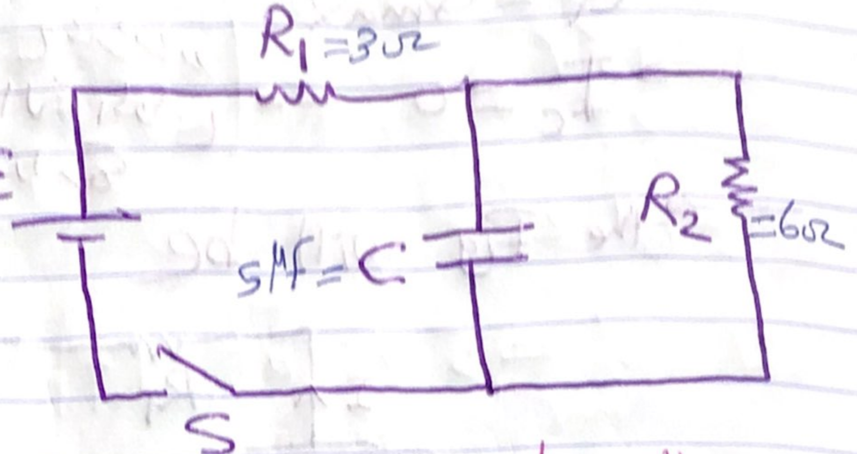
RC - circuit [illegible]

Q1



In the Figure calculate the current in the capacitor

A) when the switch is closed ($t=0$)

B) after very long time

(A) at $t=0$

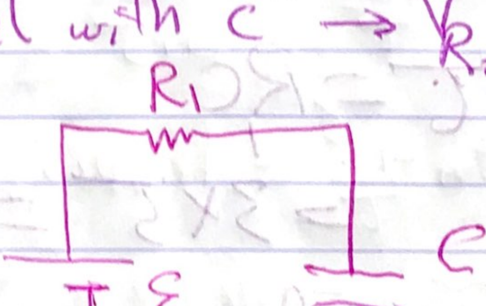
$$Q_i = 0$$

$$V_c = \frac{Q_i}{C} = 0$$

since R_2 in Pallel with c → $V_{R_2} = 0$

→ $I_{R_2} = 0$

→ the fig



$$I_c = \frac{\varepsilon}{R_1} = \frac{12}{3}$$

$$= 4\,A$$

(B) after long time

→ $Q = Q_{max}$ $\qquad I_c = 0$

→ $I_c = 0$ — ى أن الكواح غير موجود
عليك ازالة الكواح
من الدائرة

→ the Fig will be

$$I = \frac{\mathcal{E}}{R_1 + R_2} = \frac{12}{3+6} = \frac{12}{9}\ A$$

(C) Find τ (time constant)

$$\tau = R_1 C$$
$$= 3 \times 5 = 15\ \mu s$$

(D) Find Q_{max} at t

$$Q_{max} = C\mathcal{E} = 5 \times 12 = 60\ \mu C$$

E) Find V_c at $t = 5\ \mu s$

$$V_c = \varepsilon\left(1 - e^{-\frac{t}{\tau}}\right)$$

$$= 12\left(1 - e^{-\frac{5}{15}}\right)$$

$$= 12(1 - 0.716)$$

$$V_c = 3.4 \text{ volt}$$

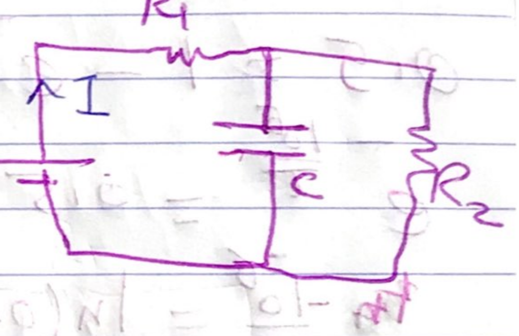
F) Find V_{R_2} at $t = 5\ \mu s$

$\rightarrow V_{R_2} = V_c = 3.4$ volt (Parallel)

