Q1 - 2024 (01 Feb Shift 1)

Two identical capacitors have same capacitance C. One of them is charged to the potential V and other to the potential 2 V. The negative ends of both are connected together. When the positive ends are also joined together, the decrease in energy of the combined system is :

(1) $\frac{1}{4}CV^2$

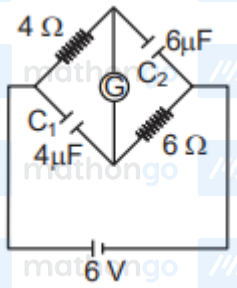
(2) $2CV^2$

(3) $\frac{1}{2}CV^2$

(4) $\frac{3}{4}CV^2$

Q2 - 2024 (01 Feb Shift 2)

A galvanometer (G) of 2Ω resistance is connected in the given circuit. The ratio of charge stored in C_1 and C_2 is :



(1) $\frac{2}{3}$

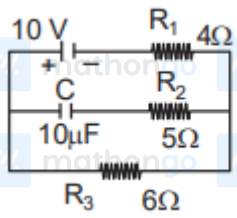
(2) $\frac{3}{2}$

(3) 1

(4) $\frac{1}{2}$

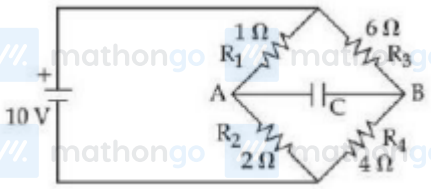
Q3 - 2024 (01 Feb Shift 2)

In an electrical circuit drawn below the amount of charge stored in the capacitor is _____ μC.



Q4 - 2024 (27 Jan Shift 1)

The charge accumulated on the capacitor connected in the following circuit is _____ μC (Given C = 150μF)



Q5 - 2024 (29 Jan Shift 1)

A capacitor of capacitance 100μF is charged to a potential of 12 V and connected to a 6.4mH inductor to produce oscillations. The maximum current in the circuit would be :

(1) 3.2 A

(2) 1.5 A

(3) 2.0 A

(4) 1.2 A

Q6 - 2024 (29 Jan Shift 1)

A 16Ω wire is bend to form a square loop. A 9 V battery with internal resistance 1Ω is connected across one of its sides. If a 4μF capacitor is connected across one of its diagonals, the energy stored by the capacitor will be $\frac{x}{2}\mu$J. where x = _____

Q7 - 2024 (30 Jan Shift 1)

A capacitor of capacitance C and potential V has energy E. It is connected to another capacitor of capacitance 2C and potential 2 V. Then the loss of energy is $\frac{x}{3}E$, where x is_____

Q8 - 2024 (31 Jan Shift 1)

A parallel plate capacitor with plate separation 5 mm is charged up by a battery. It is found that on introducing a dielectric sheet of thickness 2 mm, while keeping the battery connections intact, the capacitor draws 25%

more charge from the battery than before. The dielectric constant of the sheet is_____

Answer Key

Q1 (1)	**Q2** (4)	**Q3** (60)	**Q4** (400)
Q5 (2)	**Q6** (81)	**Q7** (2)	**Q8** (2)

Q1

$$V_C = \frac{q_{net}}{C_{net}} = \frac{CV+2CV}{2C}$$

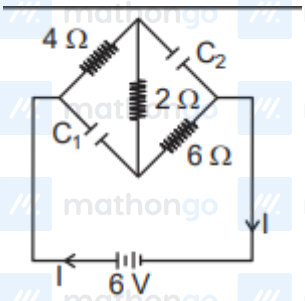
$$V_C = \frac{3\ V}{2}$$

Loss of energy

$$= \frac{1}{2}CV^2 + \frac{1}{2}C(2\ V)^2 - \frac{1}{2}2C\left(\frac{3\ V}{2}\right)^2$$

$$= \left(\frac{CV^2}{4}\right)$$

Q2



In steady state

$$\text{Req} = 12\Omega$$

$$I = \frac{6}{12} = 0.5\ A$$

$$\text{P.D across } C_1 = 3\ V$$

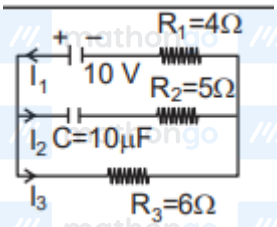
$$\text{P.D acoross } C_2 = 4\ V$$

$$q_1 = C_1 V_1 = 12\mu C$$

$$q_2 = C_2 V_2 = 24\mu C$$

$$\frac{q_1}{q_2} = \frac{1}{2}$$

Q3



In steady state there will be no current in branch of capacitor, so no voltage drop across $R_2 = 5\Omega$

