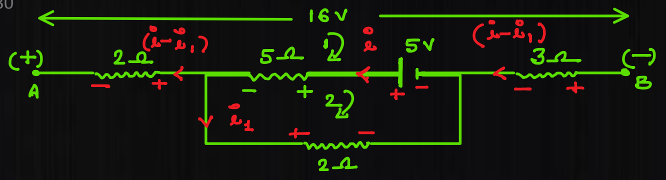
Electric Current DPP-2 Level 1 Solutions

01 August 2020 00:30

Q1 :→



KVL in loop 1

$$-2(i - i_1) - 16 - 3(i - i_1) + 5 - 5i = 0$$

$$\Rightarrow \quad 5i_1 - 10i = 11 \quad \text{—— (1)}$$

KVL in loop 2

$$5i - 5 + 2i_1 = 0$$

$$\Rightarrow \quad 5i + 2i_1 = 5 \quad \text{—— (2)}$$

eqn (2) × 5 − eqn (1) × 2

$$25i + 10i_1 = 25$$

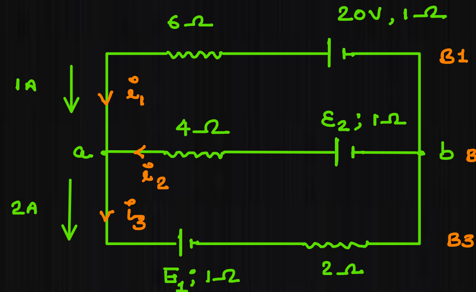
$$10i_1 - 20i = 22$$

$$45i = 3$$

$\therefore \quad i = \frac{1}{15}$ A (current flown through 5 V Batt.)

Q2 :→

all the 3 branches are in parallel combination about a & b.



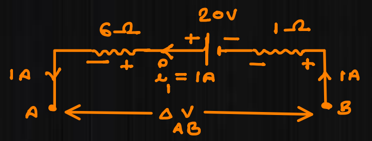
at jn. a :→ from KCL

$$i_1 + i_2 = i_3$$

$$1 + i_2 = 2$$

$$i_2 = 1\text{A} \quad \text{—— (1)}$$

considering Branch 1 :→



$$\Delta V_{AB} = -i_1 \times 1 + 20 - i_1 \times 6$$

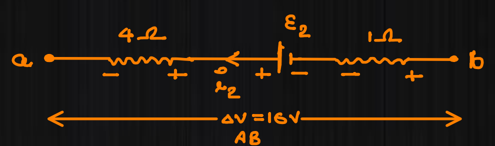
$$= 20 - 7i_1$$

as $i_1 = 1$A

$$= 20 - 7 \times 1$$

potential diff. b/w points A & B. $\quad \Delta V_{AB} = 13$ volt —— (2)

for branch ε_2 :→

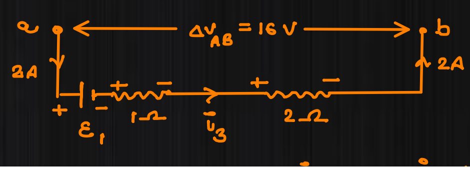


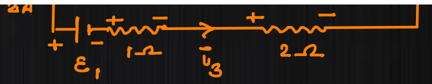
here; $\quad \Delta V_{AB} = -i_2 \times 1 + \varepsilon_2 - 4 \times i_2$

$$13 = \varepsilon_2 - 5 \times 1 \quad (\text{from eqn (1) \& (2)})$$

$$\varepsilon_2 = 18 \text{ V} \quad \text{—— (3)}$$

for Branch 3 :→





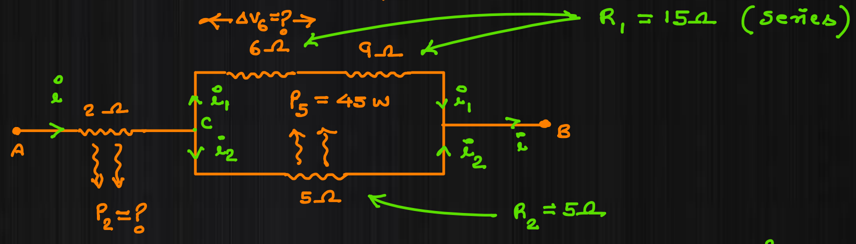
$$\Delta V_{AB} = 2 \cdot i_3 + 1 \times i_3 + \mathcal{E}_1$$

