DPP 7

1. when S is opened

$V_c - V_a = \frac{18 \times 6}{6+3} = 12\text{ V}$

$\because V_c = 18\text{ V}$

$V_a = 6\text{ V}$

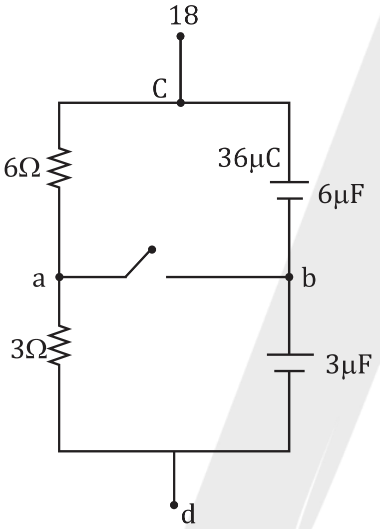
$C_{eq} = 2\mu\text{F}$

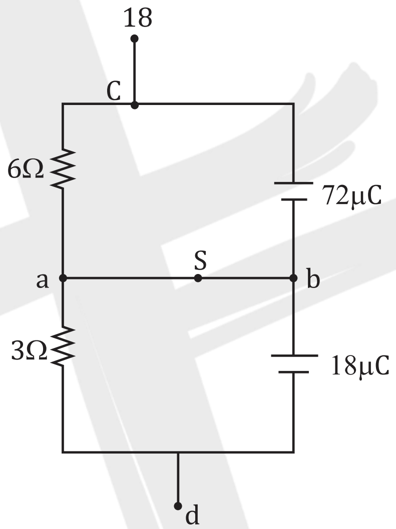
$q = CV = 18 \times 2 = 36\mu\text{F}$

$V_c - V_b = \frac{36}{6} = 6\text{ V}$

$V_b = V_c - 6 = 18 - 6 = 12\text{ V}$

$V_a - V_b = -6\text{ V}\;$ ie $K_1 = 6$





The potential difference across 6Ω resistor will be same as 6μf capacitor.

find potential of ' b ' is 6 V

$q_1' = CV = 6 \times 12 = 72\mu\text{C}$

$q_2' = CV = 3 \times 6 = 18\mu\text{C}.$

charges flow after s is closed.

$q_1 = 72 - 36 = 36\mu\text{C}$

$q_2 = 36 - 18 = 18\mu\text{C}$

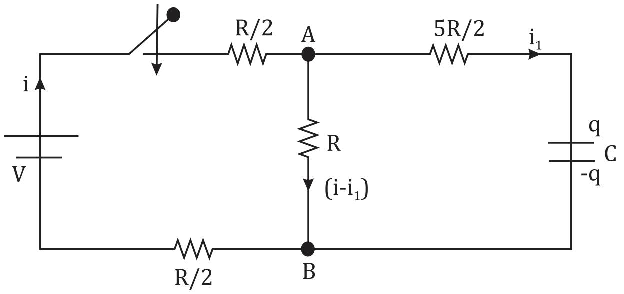
Charges flow through s after it is closed

$\Rightarrow 36 + 18 = 54\mu\text{c}$

ie $k_2 = 54$

so $\;k_1 + k_2 = 6 + 54 = 60$

2. When S is closed, let the current through the battery = i



at time ' t ' if charge on capacitor is q then

$\frac{dq}{dt} = i_1$ ...(i)

By KVL $\Rightarrow V = \frac{R}{2}i + R(l - i_1) + \frac{R}{2}i$

$= 2Ri - R\dot{i}_1$ ...(ii)

And $v = \frac{iR}{2} + \frac{iR}{2} + \frac{5R}{2}i_1 + \frac{q}{c}.$

$= iR + \frac{5R}{2}i_1 + \frac{q}{c}$ ...(iii)

from eq^n (2) $iR = \frac{V + i_1R}{2}$ ...(A)

put (A) in (3).

$$v = \frac{v}{2} + \frac{i_1R}{2} + \frac{5R\dot{i}_1}{2} + \frac{q}{c}$$

$\frac{v}{2} = 3i_1R + q/c$ ...(iv)

$\because\ i_1 = \frac{dq}{dt}$ put it in $eq^n(4)$

$$\frac{v}{2} = 3R\frac{dq}{dt} + \frac{q}{c}.$$

$$\int_0^t \frac{dt}{6Rc} = \int_0^q \frac{dq}{vc - 2q}$$

$$\frac{t}{6RC} = \frac{[\ln vc - 2q]_0^q}{-2}$$

$$\frac{t}{6RC} = \frac{\ln\left[\frac{vc - 2q}{vc}\right]}{-2}$$

$$\frac{-t}{3RC} = \ln\left[\frac{VC - 2q}{VC}\right] \Rightarrow -t/3RC.$$

$Vc - 2q = Vce$

$$q = \frac{vc}{2}\left(1 - e^{-t/3Rc}\right)$$

$\because N = 3$

3. $\because i_1 = \frac{dq}{dt} = \frac{vc}{2}\left[0 - e^{-t/3RC}\left(\frac{-1}{3RC}\right)\right]$