$\mathrm{I}_2 = 0$

$\mathrm{I}_1 = \mathrm{I}_3 = \dfrac{10}{4+6} = 1\ \mathrm{A}$

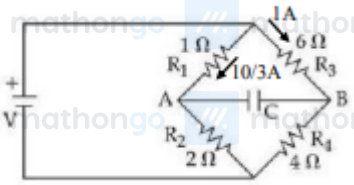
$\mathrm{V}_{\mathrm{R}_3} = \mathrm{V}_\mathrm{c} + \mathrm{V}_{\mathrm{R}_2} \quad \mathrm{V}_{\mathrm{R}_2} = 0$

$\mathrm{I}_3\mathrm{R}_3 = \mathrm{V}_\mathrm{c}$

$\mathrm{V}_\mathrm{c} = 1 \times 6 = 6\ \text{volt}$

$\mathrm{q}_\mathrm{c} = \mathrm{CV}_\mathrm{c} = 10 \times 6 = 60\mu\mathrm{C}$

Q4



$V_A + \dfrac{10}{3}(1) - 6(1) = V_B$

$V_A - V_B = 6 - \dfrac{10}{3} = \dfrac{8}{3}\text{volt}$

$Q = C\,(V_A - V_B)$

$= 150 \times \dfrac{8}{3} = 400\mu\mathrm{C}$

Q5

By energy conservation

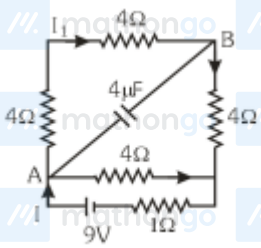
$\dfrac{1}{2}\mathrm{CV}^2 = \dfrac{1}{2}\mathrm{LI}_{\max}^2$

$\mathrm{I}_{\max} = \sqrt{\dfrac{\mathrm{C}}{\mathrm{L}}}\mathrm{V}$

$= \sqrt{\dfrac{100 \times 10^{-6}}{6.4 \times 10^{-3}}} \times 12$

$= \dfrac{12}{8} = \dfrac{3}{2} = 1.5\ \mathrm{A}$

Q6



$$I = \frac{V}{R_{eq}} I = \frac{V}{R_{eq}} = \frac{9}{1+\frac{12\times4}{12+4}} = \frac{9}{4}$$

$$I_1 = \frac{9}{4} \times \frac{4}{16} = \frac{9}{16}$$

$$V_A - V_B = I_1 \times 8 = \frac{9}{16} \times 8 = \frac{9}{2} V$$

$$\therefore U = \frac{1}{2} \times 4 \times \frac{81}{4} \mu \text{J}$$

$$\therefore U = \frac{81}{2} \mu J$$

$$\therefore x = 81$$

Q7

$$\text{Energy loss} = \frac{1}{2} \frac{C_1 C_2}{C_1 + C_2} (V_1 - V_2)^2$$

$$= \frac{2}{3} \cdot E$$

$$\therefore x = 2$$

Q8

Without dielectric

$$\mathrm{Q} = \frac{\mathrm{A} \in_0}{\mathrm{d}} \mathrm{V}$$

with dielectric

$$Q = \frac{A \in_0 V}{d - t + \frac{t}{K}}$$

given

$$\frac{\mathrm{A} \in_0 \mathrm{V}}{\mathrm{d} - \mathrm{t} + \frac{\mathrm{t}}{\mathrm{K}}} = (1.25) \frac{\mathrm{A} \in_0 \mathrm{V}}{\mathrm{d}}$$

$$\Rightarrow 1.25 \left(3 + \frac{2}{\mathrm{K}}\right) = 5$$

$$\Rightarrow \mathrm{K} = 2$$