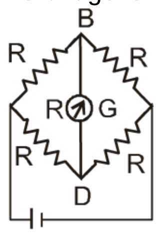
Thus, internal resistance of cell is

$r = \left(\frac{E}{V}-1\right) R = \left(\frac{2.2}{1.8}-1\right) 5 = \left(\frac{11}{9}-1\right) 5 = \frac{2}{9} \times 5 = \frac{10}{9} \ \Omega$

52. The balanced condition of wheat-stone's bridge is

$\frac{R_{AB}}{R_{BC}} = \frac{R_{AD}}{R_{DC}}$

As bridge is in balanced condition, no current will flow through BD.



$R_1 = R_{AB} + R_{BC}$
$= R + R = 2R$
$R_2 = R_{AD} + R_{CD} = R + R = 2R$
R_1 and R_2 are in parallel combination.
Hence, equivalent resistance between A and C will be.

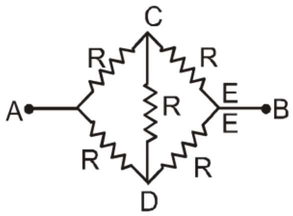
$\therefore R_{eq} = \frac{R_1R_2}{R_1+R_2} = \frac{4R^2}{4R} = R$

53. Equivalent resistance of n resistances each of r ohm in parallel is given by

$\frac{1}{R} = \frac{1}{r} + \frac{1}{r} + \text{............} + n \text{ times} = \frac{n}{r}$

so, r = nR
When these resistances are connected in series, effective resistance is
$R' = r + r + \text{...........} + n \text{ times} = nr$
$R' = n (nR) = n^2R$

54. The given circuit can be redrawn as shown. From circuit,



$\frac{FC}{CE} = \frac{FD}{DE} = 1$

Thus, it is balanced Wheastone's bridge, so resistance in arm CD is ineffective and so, current do not flows in this arm.
Net resistance of the circuit is

$\frac{1}{R'} = \frac{1}{(R+R)} + \frac{1}{(R+R)} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} = \frac{1}{R}$

$\therefore R' = R$
So, net current drawn from the battery

$i' = \frac{V}{R'} = \frac{V}{R}$

As from symmetry, upper circuit AFCEB is half of the whole circuit and is equal to AFDEB. So, in both the halves half of the total current will flow.
Hence, in AFCEB, the current flowing is

$i = \frac{i'}{2} = \frac{V}{2R}$.

55. The circuit given resembles the balanced Wheatstone Bridge as $\frac{4}{6} = \frac{2}{3}$.
Thus, middle arm containing 4Ω resistance will be ineffective and no current flows through it.

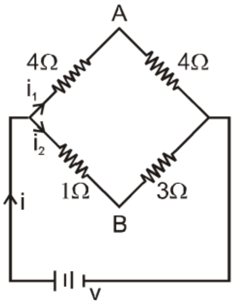
The equivalent circuit is shown as below :
Net resistance of AB and BC
$R' = 4 + 2 = 6\Omega$
Net resistance of AD and DC
$R'' = 6 + 3 = 9\Omega$
Thus, parallel combination of R′ and R″ gives

$R = \frac{R' \times R''}{R' + R''}$

$= \frac{6 \times 9}{6 + 9} = \frac{54}{15} = \frac{18}{5}\ \Omega$

Hence, current $i = \frac{V}{R} = \frac{V}{18/5} = \frac{5V}{18}$

56. Current will flow from higher to lower potential.
Resistance 4Ω and 4Ω are connected in series, so their effective resistance is
$R' = 4 + 4 = 8\Omega$
Similarly, 1Ω and 3Ω are in series
So, $R'' = 1 + 3 = 4\Omega$
Now R′ and R″ will be in parallel, hence effective resistance



$R = \frac{R' \times R''}{R' + R''} = \frac{8 \times 4}{8 + 4} = \frac{32}{12} = \frac{8}{3}\ \Omega$

Current through the circuit, from Ohm's law

$i = \frac{V}{R} = \frac{3V}{8}$ A

Let currents i_1 and i_2 flow in the branches as shown.

∴ $8i_1 = 4i_2$ ⇒ $i_2 = 2i_1$

Also $i = i_1 + i_2$ ⇒ $\frac{3V}{8} = i_1 + 2i_1$ ⇒ $i_1 = \frac{V}{8}$ A

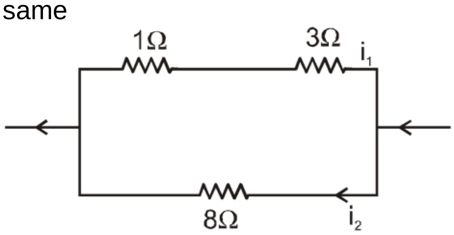
and $i_2 = \frac{V}{4}$ A

Potential drop at A, $V_A = 4 \times i_1 = \frac{4V}{8} = \frac{V}{2}$

Potential drop at B, $V_B = 1 \times i_2 = 1 \times \frac{V}{4} = \frac{V}{4}$

Since, drop of potential is greater in 4Ω resistance so. It will be at lower potential than B, hence on connecting wire between points A and B, the current will flow from B to A.

57. Resistances 1Ω and 3Ω are connected in series, so effective resistance
$R' = 1 + 3 = 4\Omega$
Now, R′ and 8Ω are in parallel. We known that potential difference across resistances in parallel order is same



Hence, $R' \times i_1 = 8i_2$
or $4 \times i_1 = 8i_2$

or $\quad i_1 = \frac{8}{4} i_2 = 2i_2 \quad$ ......(i)

Power dissipated across 8Ω resistance is

$\quad i_2^2 (8)\, t = 2W$

or $\quad i_2^2 t = \frac{2}{8} = 0.25$ W $\quad$ ......(ii)

Power dissipated across 3Ω resistance is

$\quad H = i_1^2 (3)\, t$

$\quad = (2i_2)^2 (3)t$

$\quad = 12 i_2^2\, t$

but $\quad i_2^2 t = 0.25$ W

∴ $\quad H = 12 \times 0.25 = 3W$

58. The resistances of 6Ω and 3 Ω are in parallel in the given circuit, their equivalent resistance is

$$\frac{1}{R_1} = \frac{1}{6} + \frac{1}{3} = \frac{1+2}{6} = \frac{1}{2}$$

or $\quad R_1 = 2\Omega$

Again, R_1 is in series with 4Ω resistance, hence

$\quad R = R_1 + 4 = 2 + 4 = 6\ \Omega$

Thus, the total power dissipated in the circuit

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

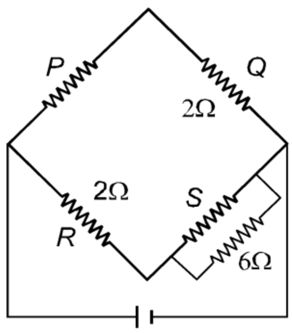
Here, $\quad V = 18$ V, $R = 6\ \Omega$

Thus, $\quad p = \frac{(18)^2}{6} = 54$ W

59. The bridge formed with given resistances is a balanced Wheatstone's bridge. The situation can be depicted as shown in figure.

As resistance S and 6 Ω are in parallel their effective resistance is

$$\frac{6S}{6+5}\ \Omega$$



Hence it is balanced, hence, it is balanced Wheatstone's bridge. For balancing condition,

$$\frac{P}{Q} = \frac{R}{\left(\frac{6S}{6+5}\right)}$$

or $\quad \frac{2}{2} = \frac{2(6+5)}{6S}$

or $\quad 3S = 6 + 5$

or $\quad S = 3\ \Omega$

60. Voltage across 2Ω is same as voltage across arm containing 1Ω and 5Ω resistances.

Voltage across 2Ω resistance,

$$V = 2 \times 3 \quad 6\ V$$

So, voltage across lowest arm, $\quad V_1 = 6V$

Current across 5Ω, I = $I = \frac{6}{1+5}$ = 1A

Thus, power across 5Ω,

$\quad P = I^2R = (1)^2 \times 5 = 5W$

61. In parallel resistances potential difference across them is same.

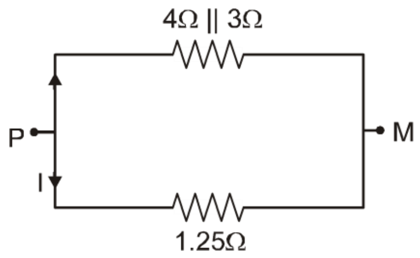
Potential difference across PM

$V = 4 \times 1 = 4$ volt (ie, across 4Ω)

Equivalent resistance of lower side arm,

$R_{eq} = 1 + \frac{0.5 \times 0.5}{0.5 + 0.5} = 1.25\ \Omega$

Now the circuit can be shown as



Let current I flows in lower branch, so

$1.25\ I = 4\ V$

or $I = \frac{4}{1.25} = 3.2\ A$

Therefore, 3.2 A current flows in 1Ω resistance, hence potential difference between M and N is

$V' = 3.2 \times 1 = 3.2$ volt

SECTION (E)

1. $E_{eq} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$ $\quad r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$

Therefore statement II is correct bul I is wrong.

2. Assume M cells are connected correct and N cells connected wrong.

$M + N = 12$ ....(1)

$(M + 2) E – NE = 3R \Rightarrow M – N + 2 = \frac{3R}{E}$ ......(2)

$ME – (N + 2)E = 2R \Rightarrow M – N – 2 = \frac{2R}{E}$ ......(3)

from eq (I) and (II)

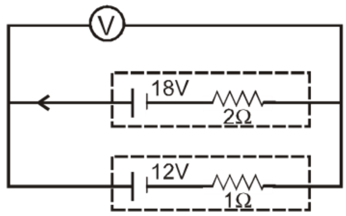
$– M + N + 10 = 0 \Rightarrow M – N = 10$ ......(4)

from eq (1) and (4)

$M = 11, N = 1$

3. It is clear that the two cells oppose each other hence, the effective emf in closed circuit is 18 – 12 = 6V and net resistance is 1 + 2 = 3Ω (because in the closed circuit the internal resistances of two cells are in series).

