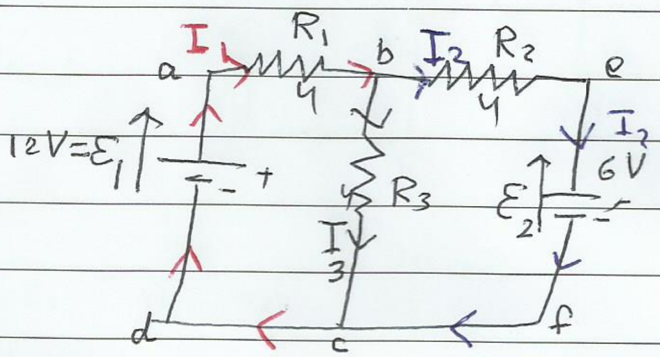
Chapter 27 - Discussion

(27-2) $\varepsilon_1 = 12V$,

$\varepsilon_2 = 0.5\varepsilon_1 = 6V$

$R_1 = R_2 = R_3 = 4\Omega$

find i_1, i_2, i_3?



At point ⓐ $\sum I_{in} = \sum I_{out}$

$$I_1 = I_2 + I_3 \quad ①$$

$\sum V_{abcda} = 0 \Rightarrow -I_1R_1 + -I_3R_3 + +\varepsilon_1 = 0$

$$\varepsilon_1 = I_1R_1 + I_3R_3$$

$$12 = 4I_1 + 4I_3$$

$$3 = I_1 + I_3 \quad ②$$

$\sum V_{befcb} = 0 \Rightarrow -I_2R_2 + -\varepsilon_2 + +I_3R_3 = 0$

$$\varepsilon_2 = I_3R_3 - I_2R_2$$

$$6 = 4I_3 - 4I_2 \quad ③$$

put ① in ② $\Rightarrow 3 = (I_2 + I_3) + I_3$

$$3 = I_2 + 2I_3 \quad ②'$$

multiply ②' by 4 $\Rightarrow 12 = 4I_2 + 8I_3 \quad ②'$

$$6 = -4I_2 + 4I_3 \quad ③ \text{ Add}$$

$$18 = 12I_3$$

$$I_3 = \frac{18}{12} = 1.5A$$

from ② $I_1 = 3 - I_3 = 3 - 1.5 = 1.5A$

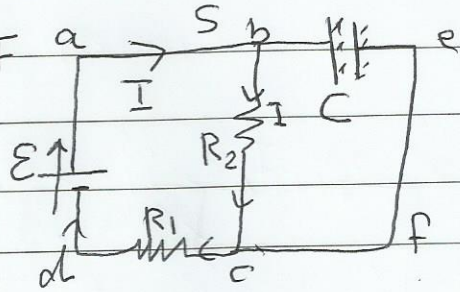
$$I_1 = 1.5A$$

from ① $I_2 = I_1 - I_3 = 1.5 - 1.5 = 0$

$$I_2 = 0$$

(27-9) $R_1 = 10k\Omega$, $R_2 = 15k\Omega$, $C = 0.4\mu F$
$\mathcal{E} = 20V$

First: Closing S(switch) for along time)



$\sum V_{abcda} = 0 \Rightarrow$

$-IR_2 + -IR_1 + \mathcal{E} = 0 \Rightarrow I = \frac{\mathcal{E}}{R_1 + R_2} = \frac{20}{(10+15)} = \frac{20}{25} mA$

$I = 0.8mA$

$\sum V_{befcb} = 0 \Rightarrow -\frac{Q}{C} + IR_2 = 0 \Rightarrow \frac{Q}{C} = IR_2 = 0.8(15) = 12V$

$Q = C(\frac{Q}{C}) = CV_c = 0.4(12) = 4.8\mu C$

at $t=0$ the Switch is opend

at $t=0$ $\quad Q_0 = 4.8\mu C$, $\quad V_{co} = 12V$

at any time

$V_c = V_{co} e^{-t/R_2C}$, $\tau = R_2C = 15\times10^3 \times 0.4\times10^{-6}$

$\tau = 6\times10^{-3}s = 6ms$

$V_c(t) = 12 e^{-t/R_2C}$

$Q(t) = Q_0 e^{-t/R_2C} = 4.8\times10^{-6} e^{-t/\tau}$

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

$I = Q_0(\frac{-1}{R_2C}) e^{-t/R_2C}$

$I = \frac{4.8\times10^{-6}}{6\times10^{-3}} e^{-t/R_2C} = 0.8\times10^{-3} e^{-t/R_2C}$

