

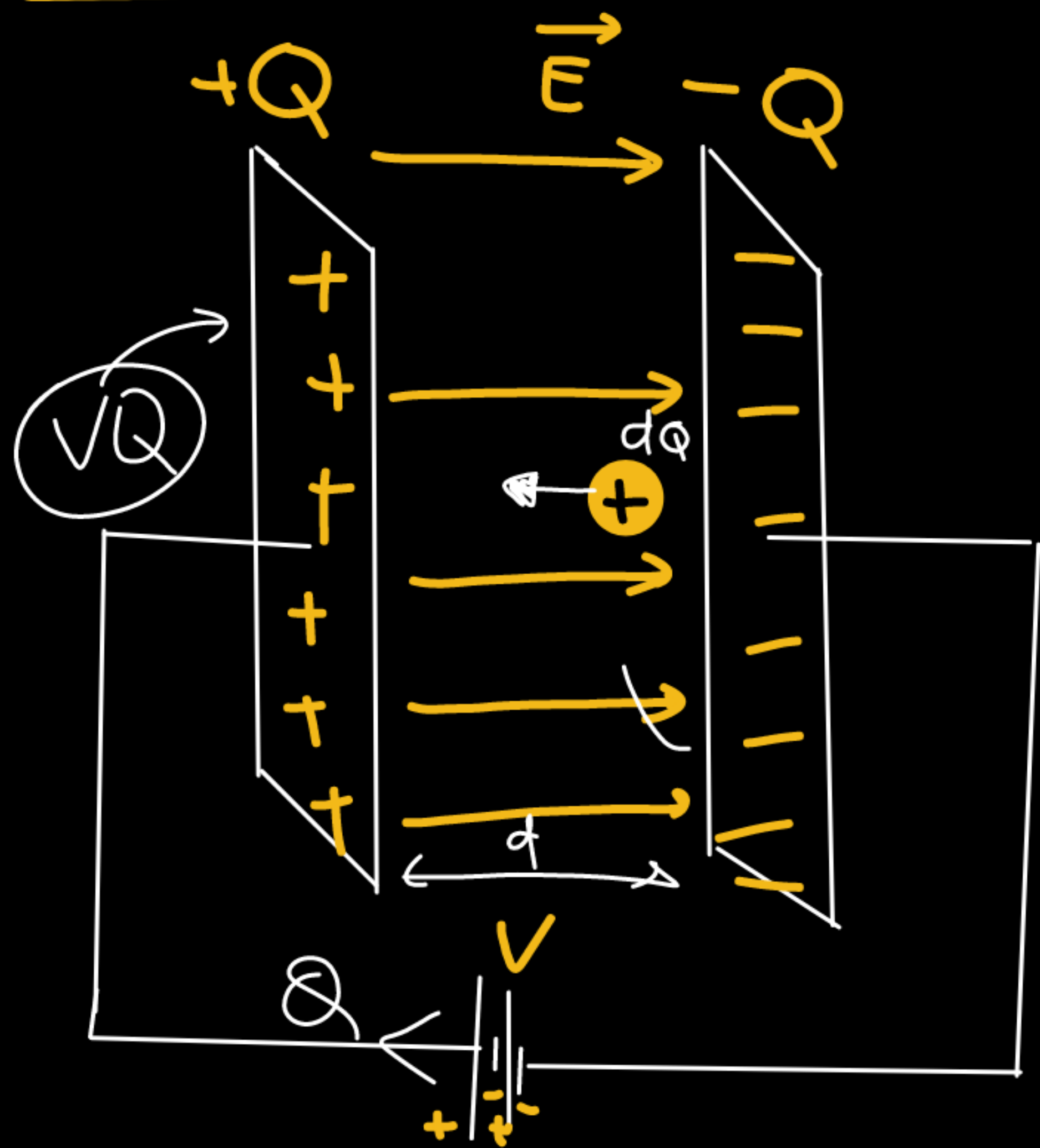
संधारित्र में संचय ऊर्जा

$$V = \frac{W}{Q}$$

Energy stored in a Capacitor

$$W = \frac{Q^2}{2C}$$

$$U = W = \frac{Q^2}{2C}$$



$$V = \frac{dW}{dQ}$$

$$dW = V \cdot dQ \quad \dots \quad \left[V = \frac{Q}{C} \right]$$

$$dW = \frac{Q}{C} dQ$$

दोनों तरफ समाकलन करने पर (Integration)