The current in circuit will be in direction of arrow shown in figure.



$I = \frac{\text{effective emf}}{\text{total resistance}} = \frac{6}{3} = 2A$

The potential difference across V will be same as the terminal voltage of either cell.

Since, current is drawn from the cell of 18 volt, hence,

$V_1 = E_1 – ir_1$

$= 18 – (2 \times 2) = 18 – 4 = 14\ V$

Similarly, current enters in the cell of 12V hence

$V_2 = E_2 + ir_2$

$= 12 + 2 \times 1$

$= 12 + 2 = 14\ V$

Hence, V = 14V

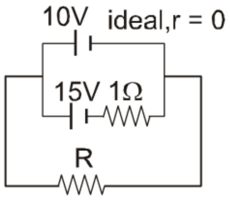
4. Current when cells are connected in series

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

in parallel $i_p = \frac{nE}{r+nR}$

According to euesion $i_s = i_p$

$\frac{nE}{nr+R} = \frac{nE}{r+nR}$ r + nR = nr + R (b – 1) R = r (n – 1) ⇒ R = r

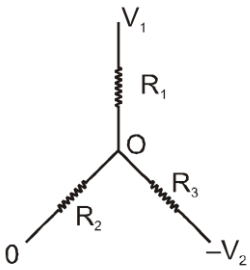
5. 

For ideal r → 0

$E = \frac{\frac{10}{r}+\frac{15}{1}}{\frac{1}{r}+\frac{1}{1}} = \frac{10+15r}{1+r}$

E = 10 V

6. Potential of Junction O



$$V_0 = \frac{\frac{V_1}{R_1}+0-\frac{V_2}{R_3}}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

Current through R_2 will be zero if

$V_0 = 0$ ⇒ $\frac{V_1}{V_2} = \frac{R_1}{R_3}$

7. Let emf of both cells are E_1 and E_2 and internal resistances are r_1 and r_2. In parallel order, we have

$E = E_1 = E_2$

Effective internal resistance of both cells

$\frac{1}{R} = \frac{1}{r} + \frac{1}{r}$

⇒ $R = \frac{r}{2}$

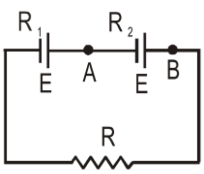
So, emf is equal to the emf of any of the cell and internal resistance is less than the resistance of any of cell.

Hence, (ii) is right and (i) is wrong.

8. $R_{eq} = R_1 + R_1 + R$

∴ $I = \frac{2E}{R_1+R_2+R}$

According to the questions,



$V_A - V_B = E - IR_2$

$0 = E - IR_2$

$E = IR_2$

$E = \dfrac{2E}{R_1 + R_2 + R}.R_2$

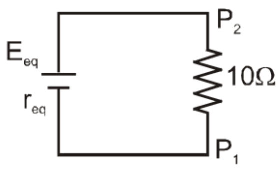
$R_1 + R_2 + R = 2R_2$

$\therefore \quad R = R_2 - R_1$ **Ans.**

9. $V_R = 2V = \left(\dfrac{R}{500 + R}\right) \times 12$

$\Rightarrow \quad R = 100\ \Omega$

10. $E_{eq} = \left(\dfrac{\frac{5}{2} - \frac{2}{1}}{\frac{1}{2} + 1}\right) V \qquad r_{eq} = \dfrac{2 \times 1}{2 + 1} = \dfrac{2}{3}\ \Omega$



$i = \dfrac{E_{eq}}{10 + r_{eq}} = 0.03$ A from P_2 to P_1

11. Current in the circuit is given by Ohm's law.
Net resistance of the circuit = $r_1 + r_2 + R$
Net emf in series = E + E = 2E

Therefore, from Ohm's law, current in the circuit

$i = \dfrac{\text{Net emf}}{\text{Net resistance}}$

$\Rightarrow \quad i = \dfrac{2E}{r_1 + r_2 + R} \quad \Rightarrow \quad 2r_1 = r_1 + r_2 + R$

$\therefore$ R = external resistance = $r_1 - r_2$

Note: The question is wrong as the statement is when the circuit is closed, the potential difference across the first cell is zero which implies that in a series circuit, one part cannot conduct current which is wrong, Kirchhoff's law is violated. The equation must have been modified.

SECTION (F)

1. $R_{eq} = 200 + \dfrac{300 \times 600}{300 + 600} + 100 = 500\ \Omega$

$I = \dfrac{100}{500} = \dfrac{1}{5}$ amp

$I_{600} = \dfrac{\frac{1}{600}}{\frac{1}{300} + \frac{1}{600}} \times \dfrac{1}{5} = \dfrac{1}{15}$ amp

Reading of volt meter = $I\ R_{600} = \dfrac{1}{15} \times 600 = 40$ V

2. $R_{eq} = 2 + \dfrac{4}{2} + \dfrac{15}{3} + R_A = 9 + R_A$

$I = \dfrac{V}{R_{eq}} \quad \Rightarrow \quad 1 = \dfrac{10}{9 + R_A} \quad \Rightarrow \quad R_A = 1\Omega$

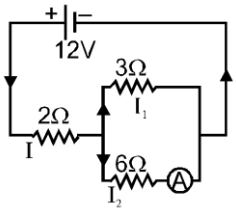
if 4Ω replace by 2Ω resistance then

$R_{eq} = 2 + \dfrac{2}{2} + \dfrac{15}{3} + 1 = 9\Omega$

$I = \frac{10}{9}$ amp

3. $\frac{6}{R} = \frac{\ell}{x-\ell}$ $\qquad \frac{6}{R} = \frac{30}{20}$ $\qquad \Rightarrow \qquad R = 4\Omega$

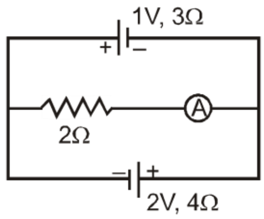
4.



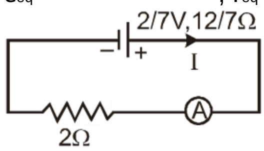
$R_{xy} = 2 + \frac{3 \times 6}{9} = 2 + 2 = 4$

$I = \frac{12}{4} = 3 \qquad \Rightarrow \qquad I_1 : I_2 = 6 : 3 = 2 : 1 \qquad \Rightarrow \qquad I_2 = \frac{I}{3} \times 3 = 1$ **Ans.**

5.

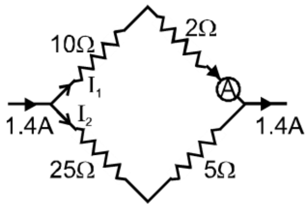


$\varepsilon_{eq} = \frac{\frac{2}{4} - \frac{1}{3}}{\frac{1}{3} + \frac{1}{4}} = \frac{2}{7}V$, $r_{eq} = \frac{4 \times 3}{4+3} = \frac{12}{7}$



$I = \frac{\frac{2}{7}}{\frac{12}{7} + 2} = \frac{1}{13}A$

6.



$I_1 : I_2 = 30 : 12 = 10 : 4 = 5 : 2$

$I_1 = \frac{5}{7} \times 1.4 = 1$ A **Ans.**

8. Potential gradient = $\frac{V}{\ell}$

9. Potential gradient = $\frac{V}{\ell}$

13. Potential gradient = $\frac{V}{\ell} = \frac{IR}{\ell} = \frac{2\times 0.5}{1} = 1$

14. $r_{eq} = 10 + 20 = 30$, $I = \frac{3}{30} = \frac{1}{10}$, $V = \varepsilon - IR = 3 - \frac{1}{10} \times 10 = 2$

Potential gradient = $\frac{V}{\ell} = \frac{2}{10} = 0.2$

15. V = 2 × 0.1 = 0.2 V

Potential gradient = $\frac{V}{\ell} = 0.2$ ⇒ $I = \frac{V}{0.2} = \ell = 1$ m

V = 2 × 0.1 = 0.2 V

16. Potential gradient = $\frac{V}{\ell} = \frac{1.5}{7.5} = \frac{1}{5}$

Voltage across resistor = IR = 3.5 × 0.2 V

$\frac{1}{5} = 0.2 \times \frac{3.5}{\ell}$ ⇒ $\ell = 3.5$ m

17. $V \propto \ell$

$\ell \propto R$

$\frac{\ell_1}{\ell_2} = \frac{R_1}{R_2}$ ⇒ $\frac{50}{\ell} = \frac{\frac{4\times 4}{4+4}}{4}$

$\ell = 100$ cm

18. Potentiometer is used to measure the exact potential difference between two points of an electric circuit or to measure the emf of a cell.

19. The voltmeter in an electric circuit is always connected in parallel. Therefore, for resistance of circuit to be minimum, the resistance of voltmeter should be high.
The resistance of ideal voltmeter is infinite.

20. Ammeter has low resistance and voltmeter has very high resistance. So, ammeter can be converted into series.

21. According to formula of potentiometer

$r = \frac{l_1 - l_2}{l_2} \times R = \frac{125-100}{100} \times 2 = 0.5\ \Omega$

22. When we measure the emf of a cell by the potentiometer then no current draws in the circuit in zero-deflection condition i.e., cell is in open circuit. Thus, in this condition the actual value of a cell is found. In this way potentiometer is equivalent to an ideal voltmeter of infinite resitance.
NOTE : The emf by the potentiometer is measured from null method in which zero deflection position is found on the wire.