At $t = 4ms \rightarrow I = 0.8\times10^{-3} e^{-4/6} = 0.8\times10^{-3}(0.513)$

$I = 0.41 mA$

At $t = 4ms$ find $\frac{di}{dt} = ?$

$\frac{di}{dt} = \frac{0.8\times10^{-3}}{R_2C} e^{-t/R_2C} = \frac{0.8\times10^{-3}}{6\times10^{-3}} e^{-t/\tau} = 0.133 e^{-t/\tau}$

$$\left.\frac{di}{dt}\right|_{t=4ms} = 0.133\, e^{-4/6} = 0.13(0.513) = 0.067\ A/s$$

$$P_{R_2} = I^2 R_2 = \left[0.8\times10^{-3} e^{-t/\tau}\right]^2 \left[15\times10^{3}\right]$$

$$P_{R_2} = 9.6\times10^{-3}\, e^{-2t/\tau}$$

$$\frac{dP_{R_2}}{dt} = 9.6\times10^{-3}\left[\frac{-2}{\tau} e^{-2t/\tau}\right]$$

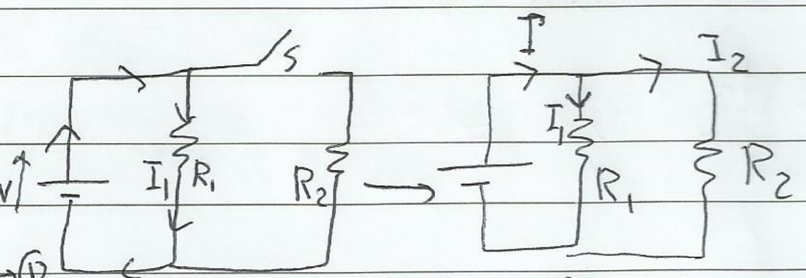
$$= 9.6\times10^{-3}\left(\frac{2}{6\times10^{-3}}\right) e^{-2t/\tau}$$

$$\frac{dP_{R_2}}{dt} = 3.2\, e^{-2t/\tau}$$

$$\left.\frac{dP_{R_2}}{dt}\right|_{t=4ms} = 3.2\, e^{-2(4)/6} = 3.2\, e^{-8/6} = 3.2\, e^{-1.333} = 3.2(0.26359) = 0.84\ \text{Watt/s}.$$

(27-14) Circuit ⓐ

$R_1 = R_2 = 4\,\Omega$



① ②

(S) opend, Circuit → ①

$$I_1 = \frac{\mathcal{E}}{R_1} = \frac{12}{4} = 3A$$

$$V_1 = I_1 R_1 = 12V$$

(S) is Closed circuit ② → $R_1 + R_2$ in Parallel

$$R_{12} = \frac{R_1 R_2}{R_1 + R_2} = \frac{4(4)}{4+4} = 2\,\Omega$$

$$I = \frac{\mathcal{E}}{R_{12}} = \frac{12}{2} = 6A \to I_1 = I_2 = 3A$$

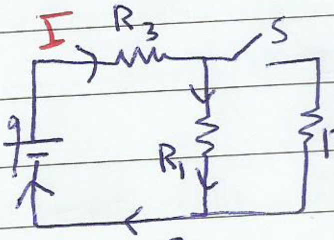
$$\to V_1 = I_1 R_1 = 3(4) = 12V$$

$$(\Delta V_1) = V_{1\,closed\,s} - V_{1\,opened\,s} = 12 - 12 = 0$$

(27-14) Circuit (b)

$\mathcal{E} = 12V$

$R_1 = R_2 = R_3 = 4\Omega$



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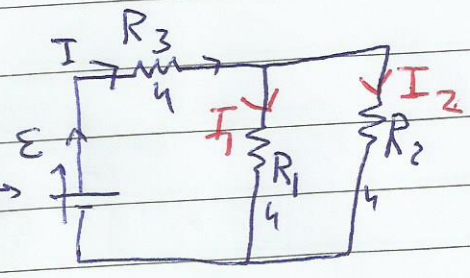