$i_1 = \frac{v}{2R}\left[\frac{e^{-t/3Rc}}{3}\right].$

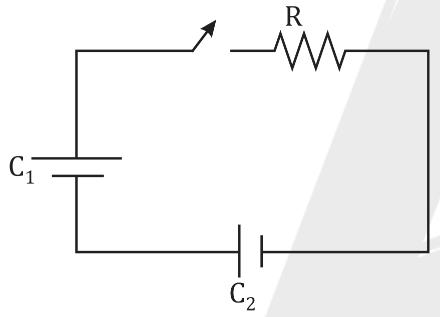
$\because i = \frac{v}{2R} + \frac{i_1}{2}$

$i - i_1 = \frac{v}{2R} - \frac{i_1}{2}$

$(l - i_1) = \frac{v}{2R}\left[1 - \frac{e^{-t/3RC}}{6}\right].$

$2^K - 2 = 6 \Rightarrow K = 3$

4.



Total change $= q_0$

$q_2 = \frac{c_2}{c_1 + c_2} q_0$

$q_2(t) = q_2\left(1 - e^{-t/Rc_{eq}}\right)$

$Rc_{eq} = 80 \times \left[\frac{6\mu f \times 4\mu f}{10\mu F}\right]$

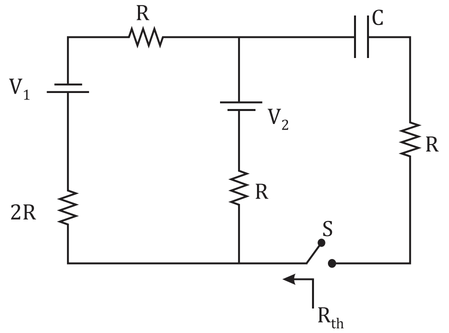
$RC_{eq} = 80 \times \frac{24}{10}\mu = 192\mu \text{ sec}$

$q_2(t = 192\mu \text{ sec}) = \frac{c_2}{c_1 + c_2} q_0 \left[1 - e^{\frac{-192\mu}{192\mu}}\right]$

$= \frac{4\mu}{10\mu}\left(\frac{30e}{e-1}\right)\left[1 - \frac{1}{e}\right] = 12\mu c$

$q_2(t = 192\mu \text{ sec}) = 12\mu c$

5.



$$\frac{1}{R_{th}} = \frac{1}{3R} + \frac{1}{R}$$

$$R_{th} = \frac{3R}{4}$$

$$R_{eq} = \frac{3R}{4} + R = \frac{7R}{4}$$

$\because \tau =$ time constant $= RC.$

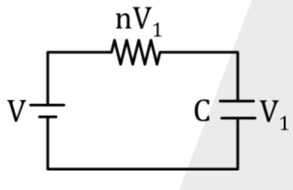
$$\tau = \frac{7RC}{4}$$

6. When switch is closed, the energy stored in the capacitor will be dissipated through resistor.

$$\frac{Q^2}{2C} = 3.6 \times 10^{-3}.$$

$$Q = 120\mu C$$

7.



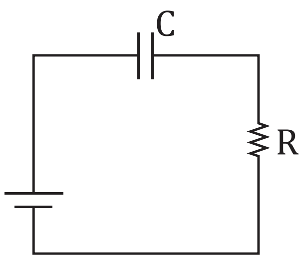
$$nv_1 + v_1 = v \Rightarrow v_1 = \frac{v}{(n+1)}$$

$$v_1 = v[1 - e^{-t/Rc}]$$

$$\frac{v}{n+1} = v[1 - e^{-t/Rc}]$$

$$t = RC \ln\left[\frac{n+1}{n}\right]$$

8.



$$\because I = \frac{V}{R} e^{-t/RC.}$$

$$\text{Log } I = \log\frac{V}{R} - \frac{t}{RC}$$

$y = c + mx$

$\therefore y = \log I,\ c = \log\frac{V}{R},$

$x = t \Rightarrow m = \frac{-1}{RC}$

first slope is greater than second slope ie $\frac{1}{RC_1} > \frac{1}{RC_2}$

ie $c_1 < C_2 \Rightarrow$ capacitance increased.

9. charge on capacitor $q = q_{max}\left(1 - e^{-t/RC}\right)$ As the q_{max} of the both curve is same so both capacitor will be charged to same charge.

curve 2 is taking more time to reach q_{max} . ie $\tau_2 > \tau_1 \Rightarrow C_2R_2 > C_1R_1$

$\because q_{max}$ is same for both curves

$\therefore C_1E_1 = C_2E_2$

$\because C_2$ and C_1 are different so E_2 and E_1 will be different

10. $\because \tau_2 > \tau_1 \Rightarrow c_2R_2 > c_1R_1$

$\frac{R_1}{R_2} < \frac{C_2}{c_1}$