23. To increase the range of voltmeter, resistance will have to increase.

24. Potential gradient of a wire equal to potential fall per unit length.

Potential gradient = Potential fall per unit length = Current × Resistance per unit length = $i \times \frac{R}{\ell}$

but $R = \frac{\rho\ell}{A}$ ⇒ $\frac{R}{\ell} = \frac{\rho}{A}$ ∴ Potential gradient = $i \times \frac{\rho}{A}$

Here, $\rho = 10^{-7}\ \Omega$–m, i = 0.1 A × A = 10^{-6} m^2

Hence, potential gradient = $0.1 \times \frac{10^{-7}}{10^{-6}} = \frac{0.1}{10} = 0.01 = 10^{-2}$ V/m

25. In electrolysis, according to first law of Faraday, the mass of a substance deposited at an electrode is directly proportional to the charge passed through the electrolyte i.e.,

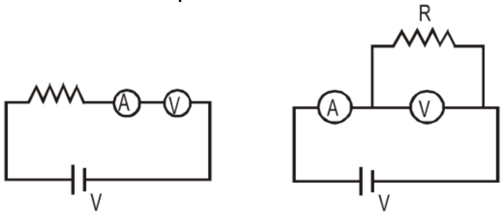
$m \propto q$

If a current i passes for a time t, then as we know,

$q = it$

Hence, $m \propto it$ or $m \propto i$

Thus, mass deposited at an electrode is directly proportional to current.

27. 

Equaivalent resistance decrease so current will increases.

$V_A + V_V = V$

Due to change, V_A increases so voltmeter reading will decrease.

28. The ratio $\frac{AC}{CB}$ will remain unchanged.

29. When we have to convert galvanometer into an ammeter, we connect a small resistance in parallel with the coil of galvanometer, whose value depends upon the range of the ammeter.

30. Sensitivity of potentiometer

$\propto \frac{1}{\text{potential gradient}}$

But potential gradient = $\frac{V}{L}$

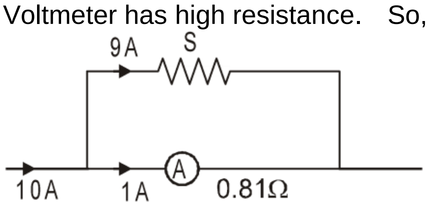
Where, v is the emf of the cell and L is the length of the wire.

$\therefore$ Sensitivity of a potentiometer $\propto \frac{V}{L}$

Sensitivity of a potentiometer can be increased by increasing the length of the potentiometer wire.

31. The wire of potentiometer is of manganin because its resistivity is very high and temperature coefficient of resistivity is low.

32. Voltmeter has high resistance. So, option is (3)

33. 

$0.8 \times 1 = 9\,S \Rightarrow S = 0.09\Omega$

34. Potential gradient = $\frac{E}{100}$ V/cm $\Rightarrow$ e.m.f. of battery = $30 \times \frac{E}{100}$

35. $\frac{x}{20} = \frac{y}{80} \Rightarrow 4x = y \Rightarrow$ New position of null point will be at the mid point.

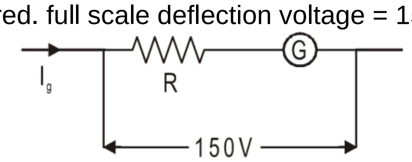
36. The internal resistance of the cell

$r = \left(\dfrac{\ell_1 - \ell_2}{\ell_2}\right) R \Rightarrow \quad = \dfrac{240-120}{120} \times 2 = 2\Omega$ **Ans.**

37. $I_g = 15$ mA $\quad V_g = 75$ mV

Galvanometer resistance, $G = \dfrac{V_g}{I_g} = 5\Omega$

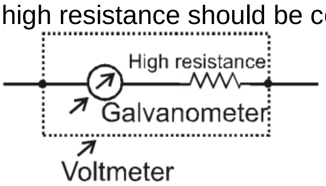
Required. full scale deflection voltage = 150 V



$\Rightarrow \quad 150 = I_g (R + G) \quad \Rightarrow \quad R = 9995\ \Omega$ **Ans.**

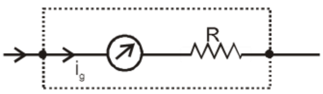
38. $\dfrac{55}{20} = \dfrac{R}{80} \quad \Rightarrow \quad R = 220\ \Omega$

39. A galvanometer has its own resistance low but a voltmeter must have high resistance. A voltmeter indeed is a modified from of a pivoted coil galvanometer. Since the resistance of coil of galvanometer of its own is low, its resistance is to be increased as is a necessary condition for a voltmeter. For this an appropriate high resistance should be connected in series with the galvanometer as shown.



Note : The resistance of an ideal voltmeter should be infinite.

40. To convert a galvanometer into voltmeter, high resitance should be connected in series with it. Let R is the resistance connected in series with the galvanometer.



$i_g = \dfrac{V}{G+R}$ or $R = \dfrac{V}{i_g} - G$

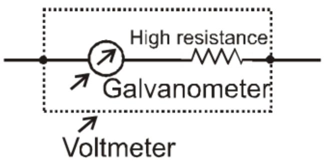
Given, G = 50Ω,

$i_g = 25 \times 4 \times 10^{-4} = 10^{-2}$ A, V = 25V

$\therefore R = \dfrac{25}{10^{-2}} - 50 = 2500 - 50 = 2450\Omega$

41. To work as voltmeter, the resistance of galvanometer should be high.

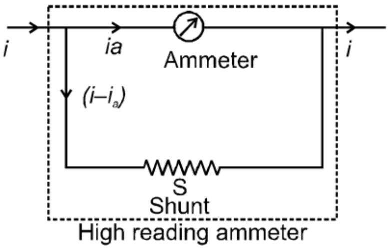
A voltmeter indeed is a modified form of a pivoted coil galvanometer. Since, the resitance of coil of galvanometer of its own is low, hence to convert a galvanometer into a volmeter, its resitance is to be increased. For this an appropirate high resistance is joined in series with the galvanometer as shown in figure.



The value of this resistance to be connected depends on the range of the voltmeter.

Note: A voltmeter is always connceted in parallel in an electric circuit.

42. The potential difference across ammeter and shunt is same.
Let i_α is the current flowing through ammeter and i is the total current. So. a current $i - i_a$ will flow through shunt resistance.
Potential difference across ammeter and shunt resistance is same.

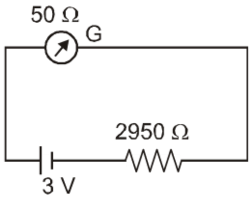


i. e., $i_a \times R = (i - i_a) \times s$ or $S = \frac{i_a R}{i - i\alpha}$ … (i)

Given, $i_a = 100$ A, i = 750 A, R = 13 Ω. Hence, $S = \frac{100 \times 13}{750 - 100} = 2\ \Omega$

43. Current through the galvanometer

$I = \frac{3}{(50 + 2950)} = 10^{-3}$ A



Current for 30 divisions = 10^{-3} A

Current for 20 divisions = $\frac{10^{-3}}{30} \times 20 = \frac{2}{3} \times 10^{-3}$ A

For the same deflection to obtain for 20 division, let resistance added be R

$\therefore \quad \frac{2}{3} \times 10^{-3} = \frac{3}{(50 + 1R)} \quad \Rightarrow \quad R = 4450\ \Omega$

44. This problem is based on the application of potentiometer in which we find the internal resistance of a cell.
In potentiometer experiment in which we find internal resistance of a cell, let E be the emf of the cell and V the terminal potential difference, then where l_1 and l_2 are lengths of potentiometer wire with and without short circuited through a resistance.

$\frac{E}{V} = \frac{l_1}{l_2}$ Since, $\frac{E}{V} = \frac{R + r}{R}$ [$\therefore$ E = I (R + r) and V = IR] $\therefore \quad \frac{R + r}{R} = \frac{l_1}{l_2}$

or $1 + \frac{r}{R} = \frac{110}{100}$ or $\frac{r}{R} = \frac{10}{100}$ or $r = \frac{1}{10} \times 10 = 1\Omega$

EXERCISE # 2

1. $X = \varepsilon_0 L \frac{\Delta v}{\Delta t}$

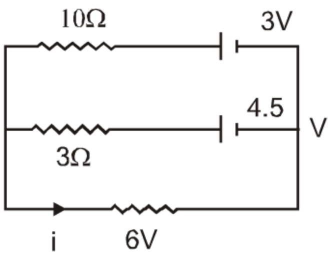
$[X] = [\varepsilon_0][L]\left[\frac{\Delta v}{\Delta t}\right]$

$[Dv]$ = [Electric field] [Length] = $\frac{[\text{Force}]}{[\text{charge}]}$ [Length] = $\frac{MLT^{-2}L}{Q}$ = $MQ^{-1}L^2T^{-2}$

$[\varepsilon_0] = M^{-}L^{-3}T^4I^2$ (as in question no. 6) = $M^{-1}L^{-3}Q^2T^2$

$\therefore [X] = M^{-1}L^{-3}Q^{2}T^{2}\,L\,\dfrac{MQ^{-1}L^{2}T^{-2}}{T} = QT^{-1} = I$ $\quad\therefore$ [x] is that of current

3.



$E_q = \dfrac{\dfrac{4.5}{3}+\dfrac{3}{10}}{\dfrac{1}{3}+\dfrac{1}{10}} = \dfrac{54}{13}$ = V $\Rightarrow$ $r_{eq} = \dfrac{3\times 10}{13} = \dfrac{30}{13}\ \Omega$

$i = \dfrac{54/13}{6+\dfrac{30}{13}} = \dfrac{54}{108} = \dfrac{1}{2}$ amp. $\Rightarrow$ $V_{6\Omega} = i.R = \dfrac{1}{2} \times 6 = 3V$

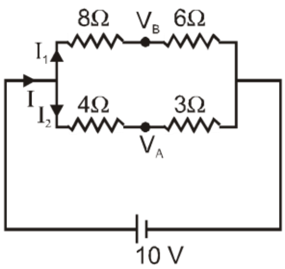
There fore current in 10Ω is zero.

4. $I = \dfrac{8-4}{9+1+2} = \dfrac{1}{3}A$

$V_p - 1 \times I + 4 - 8 - 2I - V_Q = 0$

$V_P - V_Q = 3\ V$

6.