② ← ②

(S) is opened circuit ① → ①

$$I = \frac{\mathcal{E}}{R_1 + R_3} = \frac{12}{8} = 1.5A$$

$$V_1 = I_1 R_1 = (1.5)(4) = 6V$$

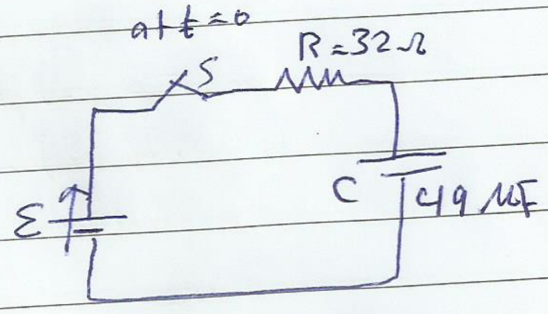
(S) is closed circuit ②

$$I = \frac{\mathcal{E}}{R_3 + R_{12}} = \frac{12}{4+2} = \frac{12}{6} = 2A$$

$$V_1 = I_1 R_1 \,;\; I_1 = I_2 = 1A$$

$$V_1 = 1(4) = 4V$$

$$\Delta V_1 = V_1(S \text{ closed}) - V_1(S \text{ opened})$$
$$= 4 - 6$$
$$= -2V$$



(27-21) $\tau = RC = 32(49 \times 10^{-6})$
$= 1.568 \times 10^{-3} s$

Find t? when $V_c = V_R$

$$V_c = \mathcal{E}(1 - e^{-t/\tau}) \;,,,\; V_R = \mathcal{E} e^{-t/\tau}$$

$$V_c = V_R$$

$$\mathcal{E}(1 - e^{-t/\tau}) = \mathcal{E} e^{-t/\tau} \Rightarrow 1 - e^{-t/\tau} = e^{-t/\tau}$$

$$1 = 2e^{-t/\tau} \Rightarrow e^{-t/\tau} = 0.5$$

$$-\frac{t}{\tau} = \ln 0.5 \Rightarrow t = -\tau \ln 0.5$$

$$t = 0.69\tau$$

$$t = 1.08 \times 10^{-3} s = 1.1 \text{ ms}$$

or

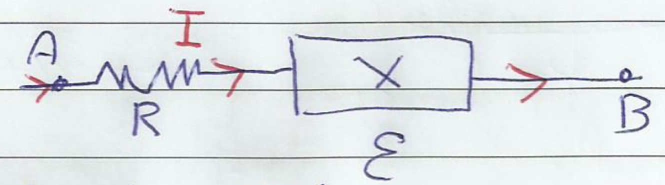
$$V_c = V_R = \frac{\mathcal{E}}{2} \Rightarrow V_R = \frac{\mathcal{E}}{2} \rightarrow \mathcal{E} e^{-t/\tau} = \frac{\mathcal{E}}{2}$$

$$e^{-t/\tau} = 0.5 \Rightarrow t = 0.89\tau = 1.1 \text{ ms}$$

(27-33)

$I = 2A$

$R = 2\Omega$



AB absorbs energy at a rate = 50W

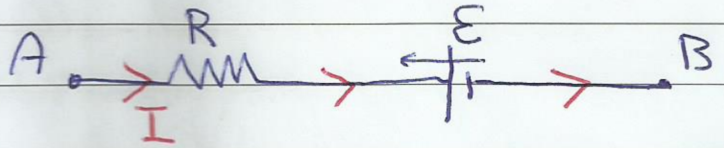
a) $P_{AB} = I V_{AB}$

$$V_{AB} = \frac{P_{AB}}{I} = \frac{50}{2} = 25V$$

$V_{AB} = 25V$

$$P_R = I^2 R = (2)^2 (2) = 8 \text{ Watt}$$

$\mathcal{E}$ absorbs $= 42$ Watt this means I & $\mathcal{E}$ are opposit



$$V_A + {}^{-}RI + {}^{-}\mathcal{E} = V_B$$

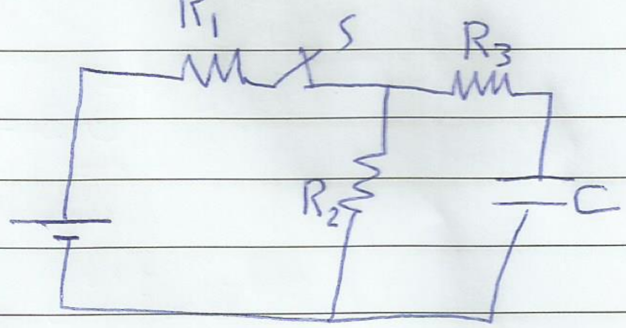
$$(V_A - V_B) - RI = \mathcal{E} \Rightarrow$$

$$\mathcal{E} = 25 - 2(2) = 21V$$

(27-47) $\mathcal{E} = 1.2kV$, $C = 6.5\mu F$

$R_1 = R_2 = R_3 = 0.73 M\Omega$

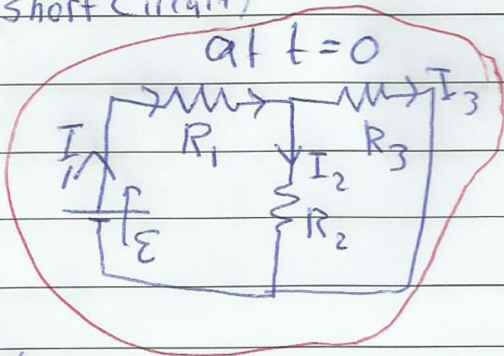
S closed at $\boxed{t=0}$ I_1, I_2, I_3 ?



