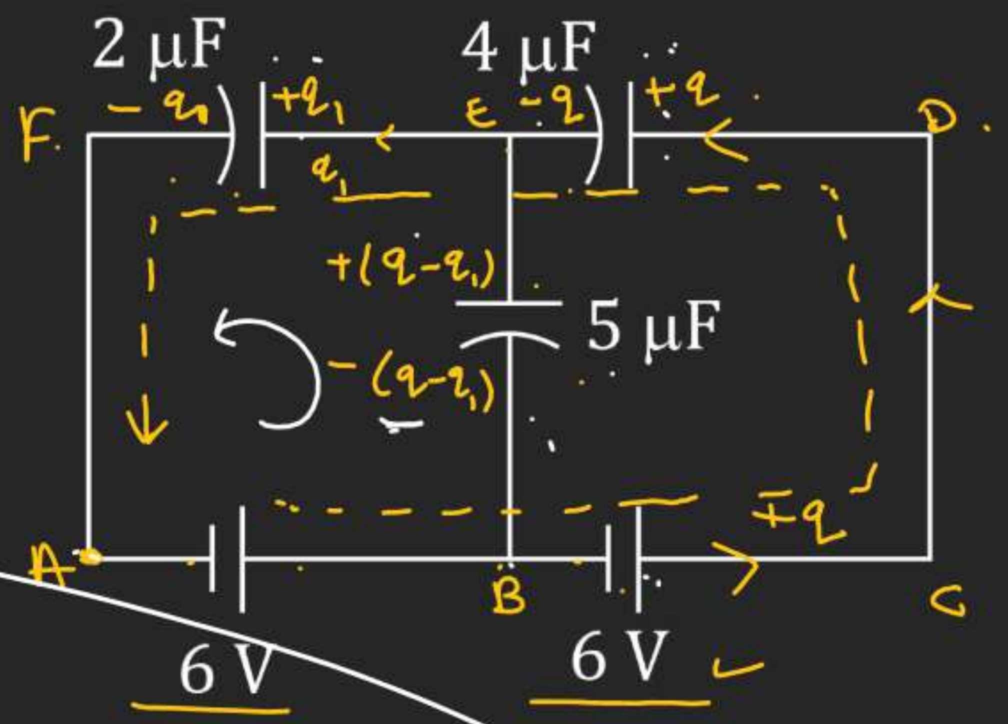
Q.3 Find the charges on the three capacitors shown in figure (a).



(a)