(E) Find V_{R_1} at $t = 5\ \mu s$

$$V_{R_1} = 12 - 3.4 = 8.6 \text{ volt}$$

(G) Find I, I_c, I_{R_2} at $t = 5\ \mu s$



$$I = \frac{V_{R_1}}{R_1} = \frac{8.6}{3} = 2.87\ A$$

$$I_{R_2} = \frac{V_{R_2}}{R_2} = \frac{3.4}{6} = 0.57\ A$$

$$I_c = I - I_{R_2} = 2.87 - 0.57 = 2.3\ A$$

or $I = I_i e^{-t/\tau} = 4 e^{-5/15} = 2.87$

charging capacitor

Ex / In Figure

Given

$\varepsilon = 10\,V$

$C = ??$

$R = 10^4\,\Omega$

if $V_c = 5\,V$ at $t = 1\,\mu s$

$$\tau = RC =$$

$$V_c = \varepsilon(1 - e^{-\frac{t}{\tau}})$$

$$5 = 10(1 - e^{-\frac{10^{-6}}{\tau}})$$

$$0.5 = 1 - e^{-\frac{10^{-6}}{\tau}}$$

$$e^{-\frac{10^{-6}}{\tau}} = 0.5$$

$$\frac{-10^{-6}}{\tau} = \ln(0.5) \rightarrow \tau = \frac{-10^{-6}}{\ln 0.5} = 1.44 \times 10^{-6}$$

$$\tau = 1.44 \times 10^{-6}$$

$$RC = 1.44 \times 10^{-6}$$

$$10^4 \times C = 1.44 \times 10^{-6} \rightarrow C = 1.44 \times 10^{-10} = 144\,pF$$

EX Find time needed for a capacitor to have a charge equal 99% from its max charge

$Q = 99\%\, Q_{max} \longrightarrow t = ??\, \tau$

$$Q = Q_{max}\left(1 - e^{-\frac{t}{\tau}}\right)$$

$$0.99\, \cancel{Q_{max}} = \cancel{Q_{max}}\left(1 - e^{-\frac{t}{\tau}}\right)$$