At $t=0$ $\boxed{C}$ behaves as a wire (short circuit)

R_2 & R_3 in Parallel

$$R_{23} = \frac{R_2 R_3}{R_1 + R_3} = \frac{0.73 M\Omega}{2}$$



$R_{23} = 0.365 K\Omega$

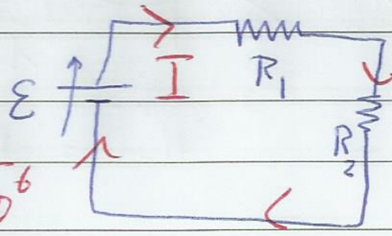
$$I_1 = \frac{\mathcal{E}}{R_1 + R_{23}} = \frac{1.2 \times 10^3}{(0.73 + 0.365) \times 10^6}$$

$I_1 = 1.1 \text{ mA}$ $\rightarrow I_2 = I_3 = \frac{1.1}{2} = 0.55 \text{ mA}$

$$V_2 = I_2 R_2 = (0.55)(0.73) = 0.4 kV$$

At $t=\infty$ C is fully charge
C will behave as open circuit

$I_3 = 0$



the circuit at $t=\infty$

$$I = \frac{\mathcal{E}}{R_1+R_2} = \frac{1.2\times10^3}{(0.73+0.73)10^6}$$

$I = 0.82\ mA$

$I_1 = I_2 = 0.82\ mA$

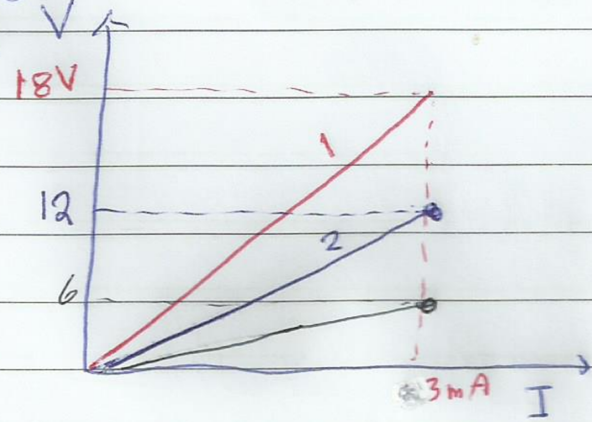
$$V_2 = I_2R_2 = (0.82)(0.73)$$
$$= 0.6\ kV$$

(27-56) From the graph V vs. I you can find the slope, the slope = R

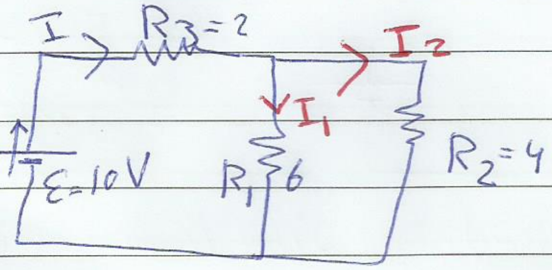
$$R_1 = \frac{\Delta V}{\Delta I} = \frac{18}{3\times10^{-3}} = 6\ k\Omega$$

$$R_2 = \frac{\Delta V}{I} = \frac{12}{3\times10^{-3}} = 4\ k\Omega$$

$$R_3 = \frac{\Delta V}{\Delta I} = \frac{6}{3\times10^{-3}} = 2\ k\Omega$$



Find I_2?



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

$$\frac{1}{R_{12}} = \frac{4+6}{24} = \frac{10}{24}$$

$R_{12} = 2.4\ k\Omega$

$$I = \frac{\mathcal{E}}{R_{12}+R_3} = \frac{10}{(2.4+2)10^3} = 2.27\ mA$$

$$I_2R_2 = I_1R_1 = IR_{12}$$
$$4I_2 = 6I_1 = 2.27(2.4) = 5.455\ V$$

$$I_2 = \frac{5.455}{4\times10^3} = 1.364\ mA = 1.4\ mA$$