K.V.L in the close loop ABCDEFA

$$6+6-\frac{q}{4}-\frac{q_1}{2}=0$$

$$\frac{q}{4}+\frac{q_1}{2}=12$$

$$\boxed{q+2q_1=48} \quad \text{--- (i)}$$

K.V.L in the closed loop ABEFA

$$+6+\frac{q-q_1}{5}-\frac{q_1}{2}=0$$

$$60+2(q-q_1)-5q_1=0$$

$$60+2q-2q_1-5q_1=0$$

$$7q_1-2q=60 \quad \text{--- (ii)}$$

$2\text{(i)}+\text{(ii)}$

$$2q+4q_1=96 \quad \text{--- (iv)}$$

$$11q_1=156 \Rightarrow q_1=\frac{156}{11}\,\mu C$$

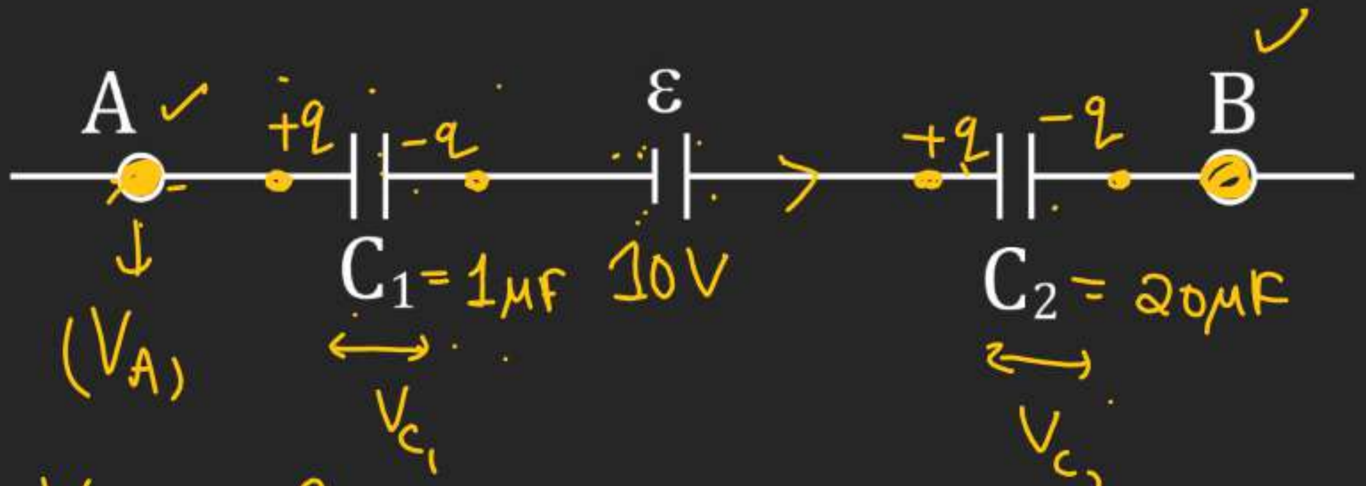
$$q=48-2q_1$$

$$=\left(48-\frac{2\times156}{11}\right)$$

$$=\frac{216}{11}$$

CAPACITOR

Q.6 A circuit has a section AB shown in Fig. The emf of the source equals $\varepsilon = 10\ \text{V}$, the capacitor capacitances are equal to $C_1 = 1.0\mu\text{F}$ and $C_2 = 20\mu\text{F}$, and the potential difference $V_A - V_B = 5.0\ \text{V}$. Find the voltage across each capacitor.



$$V_A - \frac{q}{1} + 10 - \frac{q}{20} = V_B$$

$$(V_A - V_B) + 10 = \left(q + \frac{q}{20}\right)$$

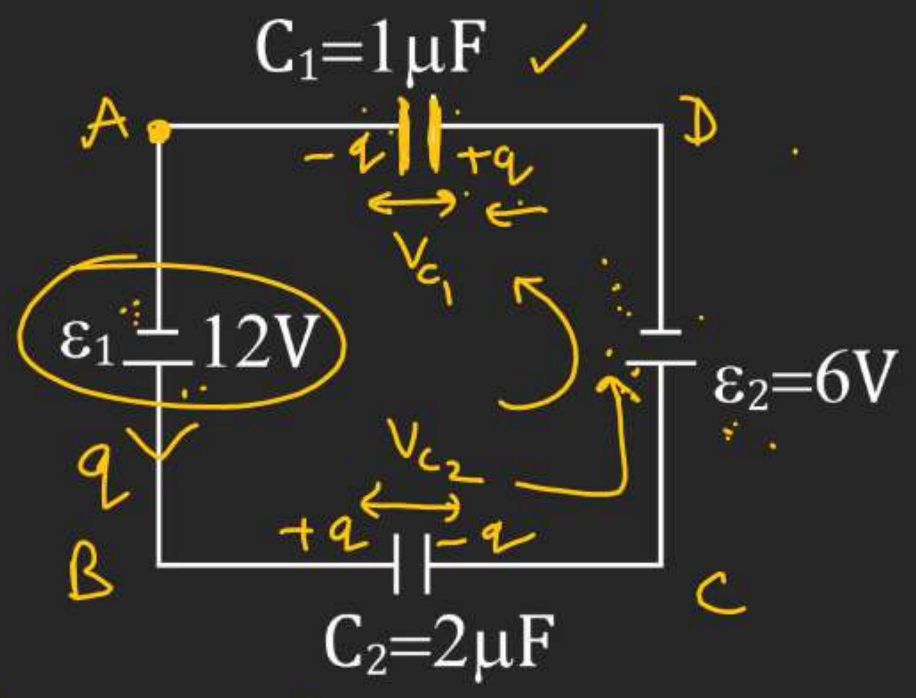
$$15 = \frac{21q}{20}$$

$$q = \left(\frac{\cancel{15}^{\,5} \times 20}{\cancel{21}_{\,7}}\right) = \frac{100}{7}\ \mu C$$

$$V_{C_1} = \frac{q}{C_1} = \frac{100}{7 \times 1} = \frac{100}{7}\ \text{Volt}$$

$$V_{C_2} = \frac{q \to \mu C}{C_2 \to \mu F} = \frac{100}{7 \times 20} = \frac{5}{7}\ \text{Volt}$$

Q.7 In a circuit shown in Fig. find the potential difference between the left and right plates of each capacitor.