$R_{eq} = \dfrac{140\times 7}{14+7} = \dfrac{14}{3}\Omega$

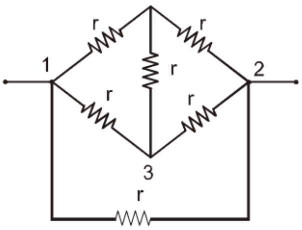
Net Current $I = \dfrac{10}{\dfrac{14}{3}} = \dfrac{15}{7}A$ From Current division

$I_1 = \dfrac{7}{21}\times\dfrac{15}{7} = \dfrac{5}{7}A$

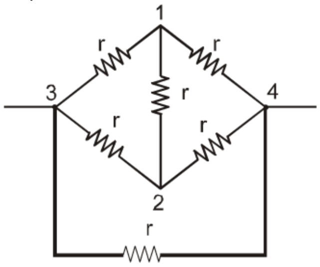
$I_2 = I - I_1 = \dfrac{15}{7} - \dfrac{5}{7} = \dfrac{10}{7}A$ From KVℓ

$8\,I_1 + V_B - V_A - 4I_2 \rightarrow V_A - V_B = 8 \times \dfrac{5}{7} - 4\times\dfrac{10}{7} = 0$

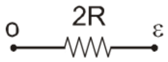
7.



$r_{eq} = r_{12} = \frac{r}{2}$



$r_{eq} = r_{34} = \frac{r}{2}$

8. 

Current flow in 2R resistance is from right to left.

9. $R_{eq} = \frac{R/2 \times 2R}{R/2 + 2R} = \frac{2R}{5}$

10. Current I can be independent of R_6 only when R_1, R_2, R_3, R_4 and R_6 form a balanced wheatstone bridge.

Therefore $\frac{R_1}{R_2} = \frac{R_3}{R_4}$ or $R_1 R_4 = R_2 R_3$

11. Condition for maximum power is

$r = R$

$4 = \frac{6R \times 3R}{9R}$ ⇒ $R = 2$

12. $R_{AB} = \frac{9 \times 12}{9 + 12} + 7 = \frac{85}{7}$

14. $L \alpha \ell$

L → total length

ℓ → balanced length

$\frac{L_1}{L_2} = \frac{\ell_1}{\ell_2} = \frac{400}{500} = \frac{100}{\ell_2}$ ⇒ $\ell_2 = 125$ cm

16. 60 Ω resistance and resistance of voltmeter 40 Ω are in parallel. ∴ Their effective resistance

$R_1 = \frac{60 \times 40}{60 + 40} = 24\ \Omega$ ∴ Total resistance of circuit

$R_t = 24 + 40 = \Omega$ Current in main circuit

$i = \frac{v}{R_t} = \frac{6}{64} = \frac{3}{32}$ amp ∴ potential difference across 60 Ω read by voltmeter,

$v = iR_1 = \frac{3}{32} \times 24 = 2.25$ volt

17. For first filament

$H = \frac{V^2}{R_1} t_1 \Rightarrow R_1 = \frac{V^2}{H} t_1$ ...(i)

For second filament

$$H = \frac{V^2}{R_2} t_2 \quad \Rightarrow \quad R_2 = \frac{V^2}{H} t_2 \qquad ...(ii)$$

When placed in parallel

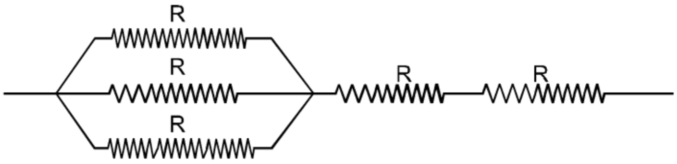
$$H = \frac{V^2}{R_p} t_2 \quad \Rightarrow \quad R_p = \frac{V^2}{H} t_P \qquad ...(iii)$$

From Eqs. (i),(ii), (iii) we get

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

$$\Rightarrow \quad \frac{H}{V^2 t_P} = \frac{H}{V^2 t_1} + \frac{H}{V^2 t_2} \quad \Rightarrow \quad \frac{1}{t_P} = \frac{1}{10} + \frac{1}{15} \quad \Rightarrow \quad t_P = 6 \text{ min.}$$

18. $\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R} \quad \Rightarrow \quad R_P = \frac{R}{3}\Omega$



$R_5 = R + R = 2R\Omega$

$R_{net} = R_P + R_S = 2R + \frac{R}{3} = \frac{7R}{3}\Omega$

19. From the given figure, current through lower branch of resistance which are joined in series is

$$i_1 = \frac{10}{4+3} = \frac{10}{7} \text{ A}$$

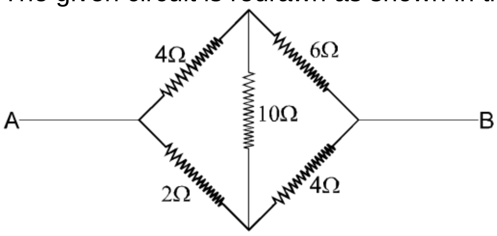
Again current through upper branch of resistance which are also connected in series, si

$$i_2 = \frac{10}{8+6} = \frac{10}{14} \text{ A}$$

Now, according to the Kirchhoff's voltage law

$$V_B - V_A = 8 \times i_2 - 4 \times i_1 = 8 \times \frac{10}{14} - 4 \times \frac{10}{7} = 0$$

20. The given circuit is redrawn as shown in the fig.



It is balanced Wheatstone bridge, therefore 10Ω resistance is ineffective. In the upper arm 4 Ω and 8 Ω are in series, their effective resistance is

$$R_U = 4 + 8 = 12\ \Omega$$

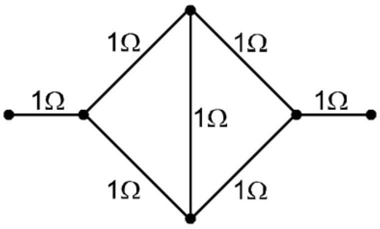
similarly, in the lower arm resistances 2 Ω and 4 Ω are also in series their effective resistance is

$$R_L = 2 + 4 = 6\ \Omega$$

Now, resistances R_U and R_L are in parallel. So, resultant resistant between points A and B is

$$R_{AB} = \frac{R_U R_L}{R_U + R_L} = \frac{12 \times 6}{12 + 6} = 4\ \Omega$$

21. After adjoining two conductors, the circuit will acquire the form shown in the following figure. From symmetry considerations, we conclude that the central conductor will not be effective in electric charge transfer. Therefore, if the initial resistane R_1 of circuit was 5Ω, where resistance of each conductor is 1Ω, the new resistance of the circuit will become



$R_2 = 2 + \frac{2}{2} = 3\ \Omega$ So, $\frac{R_1}{R_2} = \frac{5}{3}$

22. The conduction electrons while moving towards the positive end of the conductor (responsible for the current in conductor) with the atoms/ions of the condcutor, which is produced as heat.

23. The resistance of a wire of length ℓ and area of cross-section A is given by

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

Where ρ is specific resistane.

Also, $A = \pi r_2$, being radius of wire. $\therefore \frac{R_1}{R_2} = \frac{r_2^2}{r_1^2}$

Given, $r_1 = 9$ mm, $R_1 = 5\ \Omega$, $r_2 = 3$ mm $\therefore \frac{5}{R_2} = \frac{3^2}{9^2}$

Equivalent resistance of 6 wires each of resistance R_2 connected in parallel is

$$R' = \frac{R_2}{6} = \frac{45}{6} = 7.5\ \Omega$$

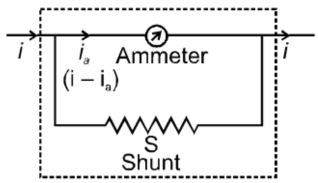
24. As shown if i is the maximum current, then a part i_g should pass through G and rest $i - i_g$ through S. Potential across G and S is same, therefore

$i_g \times G = (i - i_g) \times S \Rightarrow S = \frac{i_g G}{i - i_g}$

Given, $G = 400\ \Omega$, $i_g = 0.21$ mA $= 0.2 \times 10_{-3}$ A,

$i = 3A \quad \therefore \quad S = \frac{0.0002 \times 400}{3 - 0.0002} = 0.027\ \Omega$

25. The potential difference across ammeter and shunt is same.
Let i_a is the current flowing through ammeter and i si the total current. So, a current $i - i_a$ will flow througfh shunt resistane.



High reading ammeter

Potential difference across ammeter and shunt resistance is same.

ie, $i_a \times R = (i - i_a) \times S$

or $S = \frac{i_a R}{i - i_a}$ … (i)

Given, $S = \frac{100 \times 13}{750 - 100} = 2\ \Omega$

26. $V \propto I \Rightarrow \frac{V}{E} = \frac{I}{L}$

Where, I = balance point

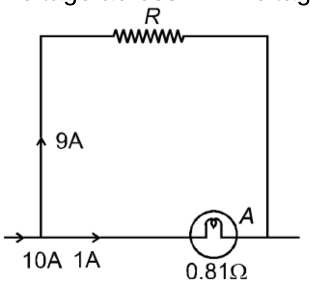
ℓ = lenght of potentiometer wire

$V = \frac{I}{L}E$ or $V = \frac{30 \times E}{100} = \frac{30}{100}E$

27. To increase the range of ammeter we have to connect a small resistane in parallel (shunt), let its value be R.

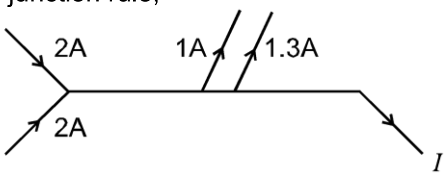
Apply KCL at junction to divide the current.