$$13 = 2 \times 2 + 1 \times 2 + \mathcal{E}_1$$

$$\therefore \mathcal{E}_1 = 13 - 6$$

$$\Rightarrow \mathcal{E}_1 = 7 \text{ volt} \quad \text{—— (4)}$$

Q3 :→



as Power appeared 5 Ω resistor $(P) = i_2^2 \times R$

$$45 = i_2^2 \times 5$$

$$i_2^2 = 9$$

$$\therefore i_2 = 3\text{ A} \quad \text{—— (1)}$$

at jn C :→

$$\frac{i_1}{i_2} = \frac{R_2}{R_1}$$

$$\frac{i_1}{3} = \frac{5}{15}$$

$$\therefore i_1 = 1\text{ A} \quad \text{—— (2)}$$

so P. D. across 6 Ω resistor $(\Delta V_{6\Omega}) = i_1 \times R_6 = 1 \times 6 = 6$ volt

as : $i = i_1 + i_2$

$$\Rightarrow i = 4\text{ A}$$

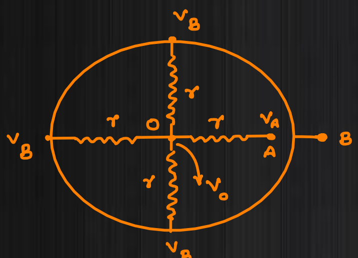
so power appeared across 2 Ω resistor

$$P_2 = i^2 \times R$$

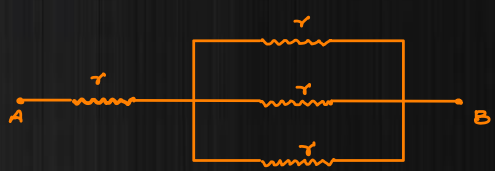
$$= (4)^2 \times 2$$

$$P_2 = 32\text{ W}$$

Q 4) i)



$\Rightarrow$

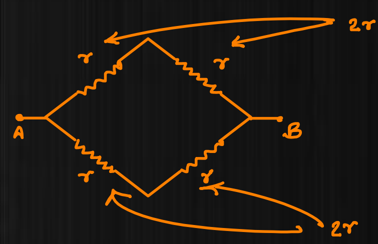


$\Downarrow$

$$\therefore R_{eq} = r + \frac{r}{3} = \frac{4r}{3}$$

ii)

$\Rightarrow$ Balanced wheat Stone Bridge



$$\therefore R_{eq} = \frac{2r}{2} = r$$

iii)

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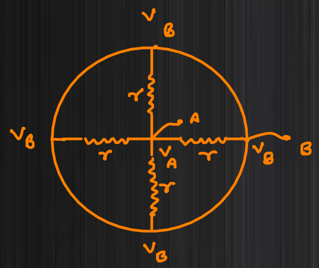
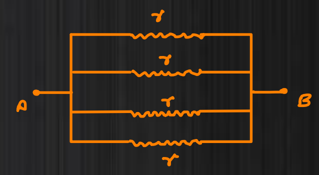


$\Rightarrow$



$R_{eq} = \frac{r}{4}$

Q5) Let the Heat required to boil the water is H Joules.
& the Resistance of both the coils are R_1 & R_2.

$$H = \frac{V^2}{R_1} \times t_1 = \frac{V^2}{R_2} \times t_2 \quad \text{— (1)}$$

note: voltage of the power source is V in all the cases.

$$\therefore \frac{R_1}{R_2} = \frac{t_1}{t_2} = \frac{6}{8}$$

$$\therefore \frac{R_1}{R_2} = \frac{3}{4} \quad \text{— (2)}$$

i) when connected in series;

$$H = \frac{V^2}{R_{eq}} \times t_s$$

$$\Rightarrow H = \frac{V^2}{R_1 + R_2} \times t_s$$

$$\Rightarrow H = \frac{V^2}{R_2 \cdot \left(\frac{R_1}{R_2} + 1\right)} \times t_s$$

from (1);

$$\Rightarrow H = \frac{H}{t_2} \times \frac{t_s}{\left(\frac{3}{4} + 1\right)} \qquad \{\because t_2 = 8\,\text{min}\}$$

$$\Rightarrow 8 \cdot \left\{\frac{3}{4} + 1\right\} = t_s$$

$$t_s = 14\,\text{min}$$

ii) when connected in parallel: $\rightarrow$

$$H = \frac{V^2}{R_{eq}} \times t_p$$

$$= \frac{V^2}{R_1 R_2} \cdot (R_1 + R_2) \cdot t_p$$

$$\Rightarrow H = \frac{V^2}{R_1} \cdot \left\{\frac{R_1}{R_2} + 1\right\} \cdot t_p$$

from eqn (1);

$$H = \frac{H}{t_1} \cdot \left\{\frac{3}{4} + 1\right\} \cdot t_p$$

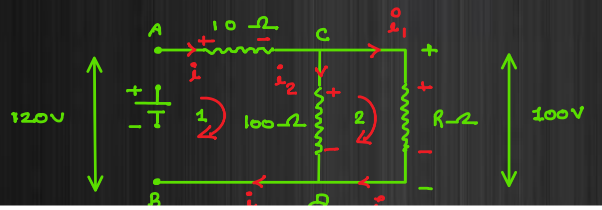
$$\because t_1 = 6\,\text{min}$$

$$6 = \frac{7}{4} \cdot t_p$$

$$\therefore t_p = \frac{24}{7}\,\text{min} = 3\,\text{min} \;\&\; 25.7\,\text{sec.}$$