K.V.L in Closed loop.

ABCDA

$$12-\frac{q}{2}-6-\frac{q}{1}=0$$

$$6=\left(q+\frac{q}{2}\right)=\frac{3q}{2}$$

$$q=\frac{12}{3}=4\mu C$$

$$V_{c_1}=\frac{4\mu C}{1\mu F}=4\text{ Volt}$$

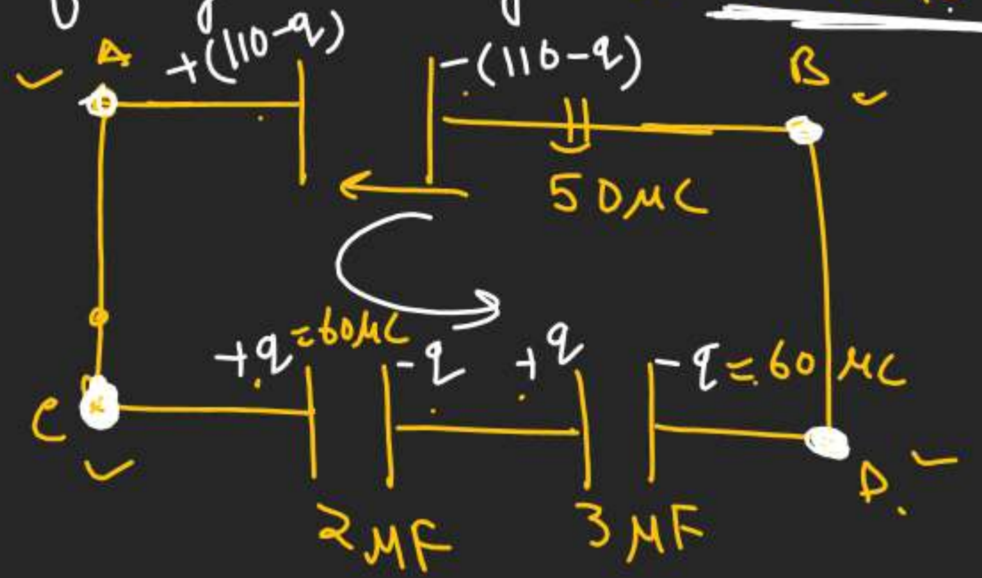
$$V_{c_2}=\frac{q}{2}=\frac{4}{2}=2\text{ Volt}$$

