Ans.1

$$i(t) = \begin{cases} \frac{1}{2} e^{-5t}, & t \geq 6 \\ 0, & t < 6 \end{cases}$$

$$Q = \int i(t)\,dt = \int_6^\infty \frac{1}{2} e^{-5t} \Rightarrow -\frac{1}{5} \times \frac{1}{2} \Big| e^{-5t} \Big|_6^\infty \Rightarrow \underline{0.1\, e^{-30}\, C}$$

Ans.2

a) $I = -C \frac{dV_c}{dt}$ (since capacitor is discharging).

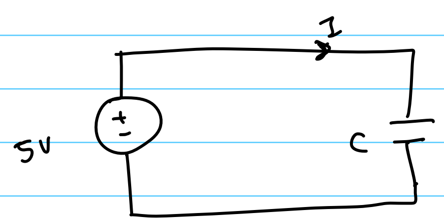
$$-\frac{I}{C} = \frac{dV_c}{dt}$$

$$\frac{dV_c}{dt} = -\frac{2}{2.5} = -\frac{4}{5} \frac{V}{s} \quad (\text{volts}/\text{sec})$$

b) $V_R(t)\Big|_{t=t_0} = i(t) \times R = 2 \times 2 = 4V$

c) $Q = CV = 2.5 \times 4 \Rightarrow 10\,C \quad (V_c(t) = V_R(t))$

Ans.3

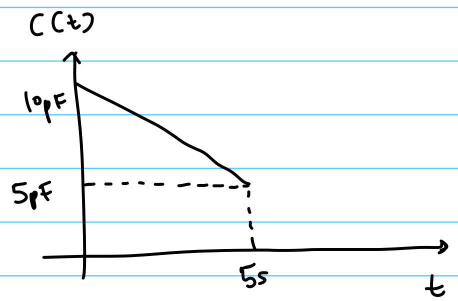



$$Q = CV$$

$$I = \frac{d}{dt}(CV)$$

$$I = V\frac{dC}{dt} + \cancel{C\frac{dV}{dt}} \rightarrow 0$$

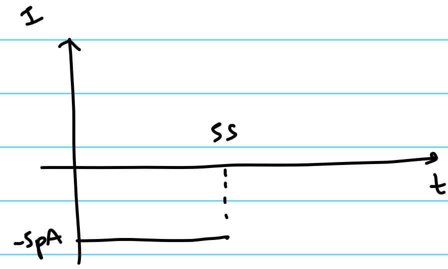
$$I = V\frac{dC}{dt}$$



a) $I = V \frac{dC}{dt}$

$\Rightarrow 5 \times \left(\frac{-5p}{5}\right)$

$\Rightarrow -5\,pA$




b) $E_c \Big|_{initial} \Rightarrow \frac{1}{2} CV^2 \Rightarrow \frac{1}{2} \times 10p \times 5^2 \Rightarrow 125\,pJ$

c) $E_c \Big|_{final} \Rightarrow \frac{1}{2} CV^2 = \frac{1}{2} \times 5p \times 5^2 \Rightarrow 62.5\,pJ$

d) Energy removed from capacitor $= (125 - 62.5)\,pJ = 62.5\,pJ$

e) Energy is delivered to the voltage source.

$$E = \int P\,dt = \int VI\,dt \Rightarrow \int V \cdot V \frac{dC}{dt} \times dt$$

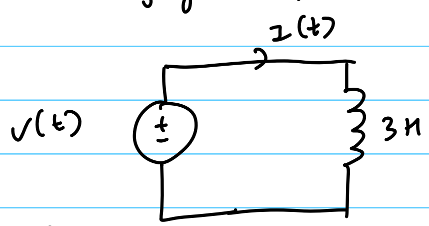
$$\Rightarrow \underline{\underline{V^2 \times \Delta C}}$$

Energy delivered to the voltage Source $\Rightarrow 25 \times 5p = 125\,pJ$

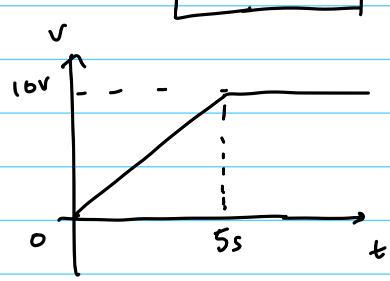
f) Yes, energy is still conserved. The difference in energy can be accounted by work done in changing the capacitance from 10pF to 5pF.

Ans. 4

a)




$$v(t) = \begin{cases} 2t \text{ Volts} & 0 < t \leq 5 \\ 10 \text{ volts} & t > 5 \end{cases}$$




$V = L \frac{di}{dt}$

$I(t) = \int_0^t \frac{V}{L} dt$

$$I(t) = \begin{cases} \frac{t^2}{3} & 0 < t \leq 5 \\ \frac{10t}{3} + C & t > 5 \end{cases}$$

find c @ t = 5

$$\frac{5^2}{3} = \frac{10 \times 5 + c}{3}$$

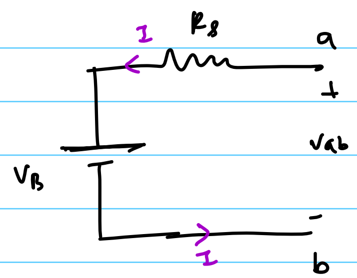
$$c = -\frac{25}{3}$$

$$\boxed{I(t) = \begin{cases} \frac{t^2}{3} & 0 < t \leq 5 \\ \frac{10t}{3} - \frac{25}{3} & t > 5 \end{cases}}$$

b) $E_L = \frac{1}{2} L I^2$

$$E_L(t) = \begin{cases} \frac{1}{2} t^4 & 0 < t \leq 5 \\ \frac{1}{2}(10t - 25)^2 & t > 5 \end{cases}$$

Ans. 5




$$V_a - IR_s - V_B = V_b$$

$$V_a - V_b = V_B + IR_s$$

$$\boxed{V_{ab} = V_B + IR_s}$$