Voltage across R = Voltage across ammeter



$\Rightarrow 9R = 0.81 \times 1 \Rightarrow R = \frac{0.81}{9} = 0.09\ \Omega$

28. Accordintg to Kirchhoff's junction rule,



Sum of incoming currents

= Sum of out going currents $2 + 2 = 1 + 1.3 + I \quad \therefore \quad I = 1.7$ A

29. If R is the resistance of the voltmeter and I current is flowing through it, then

$V = IR$ or $R = \frac{V}{I}$

If now resistance connected in series is R', then

$R + R' = \frac{3V}{I}$

$R + R' = 3R \quad \therefore \quad R' = 2R$

30. Resistances R, R and $\frac{R}{2}$ are in series, their resultant resistance, $R' = R + R + \frac{R}{2} = \frac{5R}{2}$

Resistances R' and $\frac{R}{2}$ are in parallel. Their resultant resistance $\frac{1}{R} = \frac{2}{5R} + \frac{2}{R} = \frac{2+10}{5R}$ $R = \frac{5R}{12}$

31. $R_4 = 40\ \Omega$, in balanced condition

$R_1 R'_4 = R_2 R_3$ so $R_4' = \frac{16 \times 24}{48} = 8\ \Omega$

so. $8 = \frac{40R}{40+R} \Rightarrow 8R + 320 = 40R$

so. $R = 10\ \Omega$ = Black, brown, brown in parallel with R_4

EXERCISE # 3

PART - I

1. To convert a galvanometer to ammeter a small resistance is connected in parallel to the coil of the galvanometer.

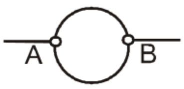
Here, $G_1 = 60\ \Omega$, $I_g = 1.0$ A, I = 5A

$I_g G_1 = (I - I_g)S$

$S = \frac{I_g G_1}{I - I_g} = \frac{1}{5-1} \times 60 = 15\ \Omega$

Putting 15 Ω resistance in parallel.

2.



3. According to ohm's law

$\frac{dV}{dI} = -r$

and V = ε if I = 0 [As V + Ir = ε]

∴ Slope of the graph = – r and intercept = ε

4. Apply Kirchhoff's second law also called loop rule.

The algebraic sum of the changes in potential in complete transversal of a mesh (closed loop) is zero i.e, $\Sigma V = 0$

Here $\varepsilon_1 - (i_1 + i_2)R - i_1 r_1 = 0$

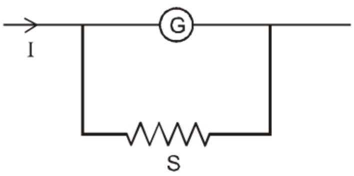
If there are n meshes in a circuit, the number of independent equation in accordance with loop law will be (n–1).

5. 1 division ≡ 1μA

Current for 1ºC = $\frac{40\mu v}{10} = 4\mu A$

1μA ≡ $\frac{1}{4}$ ºC = 0.25ºC.

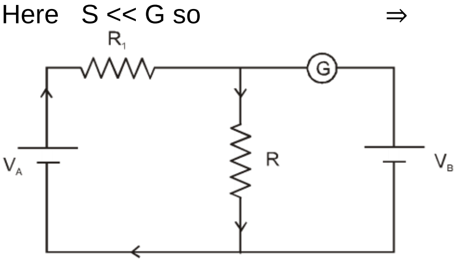
7.



$\frac{GS}{G+S} = \frac{V_G}{I} = \frac{25 \times 10^{-3}}{25}$ ⇒ $\frac{GS}{G+S} = 0.001\ \Omega$

Here S << G so ⇒ S = 0.001 Ω

8.



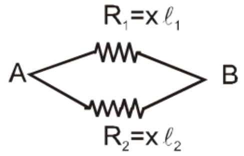
Since deflection in galvanometer is zero so current will flow as shown in the above diagram.

current $I = \frac{V_A}{R_1 + R} = \frac{12}{500+100} = \frac{12}{600}$ ⇒ So, $V_B = IR = \frac{12}{600} \times 100 = 2$ V

9. Resistance of bulb is constant

$P = \frac{v^2}{R} \Rightarrow \frac{\Delta p}{p} = \frac{2\Delta v}{v} + \frac{\Delta R}{R} \Rightarrow \frac{\Delta p}{p} = 2 \times 2.5 + 0 = 5\%$

10. Let x is the resistance per unit legth then equivalent resistance



$R = \frac{R_1 R_2}{R_1 + R_2} \Rightarrow \frac{(x_1\ell_1)(x_2\ell_2)}{x\ell_1 + x\ell_2} \Rightarrow \frac{8}{3} = x\frac{\ell_1\ell_2}{\ell_1+\ell_2} \Rightarrow x\frac{\ell_1}{\frac{\ell_1}{\ell_2}+1}$ ....(i)

also $R_0 = x\ell_1 + x\ell_2$

$12 = x(\ell_1 + \ell_2) = x\ell_2\left(\frac{\ell_1}{\ell_2}+1\right)$

$\frac{(i)}{(ii)} \Rightarrow \frac{\frac{8}{3}}{\frac{12}{1}} = \frac{\frac{x\ell_1}{\left(\frac{\ell_1}{\ell_2}+1\right)}}{X\ell_2\left(\frac{\ell_1}{\ell_2}+1\right)} = \frac{\ell_1}{\ell_2\left(\frac{\ell_1}{\ell_2}+1\right)^2} \Rightarrow \left(\frac{\ell_1}{\ell_2}+1\right)^2 \times \frac{8}{36} = \frac{\ell_1}{\ell_2}$

$(y^2 + 1 + 2y) \times \frac{8}{36} = y$ (where $y = \frac{\ell_1}{\ell_2}$)

$8y^2 + 8 + 16y = 36y$

⇒ $8y^2 - 20y + 8 = 0$ ⇒ $2y^2 - 5y + 2 = 0$

⇒ $2y^2 - 4y - y + 2 = 0$ ⇒ $2y[y-2] - 1(y-2) = 0$

⇒ $(2y-1)(y-2) = 0$ ⇒ $y = \frac{\ell_1}{\ell_2} = \frac{1}{2}$ or 2

11. $P = \frac{v^2}{R_{eq}}$ v = 10volt

$R_{eq} = \left(\frac{5R}{5+R}\right)$

P = 30W

$30 = \frac{(10)^2}{\left(\frac{5R}{5+R}\right)}$

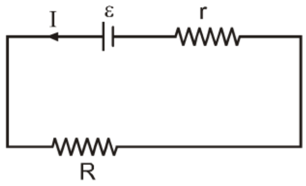
⇒ $\frac{15R}{5+R} = 10$

$15R = 50 + 10R$

⇒ $5R = 50$

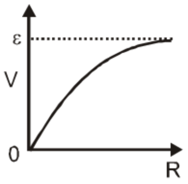
⇒ $R = 10\Omega$

12. $I = \left(\dfrac{\varepsilon}{R+r}\right)$



$V = IR = \left(\dfrac{\varepsilon}{R+r}\right)R \quad \Rightarrow \quad V = \dfrac{\varepsilon}{\left(1+\dfrac{r}{R}\right)}$ when R = 0, V = 0,

$R = \infty$, $v = \varepsilon$



13. $R = \dfrac{\rho\ell}{A} \quad \Rightarrow \quad \lambda' = 2\lambda \quad \Rightarrow \quad A' = \dfrac{A}{2} \Rightarrow$ So, R' = 4R.

$R_{new} = 4\ R_{ow} = 16$

14. $\varepsilon - IR = V = IR$

$2.1 - 0.2\ r = 0.2 \times 10$

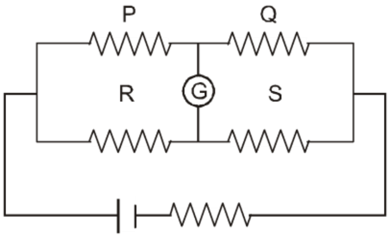
$2.1 - 0.2\ r = 2$

$0.2r = 0.1$

$r = \dfrac{1}{2} = 0.5\ \Omega$

Alternate: $i = \dfrac{E}{r+R}$

15. $i = \dfrac{7}{5+\dfrac{40\times120}{40+120}} = \dfrac{7}{5+30} = \dfrac{1}{5} = 0.2$ amp.



16. Total voltage drop = 150 × 8 = V

total resistance of wire R = 0.5 × 150

Power loss = $\dfrac{V^2}{R} = \dfrac{(150\times8)^2}{0.5\times150} = 19.2$ KW

17. $\dfrac{5}{R} = \dfrac{\ell_1}{100-\ell_1}$

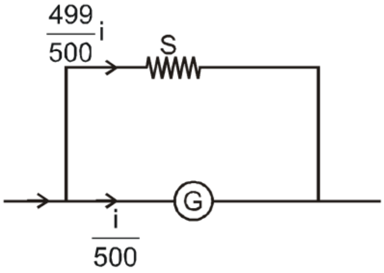
$\dfrac{5}{R/2} = \dfrac{1.6\ell_1}{100-1.6\ell_1}$

Solving ℓ_1 = 25 cm and R = 15 Ω

18. Internal resistance of the unknown cell is

$r = \left(\frac{\ell_1}{\ell_2} - 1\right) R = \left(\frac{3}{2.85} - 1\right) (9.5\Omega) = 0.5\Omega$

19.



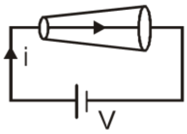
as (G) and the shunt are in parallel combination $i_g R_g = i_s R_s \Rightarrow \left(\frac{i}{500}\right)(G) = \left(\frac{499}{500}i\right)(S)$

$\Rightarrow \quad S = \frac{G}{499}$

Equivalent resitance of the ammeter

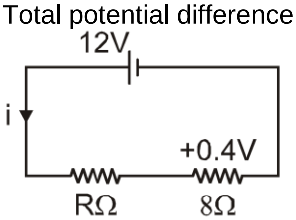
$\frac{1}{R_{eq}} = \frac{1}{G} + \frac{1}{\frac{G}{499}} \quad \Rightarrow \quad R_{eq} = \frac{G}{500}$

20.