$$\int dW = \int \frac{Q}{C} dQ$$

$$W = \frac{1}{C} \int Q dQ = \frac{1}{C} \cdot \frac{Q^2}{2}$$

$$\int x dx = \frac{x^2}{2}$$

$$\begin{aligned}U &= \frac{Q^2}{2C} \\&= \frac{(CV)^2}{2C} \quad (Q = CV) \\&= \frac{C^{\cancel{2}} V^2}{2\cancel{C}} = \frac{1}{2} CV^2 \\&= \frac{1}{2} CV \cdot V \\&= \frac{1}{2} QV = \frac{QV}{2}\end{aligned}$$

$$U = \frac{Q^2}{2C} = \frac{1}{2} CV^2$$

$$= \frac{QV}{2}$$

ENERGY DENSITY

ऊर्जा घनत्व

सिंघारित्र के इकाई आयतन में संचय ऊर्जा को ऊर्जा घनत्व कहते हैं इसे u से सूचित किया जाता है

$$u = \frac{\text{संचयित ऊर्जा}}{\text{आयतन}}$$

$$\left(\frac{J}{m^3} \right)$$

$$u = \frac{U}{V}$$

$$u = \frac{Q^2 / 2C}{A \cdot d}$$

$$= \frac{Q^2}{2CAd}$$

$$= \frac{(\sigma A)^2}{2 \cdot \frac{A \epsilon_0}{d} \cdot A d}$$

$$\left[\begin{array}{l} \sigma = \frac{Q}{A} \\ Q = \sigma A \\ C = \frac{A \epsilon_0}{d} \end{array} \right]$$