Capacitive Ckt

CAPACITOR

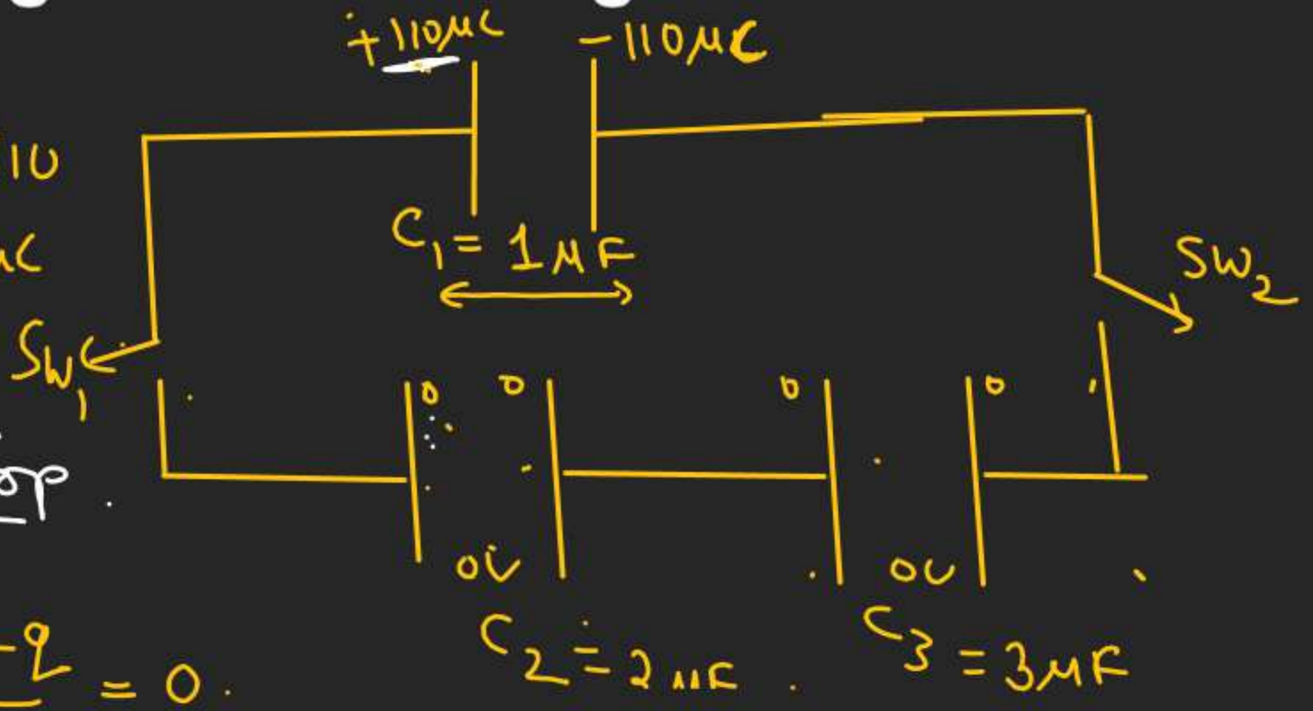
Q.8 A capacitor of capacitance $C_1 = 1.0\mu F$ charged up to a voltage $V = 110\ V$ is connected in parallel to the terminals of a circuit consisting of two uncharged capacitors connected in series and possessing the capacitances $C_2 = 2.0\mu F$ and $C_3 = 3.0\mu F$. What charge will flow through the connecting wires?

At the time of Steady all the Capacitors fully Charged $\Rightarrow$ $V_A - V_B = (V_C - V_D)$



$q_1 = C_1 \times 110$

$q_1 = 110\mu C$



K-V-L in closed loop ACDBA :-

$$-\frac{q}{2} - \frac{q}{3} + \frac{110-q}{1} = 0$$

$$110 = \left(q + \frac{q}{2} + \frac{q}{3}\right) = \frac{11q}{6} \Rightarrow q = 60\mu C$$

Nishant Jindal

CAPACITOR

Heat dissipiated after Switching :→

$$\text{Heat Energy} = (U_f - U_i)$$

$$U_i = \frac{(110)^2 \times 10^{-12}}{2 \times 1 \times 10^{-6}} = \frac{(110)^2}{2} \mu J = \left(\frac{12100}{2}\right) \mu J$$

$$= 6050\ \mu J$$

$$U_f = \left(\frac{(60)^2}{2 \times 2} + \frac{(60)^2}{3 \times 2} + \frac{(50)^2}{1 \times 2}\right) \mu J = \checkmark$$