$$e^{-\frac{t}{\tau}} = 0.01$$

$$\ln(0.01) = -\frac{t}{\tau}$$

أخذ ln للطرفين

$$\boxed{t = 4.6\, \tau}$$

$$t = 4.6\, RC$$

Ex During Discharging capacitor

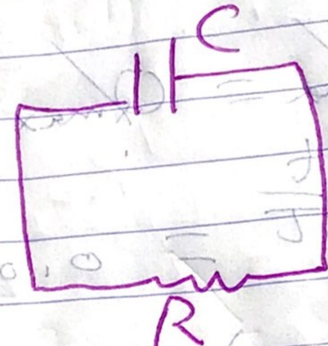
if $V_{c\,max} = 100$ volt

and $V_c = 1$ volt after $t = 10$ sec

Find ① τ ② V_c at $t = 20$ sec

①

$$V_c = V_{max}\, e^{-\frac{t}{\tau}}$$



$$1 = 100\, e^{-\frac{t}{\tau}}$$

$$\ln(0.01) = -\frac{t}{\tau}$$

$$\tau = 2.17 \text{ sec}$$

②

$$V_c = V_{max}\, e^{-\frac{t}{\tau}}$$

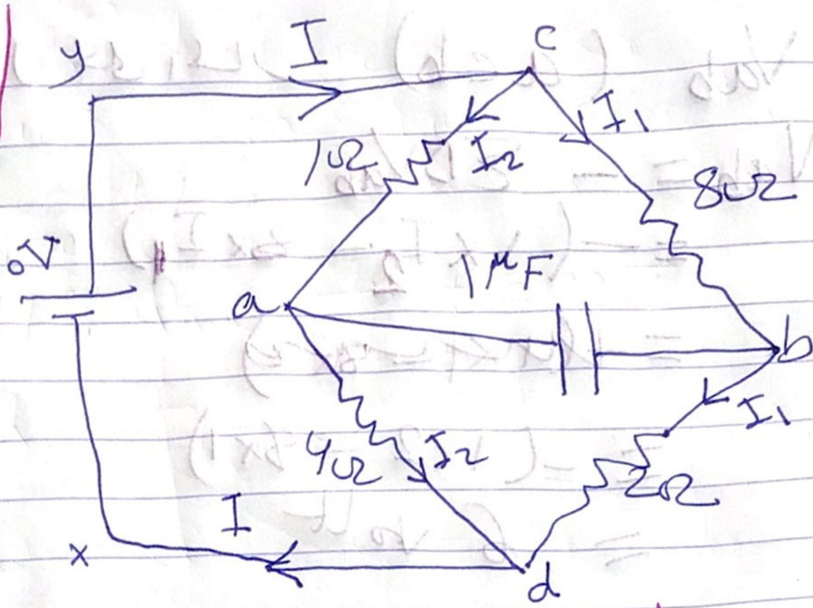
$$= 100\, e^{-\frac{20}{2.17}}$$

$$= 0.01 \text{ volt}$$

43/862

The

.



The circuit in Fig has been connected for a long time

(a) what is the potential difference across the capacitor نجيب

(b) If the battery is dissconnected from the circuit over what time interval does the capacitor discharge to one - tenth its initial voltage

(a) $V_{ab} = ??$

I_2 6 I_1 أول بد

xycbdx

$\Sigma \Delta V = 0$

$10 - 8I_1 - 2I_1 = 0 \rightarrow I_1 = 1A$

$\Sigma \Delta V = 0$ (xycadx)

$10 - 1 \times I_2 - 4 \times I_2 = 0 \Rightarrow I_2 = 2A$

7

V_{ab} (acb)

$$V_{ab} = -\sum \Delta V_{ab}$$

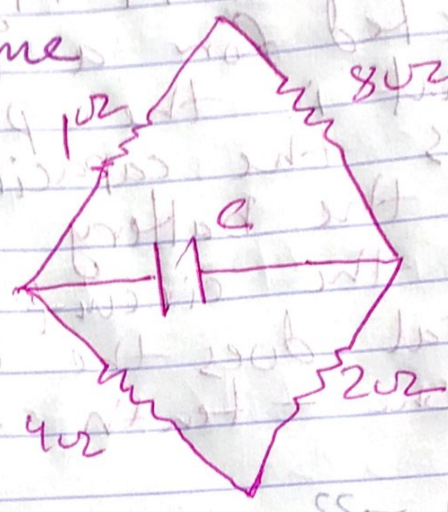
$$= -(1 \times I_2 - 8 \times I_1)$$

$$= \cancel{-(1\times 1 - 8\times 2)}$$

$$= -(1\times 2 - 8\times 1)$$

$$= 6 \text{ volt}$$

after long time

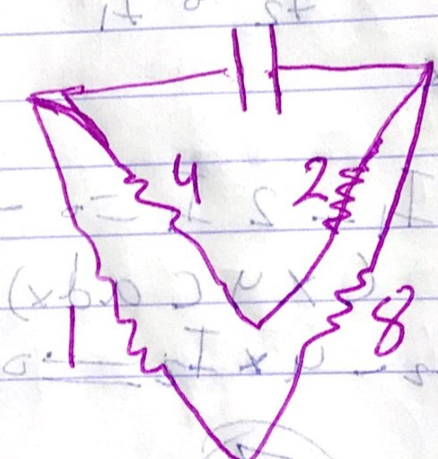


$(1,8) \xrightarrow{S} 9$

$(4,2) \xrightarrow{S} 6$

$(6,9) \xrightarrow{P}$

$$\frac{6\times 9}{6+9} = 3.6$$



at $t=0$

$\rightarrow \Delta V_i = 3.6$

$$\Delta V = \Delta V_i \, e^{-\frac{t}{\tau}}$$

$$\frac{1}{10} \cancel{\Delta V_i} = \cancel{\Delta V_i} \, e^{-\frac{t}{\tau}}$$

$$-\ln 10 = -\frac{t}{\tau}$$

$$\rightarrow \quad t = \tau \times \ln 10$$

$$= 8.29 \ \mu s$$