Current remainssame

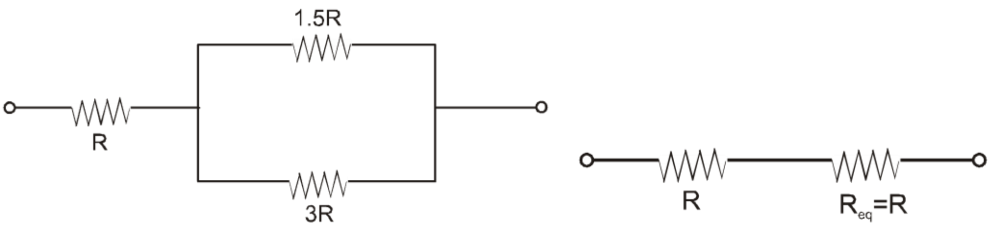
21. Total potential difference across potentio meter wier = $10^{-3} \times 400$ volt = 0.4 volt



so, $\frac{2}{R+8} = \frac{1}{20}$

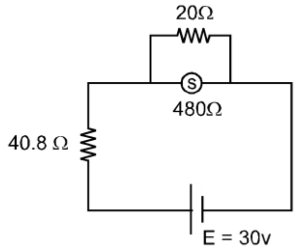
R + 8 = 40 ⇒ R = 32 Ω

22.



$V_B = V_C = V_A$

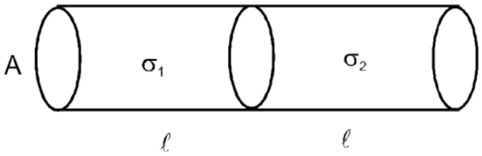
23.



Resitance of ammeter = $\frac{480 \times 20}{480 + 20}$ = 19.2 Ω.

i = $\frac{30}{40.8 + 19.2}$ = 0.5 A   Ans. is (4)

24.



$R_{ec} = \frac{\ell}{\sigma_1 A} + \frac{\ell}{\sigma_2 A} = \frac{\ell_{eq}}{\sigma_{eq} A_{eq}} \Rightarrow \frac{2\ell}{\sigma_{eq} A} = \frac{\ell}{A}\left(\frac{\sigma_1 + \sigma_2}{\sigma_1 \sigma_2}\right) \Rightarrow \sigma_{eq} = \frac{2\sigma_1\sigma_2}{\sigma_1 + \sigma_2}$ Ans. (4)

25. K = potential gradient = $\left(\frac{E_0 r}{r + r_1}\right)\frac{1}{L}$ So E = K ℓ = $\frac{E_0 r \ell}{(r + r_1)L}$

26. Q = at – bt^2

i = $\frac{dQ}{dt}$ = a – 2bt   i = 0 t = $\frac{a}{2b}$

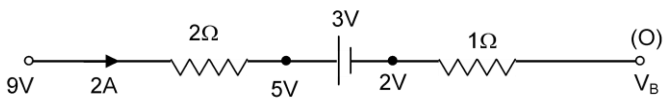
H = $\int_0^t i^2 R dt$ = $\frac{a^3 R}{6b}$

$\int_0^t I^2 R dt$

$it = \int_0^{a/2b} (a - 2bt)^2 R dt = a^2 t + \frac{4b^2 t^3}{3} - \frac{4bat^2}{2}$

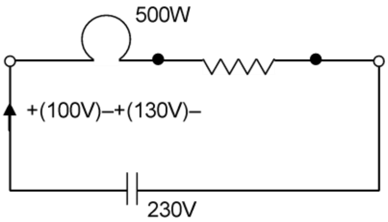
Put $t = \frac{a}{2b}$ ⇒ H = $\frac{a^3 R}{6b}$

27.



$V_A - V_B$ = 9volt

28.



$i = \frac{500}{100} = 5A$ so 130 = 5R

R = 26 Ω

29. On stretching length will be n times. Area of cross section will be $\frac{1}{n}$time.
So, resistance will become n^2R.

30. Potentiometer is more accure because it doesn't draw any current at the balance point

31. $\frac{\theta}{i_g} = \frac{5\,\text{div}}{10^{-3}\,A}$ = 5000 div ⇒ $\frac{\theta}{\Delta V} = 20\frac{\text{div}}{\text{volt}}$

(5000 div / A) × $\frac{1}{R_g}$ = 20 $\left(\frac{\text{div}}{\text{volt}}\right)$ ⇒ $R_g = \frac{5000}{20}$ = 250 Ω

32. R = 47 × 10^3 ± 10%

B	B	R	O	Y	Great	Britain	Very	good	wife
0	1	2	3	4	5	6	7	8	9

yellow violet orange ± silver

33. $i = \frac{E}{R+nR}$ ⇒ $i' = \frac{E}{R+R/n}$ = 10i so, $\frac{1}{n}$ + 1 = $\frac{n+1}{10}$ ⇒ $\frac{n+1}{n} = \frac{n+1}{10}$ ⇒ n = 10

34. $i = \frac{n\varepsilon}{nr} = \frac{\varepsilon}{r}$ So i = constant

35. Resistance for ideal voltmeter = ∞
Resistance for ideal ammeter = 0
For I[st] circuit

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

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{\infty}$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{10} + 0$$

R_{eq} = 10 Ω

$$i_i = \frac{V}{R} = \frac{10}{10} = 1A$$

V_1 = 10 V

In II[nd] circuit

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

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{10+\infty}$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{10} + 0$$

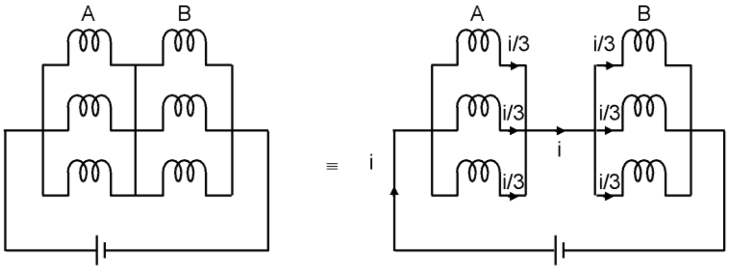
R_{eq} = 10 Ω

$$i_2 = \frac{10}{10} = 1A$$

$V_2 = 10$ V

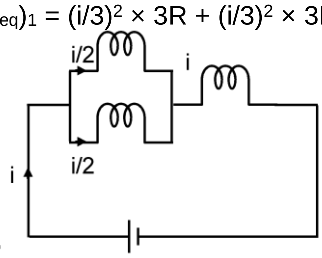
36. Fuse is used as a circuit protector

37. (i)



$(P_{eq})_1 = (i/3)^2 \times 3R + (i/3)^2 \times 3R = \frac{2}{3}\,i^2R$

(ii)



$P_{eq)2} = (i/2)^2 \times R + (i/2)^2 + i^2R = \frac{2}{3}\,i^2R$

$$\frac{P_{eq)_1}}{P_{eq)_2}} = \frac{\frac{2}{3} i^2R}{\frac{3}{2} i^2R} = \frac{4}{9}$$

38. For ideal voltmeter $R_v = \infty$

so $V_{20\,\Omega} = \frac{20}{20+30} \times 2 = \frac{4}{5}$ volt

$V_{30\,\Omega} = \frac{30}{20+30} \times 2 = \frac{6}{5}$ volt

$V = V_{30} - V_{20} = \frac{6}{5} - \frac{4}{5} = \frac{2}{5} = 0.4$ volt

39. In bridge network, No effect will occur if galvanometer and cell are inter changed

so $\frac{P}{Q} = \frac{\ell_2}{\ell_1}$

PART - II

1. Let R be their individual resistance at 0ºC. Their resistance at any other temperature t is
$R_1 = R\,(1 + \alpha_1 t)$ and $R_2 = R\,(1 + \alpha_2 t)$.
In series

$$R_{series} = R_1 + R_2 = R\,[2 + (\alpha_1 + \alpha_2)\,.t] = 2R\left[1 + \frac{\alpha_1 + \alpha_2}{2}\,t\right].$$

$\alpha_{Series} = \frac{\alpha_1 + \alpha_2}{2}$

In Parallel

$R_{Parallel} = \frac{R_1 + R_2}{R_1 + R_2} = \frac{R(1+\alpha_1 t)R(1+\alpha_2 t)}{R(2+\alpha_1+\alpha_2)t)} \approx \frac{R^2(1+\alpha_1+\alpha_2)t)}{2R(1+\frac{\alpha_1+\alpha_2}{2}t)} \approx \frac{R}{2}\left(1+\frac{\alpha_1+\alpha_2}{2}t\right)$

$\alpha_{Parallel} = \frac{\alpha_1 + \alpha_2}{2}$.

2. $R = \frac{\rho\ell}{A}$ $(\because V = A\ell \text{ const.})$

$V = A\ell$

By differentiation $0 = \ell dA + A d\ell$ ....(1)

By differentiation $dR = \frac{\rho(A d\ell - \ell dA)}{A^2}$ ....(2)

$dR = \rho \frac{2A d\ell}{A^2}$

$dR = \frac{2\rho d\ell}{A}$ or $\frac{dR}{R} = 2.\frac{d\ell}{\ell}$

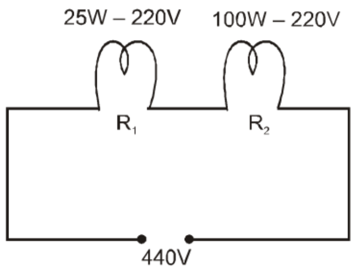
So, $\frac{dR}{R}\% = 2.\frac{d\ell}{\ell}\%$ = 2 × 0.1%

$\frac{dR}{R}\% = 0.2\%$ **Ans.**

3. $x = \frac{V}{\ell} = \frac{IR}{\ell} = \frac{IR}{\ell}\left(\frac{\rho\ell}{A}\right) = \frac{I\rho}{A}$

$x = \frac{0.2 \times 4 \times 10^{-7}}{8 \times 10^{-7}} = \frac{0.8}{8}$ = 0.1 V/m.

4.