heat

Nishant Jindal

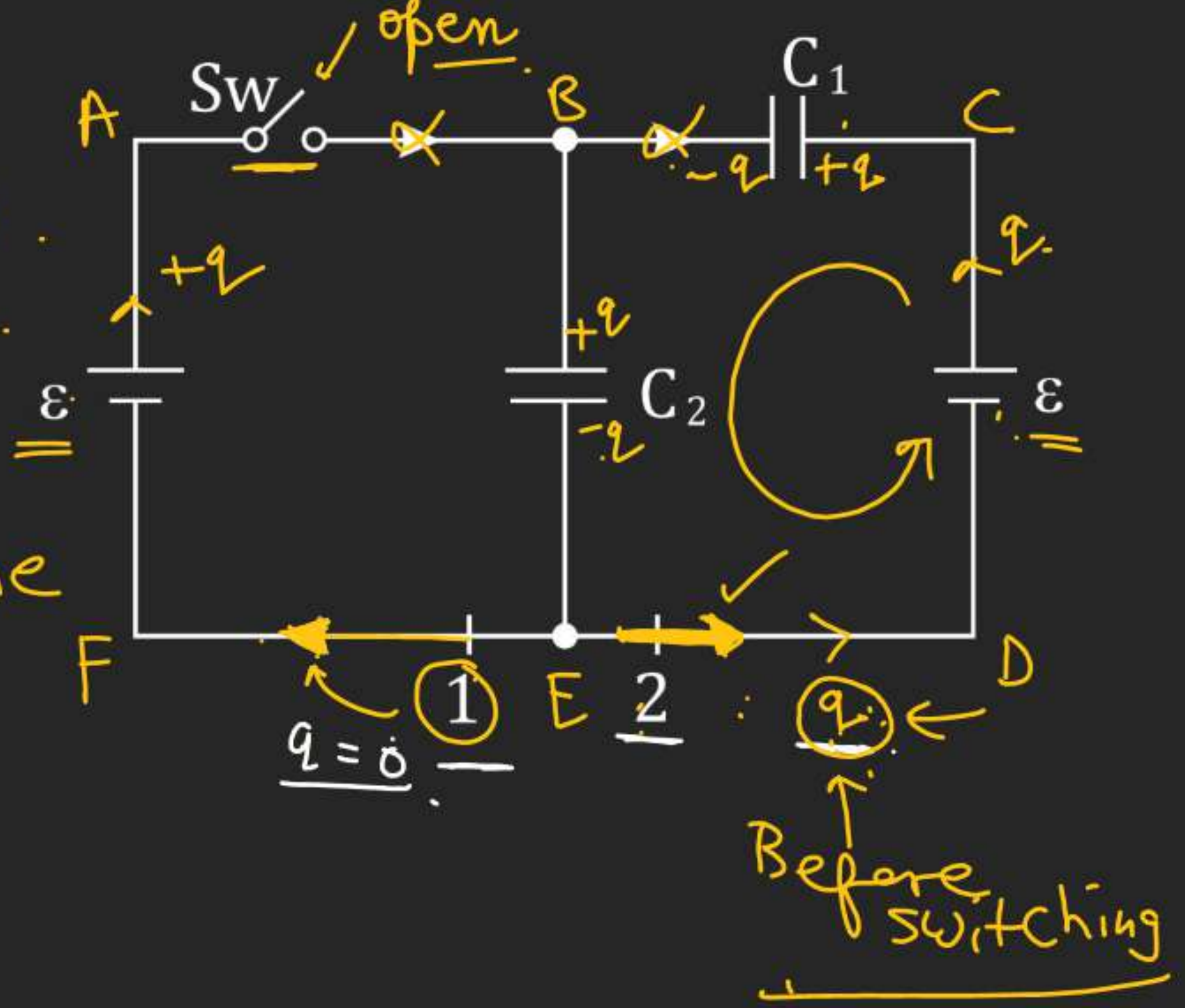
Capacitive Ckt

IRODOV

CAPACITOR

Q.9 What charges will flow after the shorting of the switch Sw in the circuit illustrated in Fig. Through sections 1 and 2 in the directions indicated by the arrows?

⇒ Calculate Charges on the Capacitors before Sw is Closed & after Sw is Closed. the difference in the Charge on the Capacitor flow through the wire