Q6: $\rightarrow$ in next chapter

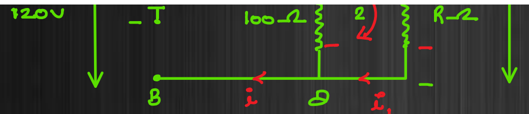
Q7: $\rightarrow$



as 100 Ω & R Ω are in parallel

$\therefore \Delta V_{CD} = 100$ volts

$\because \Delta V_{CD} = i_2 \times 100$



$\because \Delta V_{CD} = i_2 \times 100$

$100 = i_2 \times 100$

$i_2 = 1\,A$ — (1)

KVL in loop (1)

$-10i - 100 i_2 + 120 = 0$

$\Rightarrow 10 i = 120 - 100$

$\Rightarrow i = \frac{20}{10}$

$\therefore i = 2\,A$ — (2)

$\because i = i_1 + i_2$

$2 = i_1 + 1$

$\Rightarrow i_1 = 1$ Amp — (3)

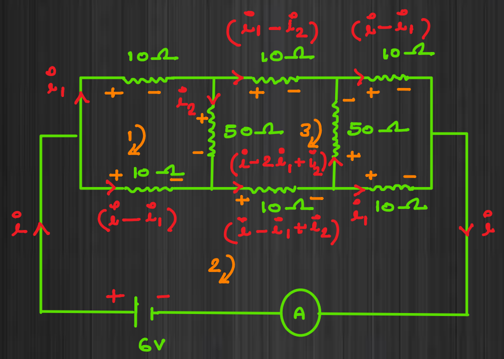
$\because \Delta V_R = i_1 \times R$

$\Rightarrow 100 = 1 \times R$

$\therefore R = 100\,\Omega$

Q8: in next chapter:

Q9:



it is a mirror symmetry problem

KVL in loop (1)

$-10 i_1 - 50 i_2 + 10(i - i_1) = 0$

$\Rightarrow 10 i - 20 i_1 - 50 i_2 = 0$

$\Rightarrow i - 2 i_1 - 5 i_2 = 0$ — (1)

KVL in loop 2

$-10(i_1 - i_2) + 50(i - 2i_1 + i_2) + 10(i - i_1 + i_2) + 50 i_2 = 0$

$\Rightarrow -120 i_1 + 120 i_2 + 60 i = 0$

$\Rightarrow i + 2 i_2 - 2 i_1 = 0$ — (2)

KVL in loop (2) :→

$-10(i - i_1) - 10(i - i_1 + i_2) - 10 i_1 + 6 = 0$

$\Rightarrow -20 i + 10 i_1 - 10 i_2 + 6 = 0$

$\Rightarrow -10 i + 5 i_1 - 5 i_2 + 3 = 0$ — (3)

eqn (1) − eqn (2)

$-7 i_2 = 0$

$\therefore i_2 = 0$ — (4)

from (2) & (4)

$i - 2 i_1 = 0$

$\therefore i_1 = \frac{i}{2}$ — (5)

from (3), (4) & (5)

$-10 i + \frac{5i}{2} - 0 + 3 = 0$

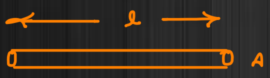
$3 = \frac{15 i}{2}$

$\therefore i = \frac{2}{5} = 0.4\,A$; Reading of the

$3 = \frac{15 i}{2}$

$\therefore i = \frac{2}{5} = 0.4\,A$; Reading of the (A)

Q10) Let the initial length is l & cross-sectional area is A.



$\because R = \frac{\rho . l}{A}$ —①

$\because V = A \times l = \text{const.}$

so $A = \frac{V}{l}$ —②

from ① & ②

$R = \frac{\rho . l^2}{V}$

$\because \rho$ & V are const.