As $R_1 = \frac{220}{25} \times 220$ and $R_2 = \frac{220}{100} \times 220$

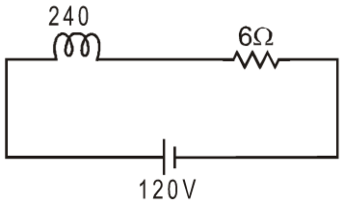
$R = R_1 + R_2 = 220 \times 220 \left(\frac{1}{25} + \frac{1}{100}\right) = 220 \times 220 \frac{1}{20}$

$\therefore I_{live} = \frac{440}{\frac{220 \times 220}{20}} = \frac{40}{220} A$ $\therefore$ 1st bulb (25 W) will fuse only

5. $R = \frac{V}{I} \Rightarrow$ $\pm\frac{\Delta R}{R} = \pm\frac{\Delta V}{V} \pm \frac{\Delta I}{I}$ = 3 + 3 = 6%

6. Statements I is false and Statement II is true

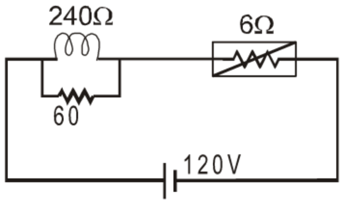
7. $P = \dfrac{V^2}{R}$



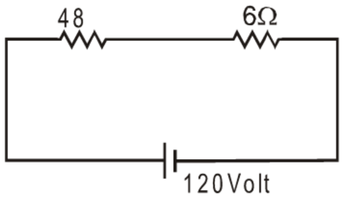
$R = \dfrac{120 \times 120}{60}$ = 240 Ω

$R_{eq.}$ = 240 + 6 = 246 Ω

$V_1 = \dfrac{240}{246} \times 120$ = 117.073 volt



$V_2 = \dfrac{48}{54} \times 120 = 106.66\,\text{Volt}$



$V_1 - V_2$ = 10.04 Volt

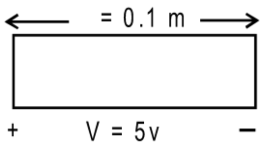
8. Total power (P) = (15 × 40) + (5 × 100) + (5 × 80) + (1 × 1000) = 2500W

P = VI

$\Rightarrow I = \dfrac{2500}{220}$ A = $\dfrac{125}{11}$ = 11.3 A

Minimum capacity should be 12 A

9.



$v_d = 2.5 \times 10^{-4}$ m/s

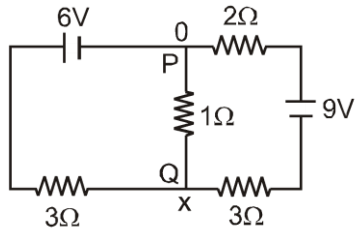
$n = 8 \times 10^{28}/m^3$

$I = neAv_d$

$\dfrac{VA}{\rho \ell} = neAv_d$

$\rho = \dfrac{V}{nev_d \ell} = \dfrac{5}{8 \times 10^{28} \times 1.6 \times 10^{-19} \times 2.5 \times 10^{-4} \times 0.1} = 1.6 \times 10^{-5}\ \Omega\,m$

10.



$\frac{x-6}{3}+\frac{x-0}{1}+\frac{x+9}{5}$ **= 0**

$x\left(\frac{5+15+3}{15}\right)$ **=** $2-\frac{9}{5}$ **=** $\frac{1}{5}$

x = $\frac{2}{23}$

i = $\frac{x-0}{1}$ **=** $\frac{3}{23}$ **=** 0.13A

from Q to P

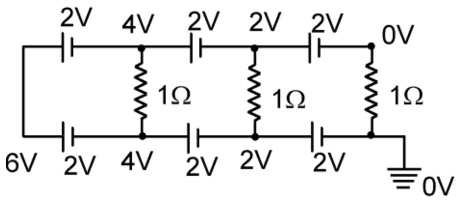
11. S = $\frac{i_g G}{I-i_g}$

here $i_g = 10^{-3}$ A G = $10^2\Omega$, I = 10A

S $\simeq$ $10^{-2}\Omega$

12. For conductor (Cu) resistance increases linearly and for semiconductor resistance decreases Exponentially in given temperature range.

13.



p.d. across each resistance is zero so current is also zero.

14. In a balanced Wheatstone bridge if the position of cell and galvanometer is exchanged the null point remains same.

15. Full deflection current, I_g = 5mA

Resistance of galvanometer, G = 15Ω.

R = $\frac{V}{I_g}-G$

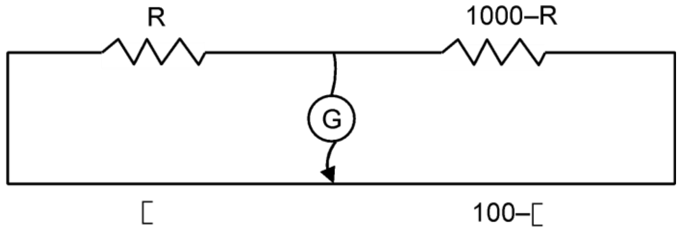
= $\frac{10}{5\times10^{-3}}-15$

= 2000 – 15

= 1985 Ω

= 1.985×10^3 Ω

16.



Say resistances are R and 1000 – R

For case-I $\frac{R}{\ell} = \frac{1000-R}{100-\ell}$

For case-II $\frac{1000-R}{\ell-10} = \frac{R}{110-\ell}$

Multiplying both equation

$$\frac{R(1000-R)}{\ell(\ell-10)} = \frac{(1000-R)R}{(100-\ell)(110-\ell)}$$

$\Rightarrow \quad \ell^2 - 10\ell = 11000 + \ell^2 - 210\ell$

$\Rightarrow \quad 200\ell = 11000$

$\Rightarrow \quad \ell = 55$ cm

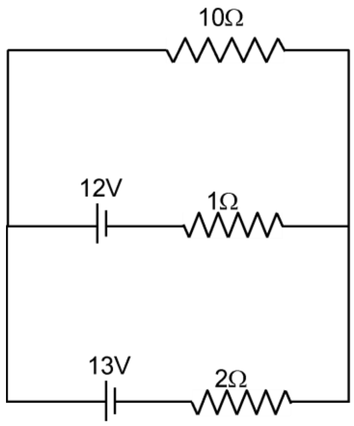
putting in first equation

$$\frac{R}{55} = \frac{1000-R}{45}$$

45R = 55000 – 55R

R = 550 Ω

17.



$E_{eq} = \dfrac{\frac{12}{1}+\frac{13}{2}}{\frac{1}{1}+\frac{1}{2}} = \dfrac{\frac{37}{2}}{\frac{3}{2}} = \frac{37}{3}$

$r_{eq.} = \frac{2}{3}$

$I = \dfrac{\frac{37}{3}}{\frac{2}{3}+10} = \dfrac{\frac{37}{3}}{\frac{32}{3}} = \frac{37}{32}$

Voltage across load = IR = $\left(\frac{37}{32}\right)(10)$ = 11.56V

18.

Color Codes	Values	Multiplier	Tolerance (%)
Black	**0**	**1**	

Brown	**1**	**10**	
Red	**2**	**100**	
Orange	**3**	**1K**	
Yellow	**4**	**10K**	
Green	**5**	**100K**	
Blue	**6**	**1M**	
Violet	**7**	**10M**	
Grey	**8**	**100M**	
White	**9**	**1G**	
Gold			**5**
Silver			**10**

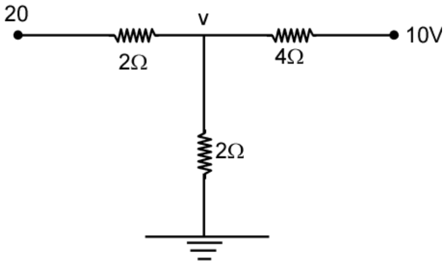
19. $i = neAv_d$

$$\frac{1.5}{1.6\times10^{-19}\times5\times10^{-6}\times9\times10^{28}} = v_d \Rightarrow \frac{1.5}{64}\times10^{-3} = v_d \Rightarrow v_d = 0.02 \text{ mm/s}$$

20. $\frac{\Delta\ell}{\ell} = 0.5\% \Rightarrow \frac{\Delta A}{A} = -0.5\%$

$R = \rho\frac{\ell}{A} \Rightarrow \frac{\Delta R}{R} = \frac{\Delta\ell}{\ell} - \frac{\Delta A}{A} \Rightarrow \frac{\Delta R}{R} = 0.5\% + 0.5\% = 1\%$

21.



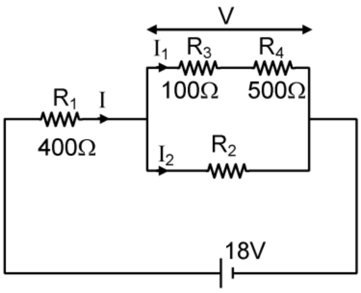
$i_1 + i_2 = i$

$$\frac{20-v}{2} + \frac{10-v}{4} = \frac{v}{2}$$

$v = 10V$

$\Rightarrow i = \frac{10}{2} = 5$ Amp.