CAPACITOR

Capacitive Ckt

When SW - open

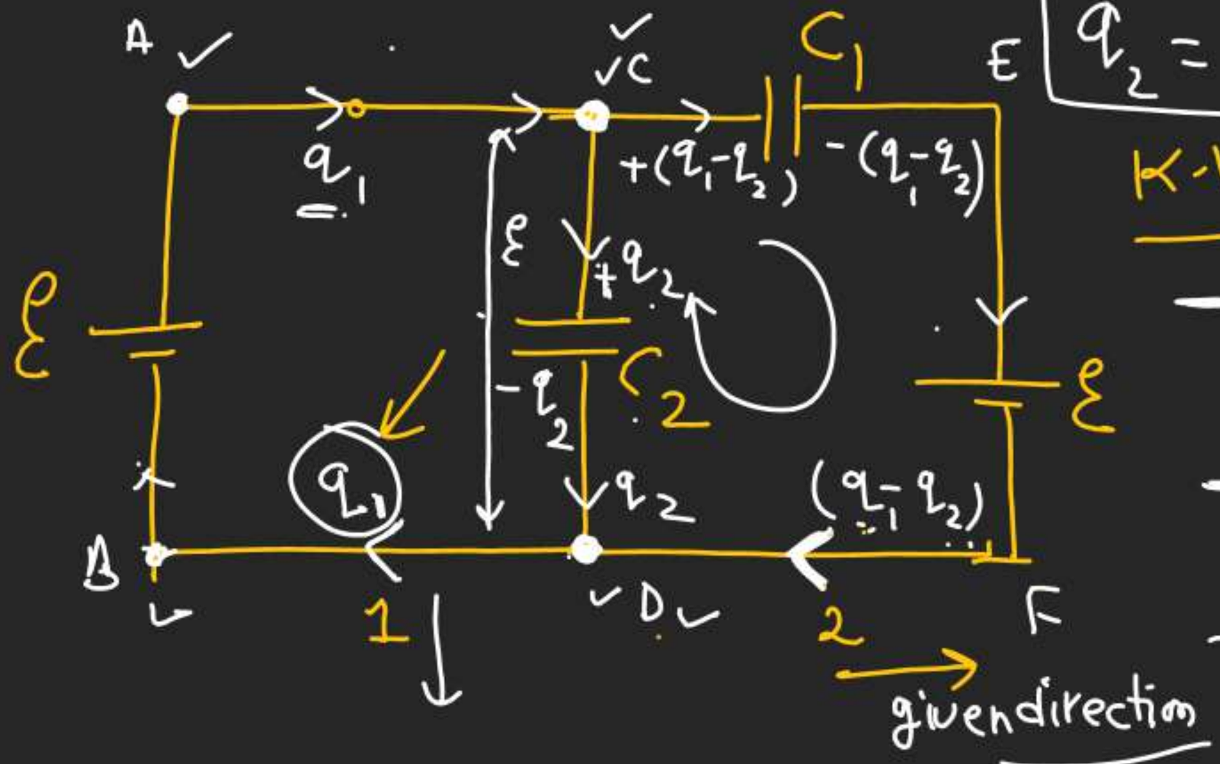
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

$$q = C_{eq} \cdot \mathcal{E}$$

$$q = \left(\frac{C_1 C_2}{C_1 + C_2}\right)\mathcal{E} \leftarrow$$

When sw closed :-



$$\boxed{q_2 = C_2 \mathcal{E}}$$

K.V.L in closed loop CEFD

$$-\left(\frac{q_1 - q_2}{C_1}\right) - \mathcal{E} + \frac{q_2}{C_2} = 0$$

$$-\frac{q_1}{C_1} + \frac{q_2}{C_1} + \frac{q_2}{C_2} = \mathcal{E}$$

$$-\frac{q_1}{C_1} + \frac{C_2\mathcal{E}}{C_1} + \frac{\cancel{C_2}\mathcal{E}}{\cancel{C_2}} = \mathcal{E}$$