$\therefore \frac{\Delta R}{R} \times 100\% = 2 \cdot \frac{\Delta l}{l} \times 100\%$

$= 2 \times 0.1\%$

$\Rightarrow \frac{\Delta R}{R} \times 100\% = 0.2\%$ increase

Q11) power supplied to or consumed by the load $(P) = V \times i$

$\therefore i = \frac{P}{V}$ —① ; current in the cables

so power loss in cables $(\Delta P) = i^2 \cdot R$

$\Rightarrow \Delta P = \frac{P^2}{V^2} \times R$ —②

a) if $V = 10^4$ volts & $P = 10^5\,W$

$\Delta P = \frac{10^{10}}{10^8} \times 5$

$\therefore \Delta P = 500\,W$

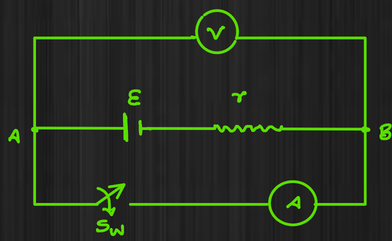
b) if $V = 2 \times 10^5$ volts & $P = 10^5\,W$

$\Delta P = 1.25\,W$

Q12) :→ when the switch S_w is open :→ cell is open circuit

so $\Delta V_{AB} = \varepsilon$ = reading of the voltmeter when S_w is open

$\therefore \varepsilon = 1.52$ volt —①



when the Sw is closed; P.D. across the points A & B

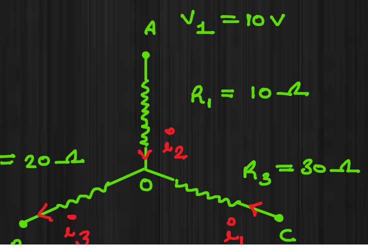
$V = \varepsilon - ir$ ← Reading of the Ammeter

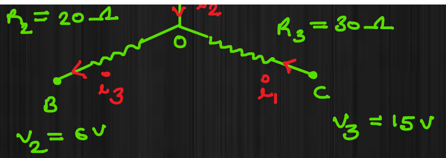
new reading of the voltmeter $\Rightarrow 1.45 = 1.52 - 1 \times r$

$\therefore r = 1.52 - 1.45$

$\Rightarrow r = 0.07\,\Omega$

Q13)





at jn O : from KVL

$$i_1 + i_2 = i_3$$

$$\Rightarrow \left(\frac{V_C - V_0}{R_3}\right) + \left(\frac{V_A - V_0}{R_1}\right) = \left(\frac{V_0 - V_B}{R_2}\right)$$

$$\Rightarrow \left(\frac{15 - V_0}{30}\right) + \left(\frac{10 - V_0}{10}\right) = \left(\frac{V_0 - 6}{20}\right)$$

$$\Rightarrow 30 - 2V_0 + 60 - 6V_0 = 3V_0 - 18$$

$$\Rightarrow 11V_0 = 108$$

potential at the jn. $V_0 = \frac{108}{11}$ volt

$$\therefore i_1 = \frac{V_C - V_0}{R_3} = \frac{15 - \frac{108}{11}}{30} = \frac{57}{330} = \frac{19}{110} \text{ A}$$

$$i_2 = \frac{V_A - V_0}{R_1} = \frac{10 - \frac{108}{11}}{10} = \frac{2}{110} = \frac{1}{55} \text{ A}$$

$$\& \; i_3 = \frac{V_0 - V_B}{R_2} = \frac{\frac{108}{11} - 6}{20} = \frac{42}{220} = \frac{21}{110} \text{ A}$$

Q14) $\because$ Distribution of electric current amoung resistances is parallel combination always takes place in inverse ratio of resistance.

$$\therefore i_1 : i_2 : i_3 = R_3 : R_2 : R_1$$

$$= \frac{\rho . l_3}{A_3} : \frac{\rho . l_2}{A_2} : \frac{\rho l_1}{A_1}$$

here $A = \pi r^2$

$$= \frac{l_3}{r_3^2} : \frac{l_2}{r_2^2} : \frac{l_1}{r_1^2}$$

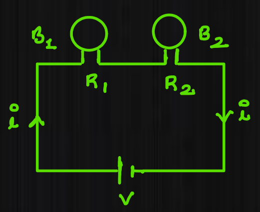
$$= \frac{4}{25} : \frac{3}{16} : \frac{2}{9}$$

$$\Rightarrow i_1 : i_2 : i_3 = 54 : 64 : 75$$

Q15) $\because P = \frac{V^2}{R}$

$$\therefore \text{resistance of } B_1 \; (R_1) = \frac{V^2}{P_1}$$

$$\text{" \quad " } B_2 \; (R_2) = \frac{V^2}{P_2}$$



$$\text{current in the circuit } (i) = \frac{V}{R_{eq}} = \frac{V}{(R_1 + R_2)}$$

$\therefore$ Total Power consumption

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$$P = i^2 \cdot R_{eq}$$

$$= \frac{V^2}{(R_1+R_2)^2} \times (R_1+R_2)$$

$$= \frac{V^2}{(R_1+R_2)}$$

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

$$\therefore P = \frac{P_1 \cdot P_2}{P_1+P_2} \text{ watt}$$