22. $V_{500} = 5V = I_1R_4$



$$I_1 = \frac{5}{500} = \frac{1}{100}$$

$\Rightarrow$ $V_{100} = 1V$

$V = 1 + 5 = 6V$

$\Rightarrow \quad V_{400} = 18 - 6 = 12V$

$I = \frac{12}{400} = \frac{3}{100} \quad \Rightarrow \quad I_2 = \frac{3}{100} - \frac{1}{100} = \frac{2}{100}$

$V_{R_2} = 6V = I_2R_2 \quad \Rightarrow \quad R_2 = \frac{6 \times 100}{2} = 300\Omega$

23. 1st digit corresponding to green will be 5
2nd digit corresponding to orange will be 3
3rd digit corresponding to yellow will be 4
Tolerance corresponding to gold will be ±5% $\quad \therefore \quad$ Resistance is $53 \times 10^4 \pm 5\%$

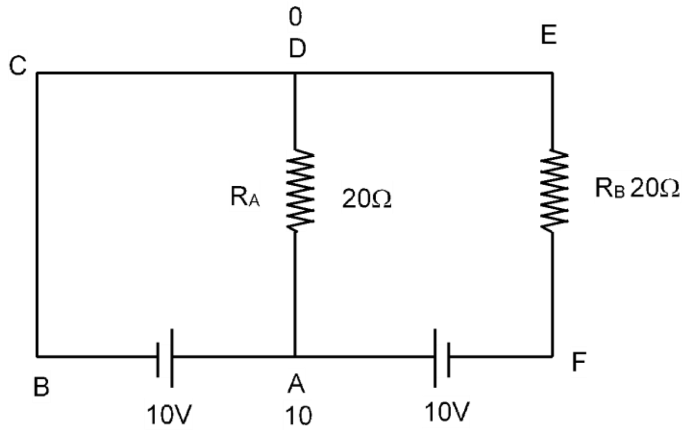
24. Green → 5, Black → 0 Red → 10^2 Brown → 1% tolerance
$I^2R = P$
$I^2 = \frac{2}{50 \times 10^2} = 4 \times 10^{-4}A$
$I = 2 \times 10^{-2}A = 20$ mA

25. $x = \frac{\varepsilon}{13r} \times \frac{12r}{\square} = \frac{12\varepsilon}{13\square}$

$\frac{\varepsilon}{2} = x\square$

$\frac{\varepsilon}{2} = \frac{12\varepsilon}{13\square}\square$

$\square = \frac{13\square}{24}$



26.
Assume $V_F = 0$
$V_E = V_F = 0$
$\Rightarrow$ Current in R_B is zero
$V_A - V_D = 10V$
$\Rightarrow \quad I = \frac{10}{20} = \frac{1}{2}A$ from A to D

27. $R_{eq} = \frac{R_1R_2}{R_1 + R_2} = \frac{6 \times 12}{6 + 12} = 4\Omega$
$P = I^2R$
$\Rightarrow 4.4 = (2 \times 10^{-3})^2R$

28. $R = 1.1 \times 10^6\,\Omega$
For second case

$$P = \frac{V^2}{R} = \frac{(11)^2}{1.1\times10^6} = 11\times10^{-5}\,W$$

29. Orange 3, Red 2, Brown 10^1

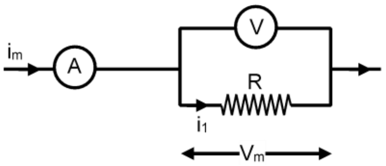
$= 320$

$$\frac{320}{R_3} = \frac{80}{40}$$

$R_3 = 160$

Brown 1, Blue 6, Brown 10^1

30. Let the measured voltage be V_m and Let the measured current be i_m and Let the ammeter be ideal, thus



$$\frac{V_m}{i_m} = R_m \quad \therefore \quad \frac{i_1R}{i_m} = R_m \quad \therefore \quad R\left(\frac{R_v}{R+R_v}\right) = R_m$$

$$\therefore \quad \frac{1}{R_m} = \frac{1}{R} + \frac{1}{R_v}$$

$$\therefore \quad \frac{1}{R_v} = \frac{1}{R_m} - \frac{1}{R} = \frac{1}{0.95R} - \frac{1}{R} \quad \therefore \quad \frac{1}{R_v} = \frac{1}{R}\left(\frac{1-0.95}{0.95}\right) \quad \therefore \quad R_v = 19R$$

$R_v = 570\ \Omega$

31. Initially

$$\frac{P}{Q} = \frac{R_1}{X} \qquad \ldots(i)$$

After interchanging P and Q

$$\frac{Q}{P} = \frac{R_2}{X} \qquad \ldots(ii)$$

From (i) and (ii)

$$1 = \frac{R_1R_2}{X^2}$$

$$X = \sqrt{R_1R_2}$$

$$= \sqrt{400\times405}$$

$= 402.5\ \Omega$

32. In circuit, when $R_h = 2\Omega$

$$i_1 = \frac{6}{4+2} = 1A, \quad \varepsilon = \frac{1\times4}{AB}\times AJ$$

$$AJ = \frac{AB}{4}\times\varepsilon \qquad \ldots..(1)$$

when $R_h = 6\Omega$

$$i_2 = \frac{6}{4+6} = 0.6A$$

$$\varepsilon_2 = \frac{0.6\times4}{AB}\times AJ$$

$AJ = \dfrac{\varepsilon_2 \times AB}{0.6 \times 4}$ .....(2)

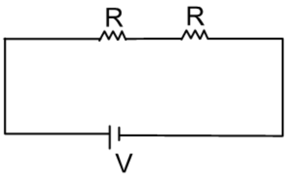
From (1) & (2)

$\dfrac{\varepsilon_2 \times AB}{0.6 \times 4} = \dfrac{\varepsilon \times AB}{4}$

$\varepsilon_2 = 0.6 \times \varepsilon$

$= 0.6 \times 0.5 = 0.3V$

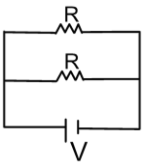
33.



$P_{generated} = 60W$

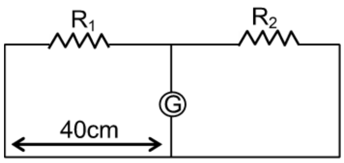
$P = 60 = \dfrac{V^2}{2R}$

$\dfrac{V^2}{R} = 120$ watt



$P_{generated} = \dfrac{2V^2}{R} = 2(120) = 240$ watt

34.



$\dfrac{R_1}{R_2} = \dfrac{40}{60} = \dfrac{2}{3}$

$\dfrac{R_1 + 10}{R_2} = \dfrac{50}{50} = 1$

$R_1 + 10 = R_2$

$R_1 + 10 = \dfrac{3}{2} R_1$

$10 = \dfrac{1}{2} R_1$ $\qquad R_1 = 20\Omega$

$\dfrac{\left(\dfrac{(R_1 + 10)R}{R_1 + 10 + R}\right)}{R_2} = \dfrac{2}{3}$

$\dfrac{R}{R_1 + 10 + R} = 1\dfrac{2}{3}$ $\qquad \Rightarrow \qquad 3R = 2R_1 + 20 + 2R$

$R = 2R_1 + 20$

$R = (40 + 20)\Omega = 60\Omega$

35. $V_{AB} = \dfrac{\frac{1}{1}+\frac{2}{1}+\frac{3}{1}}{\frac{1}{1}+\frac{1}{1}+\frac{1}{1}} = \dfrac{1+2+3}{3} = \dfrac{6}{3}$ = 2 volt

36. Full deflection current Ig = nk = 30 × 0.005
15 = 0.005 × 30 × 20 + 30 × 0.005 × R
R = 80 Ω

37. $R_1 = \dfrac{V^2}{P} = \dfrac{220 \times 220}{25}$ = 1936Ω

$R_2 = \dfrac{220 \times 220}{100}$ = 484Ω

$i = \dfrac{220}{1936 + 484} = \dfrac{220}{2420} = \dfrac{11}{121} = \dfrac{1}{11}$ Amp

$P_1 = i^2R = \dfrac{1}{121} \times 1936 = 16$ W

$P_2 = \dfrac{1}{121} \times 484 = 4$W

38. $dR = \dfrac{c\,d\ell}{\sqrt{\ell}}$

Acording to Question

$\int_0^{\ell} c\dfrac{d\ell}{\sqrt{\ell}} = \int_{\ell}^{1} c\dfrac{d\ell}{\sqrt{\ell}} \Rightarrow \left(2\sqrt{\ell}\right)_0^{\ell} = \left(2\sqrt{\ell}\right)_{\ell}^{1}$

$2\sqrt{\ell} = 2 - 2\sqrt{\ell}$

$4\sqrt{\ell} = 2$

$\ell = \dfrac{1}{4} = 0.25$ m.

39. Potential gradient = x = $\dfrac{5 \times 10^{-3}}{10 \times 10^{-2}} = \left(\dfrac{4}{R+5} \times 5\right) \times \dfrac{1}{1}$

$\Rightarrow \dfrac{1}{20} = \dfrac{20}{R+5}$

⇒ 400 = R + 5

R = 395Ω.

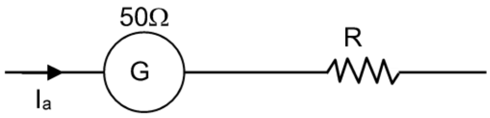
40. $Q_0 \propto i_G \Rightarrow Q_0C = i_G$

I-case $CQ_0 = \dfrac{v}{220 + R}$ ….(1)

II-case $C\dfrac{\theta_0}{5} = \dfrac{v}{\left(220 + \dfrac{5R}{5+R}\right)} \times \dfrac{5}{5+R}$ ….(2)

from (1) and (2) R = 22Ω

41.

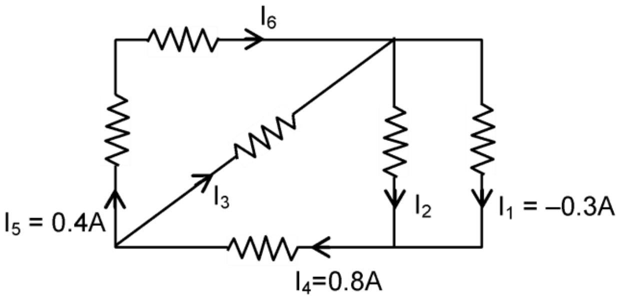


2.5 V = (50 + R) × 4 × 10^{-4} × 25

⇒ 250 = 50 + R

⇒ R = 200 Ω

42.



$I_5 + I_3 = I_4$

⇒ $I_3 = 0.8 - 0.4 = 0.4A$ ...(1)

$I_6 = I_5 = 0.4$ A ...(2)

$I_3 + I_6 = I, + I_2$

⇒ $I_2 = I_3 + I_6 - I, = 0.4 + 0.4 - (-0.3) = 1.1$ A ...(3)