$$q_1 = C_2 \mathcal{E}$$

For branch-1

Charge flow $= q_1 = (C_2 \mathcal{E})$

For branch-2

Charge flow $= (q_f) - (q_i)$

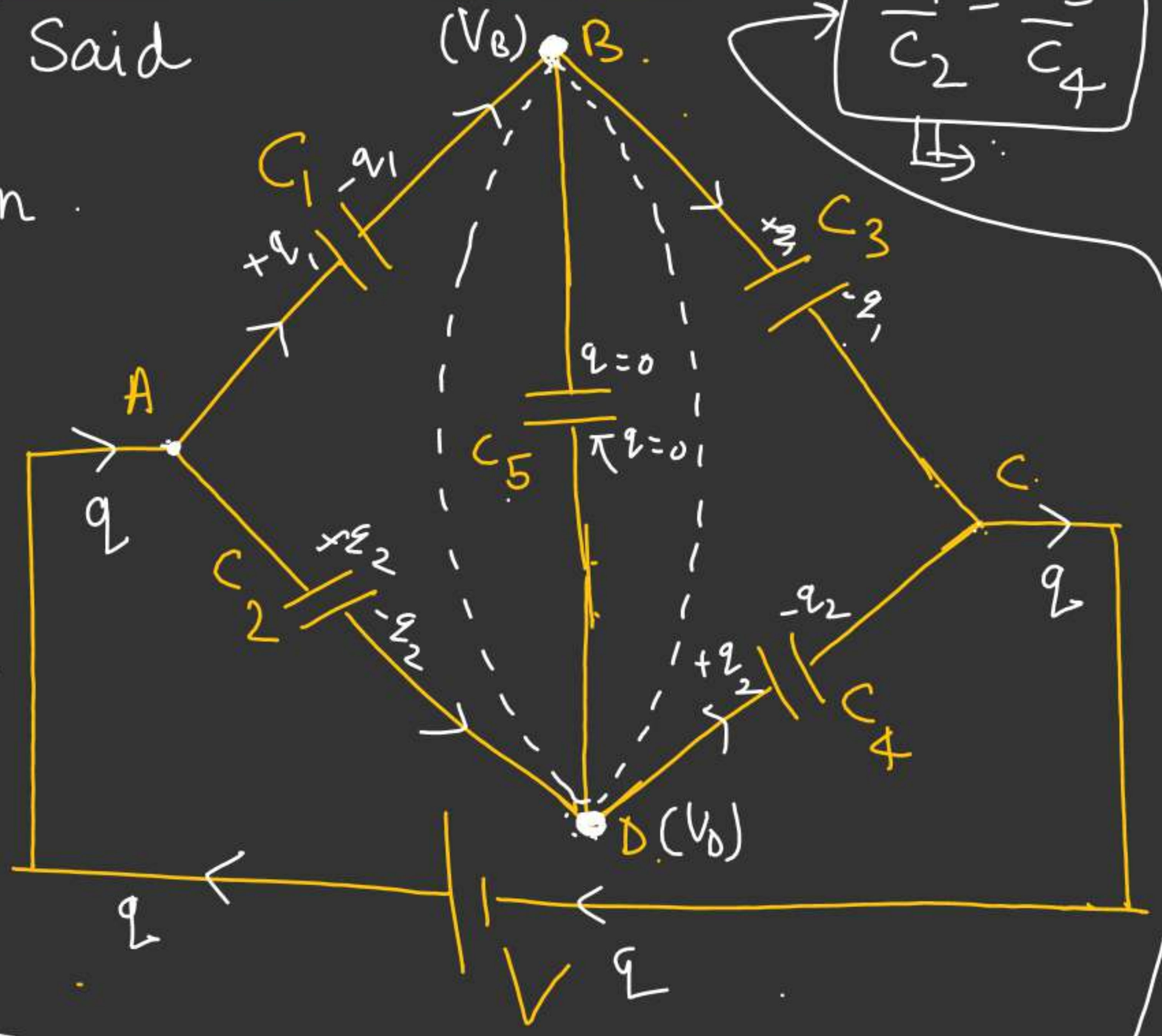
$= -(q_1 - q_2) - q$

$= 0 - q = -\frac{C_1 C_2 \mathcal{E}}{C_1 + C_2}$

Nishant Jindal

(*) Concept of balance (wheat stone bridge) →

(*) A Wheat Stone bridge is Said to be balance when ($V_B = V_D$) ie charge on Capacitor C_5 is zero.



$V_A - V_B = \frac{q_1}{C_1}$

$V_A - V_D = \frac{q_2}{C_2}$

$V_A - V_D = \frac{q_2}{C_2}$

($V_B = V_D$)

$\frac{q_1}{C_1} = \frac{q_2}{C_2}$

$\frac{q_1}{q_2} = \frac{C_1}{C_2}$ — (1)

$V_B - V_C = \frac{q_1}{C_3}$

$V_D - V_C = \frac{q_2}{C_4}$

$\frac{q_1}{C_3} = \frac{q_2}{C_4}$

$\frac{q_1}{q_2} = \frac{C_3}{C_4}$ — (2)

From (1) & (2)

$$\boxed{\frac{C_1}{C_2} = \frac{C_3}{C_4}} \quad (**)$$

Capacitive Ckt H.W. :

CAPACITOR

Q.10 In the circuit shown in Fig. the emf of each battery is equal to $V = 60\ V$, and the capacitor capacitances are equal to $C_1 = 20\mu F$ and $C_2 = 3.0\mu F$. Find the charges which will flow after the shorting of the switch Sw through the section 1, 2 and 3 in the directions indicated by the arrows.