$$= \frac{\sigma^2 \cancel{A^2}}{2 \cancel{A^2} \epsilon_0}$$

$$= \frac{\sigma^2}{2 \epsilon_0}$$

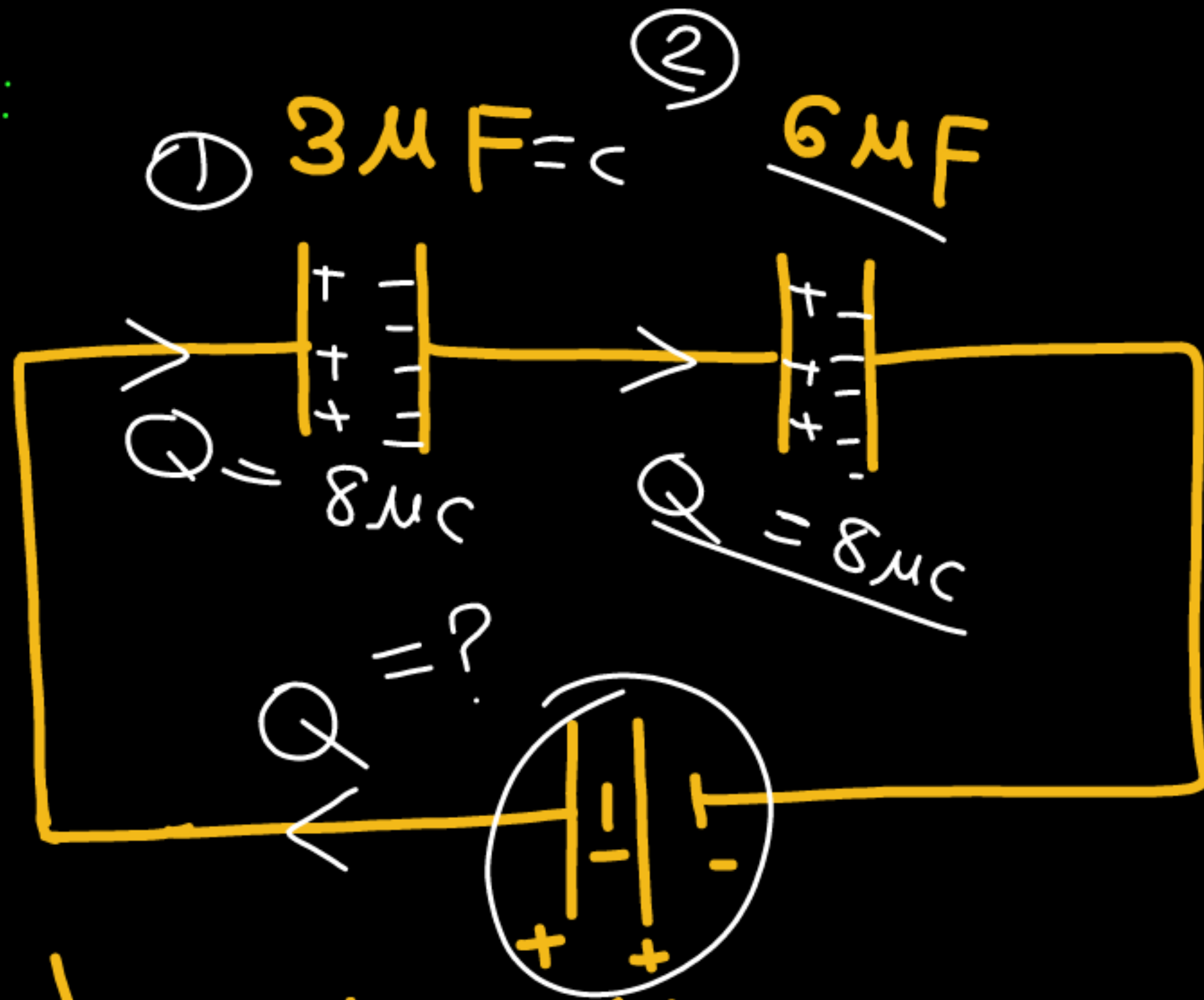
$$\left[\begin{array}{l} E = \frac{\sigma}{\epsilon_0} \\ \sigma = \epsilon_0 E \end{array} \right]$$

$$= \frac{(\epsilon_0 E)^2}{2 \epsilon_0}$$

$$= \frac{\epsilon_0 \cancel{2} E^2}{2 \cancel{2}}$$

$$= \frac{1}{2} \epsilon_0 E^2$$

Example:



(1) प्रत्येक Capacitor कितना
अर्ध संचय किया है।

$$C_{eq} = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{3 \times 6}{3 + 6} = \frac{18}{9} = 2$$

$$C_{eq} = 2\mu F \quad] \quad Q = CV = 8\mu C$$
$$V = 4V$$

कुल संचय ऊर्जा: $= \frac{1}{2} CV^2 = \frac{1}{2} C_{eq} V^2$

$$= \frac{1}{2} \times 2\mu \times 4^2$$

$$= 16\mu J$$

$$= 16 \times 10^{-6} J$$

$$① U = \frac{Q^2}{2C} = \frac{8\mu \times 8\mu}{2 \times 6\mu} = \frac{32\mu}{6} = 16\mu J$$

$$\begin{aligned}U_2 &= \frac{Q^2}{2C} = \frac{8\mu \times 8\mu}{6\mu} \\&= \frac{64\mu}{6} \\&= \boxed{\frac{32}{3} \mu\text{J}}\end{aligned}$$

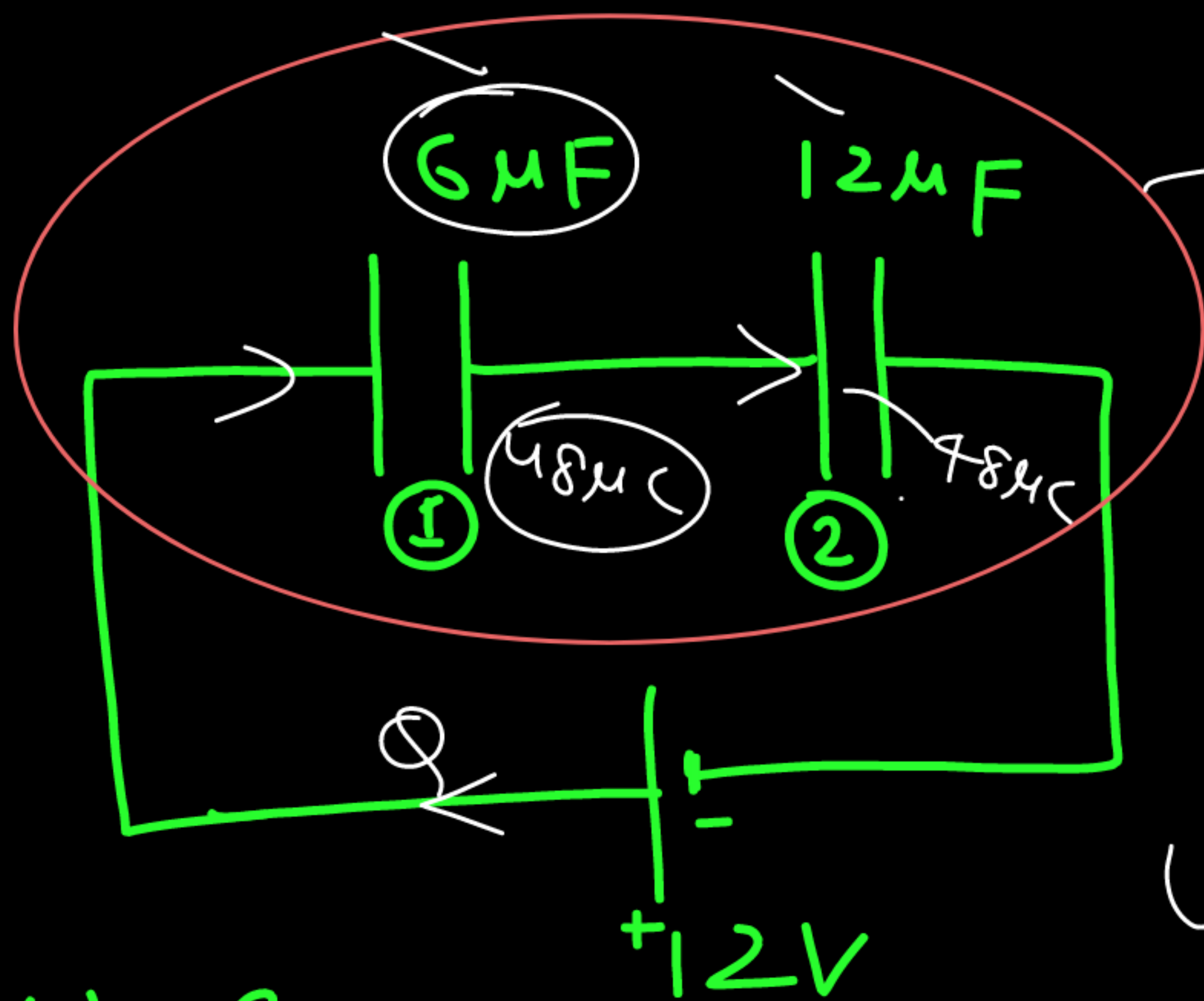
$$U_1 + U_2 = U$$

$$U = \frac{16\mu}{3} + \frac{32\mu}{3}$$

$$= \frac{48\mu}{3} \text{ J}$$

$$= \boxed{16\mu\text{J}}$$

10x



$$U_1 = ?$$

$$U_2 = ?$$

$$C_{eq} = \frac{12 \times 6}{12 + 6} = \frac{72}{18} = 4 \mu F$$

$$V = 12V$$

$$Q = CV$$

$$= 4 \mu \times 12 = 48 \mu C$$

$$U_1 = \frac{Q^2}{2C} = \frac{48 \mu \times 48 \mu}{2 \times 6 \mu}$$

$$= 192 \mu J$$