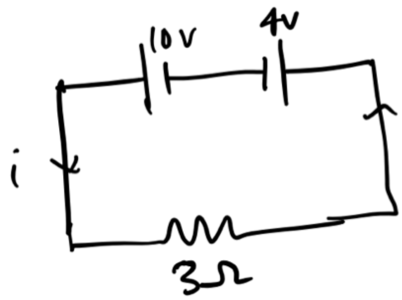
Ans.1)



$i = \frac{10-4}{3} = 2A$

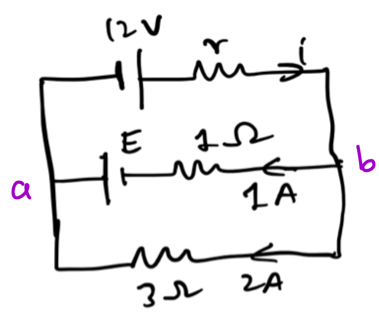
power $= V.I = i^2R = \frac{V^2}{R}$

a) Power supplied by 10V battery => $10 \times 2 = 20W$

b) Power absorbed by 4V battery => $4 \times 2 = 8W$

c) Power dissipated in 3Ω resistor => i^2R => $4 \times 3 = 12W$

Ans.2



$i = 1+2 = 3A$

$V_{ab} = -12 + ir = E - 1 = -6$

$E - 1 = -6$; $\underline{\underline{E = -5V}}$

$-12 + ir = -6$

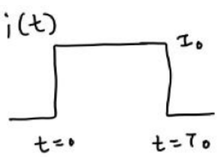
$i = 3A$; $-12 + 3r = -6$; $3r = 6$; $\underline{\underline{r = 2\Omega}}$

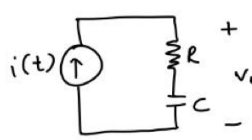
Power supplied by 12V battery => $12 \times 3 = 36W$

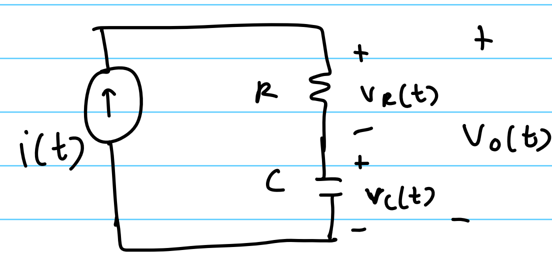
power dissipated in the 3Ω resistor => i^2R => $2^2 \times 3$ => $12W$

Ans.3

a)

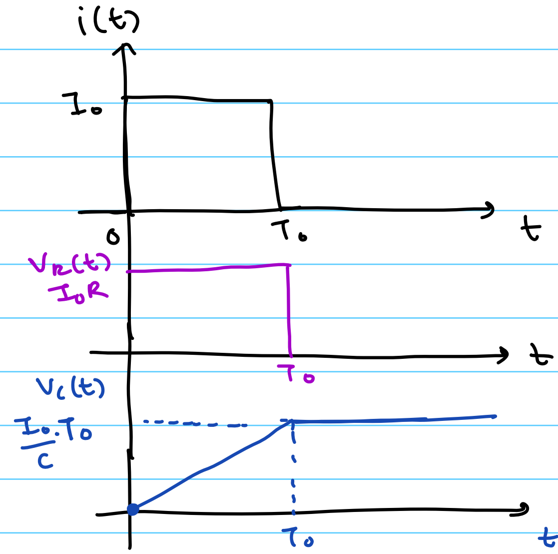




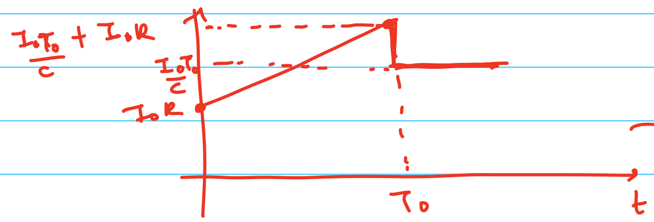


For a capacitor $I = C\frac{dv}{dt}$

$$V = \int \frac{I}{C}\,dt \;;$$

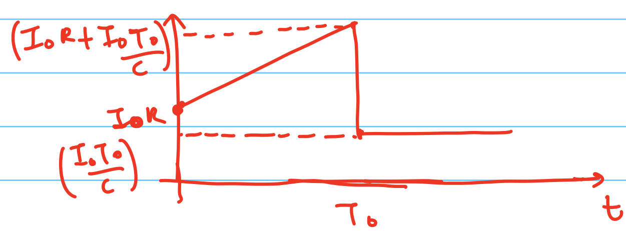


$$\boxed{V_o(t) = V_c(t) + V_R(t)}$$

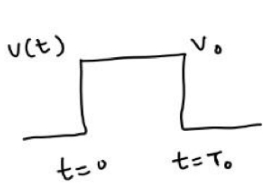


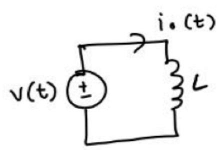
Assuming $\frac{I_o T_o}{C} > I_o R$

else if $\frac{I_o T_o}{C} < I_o R$



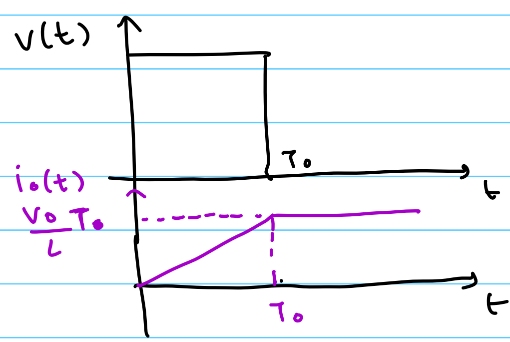
b)





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

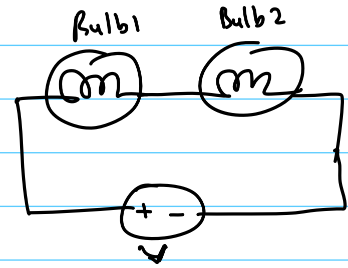
$$i = \int \frac{v}{L}\,dt$$



Ans.4 Bulb1 $\rightarrow (P_1, V) \rightarrow$ Resistance $= \dfrac{V^2}{P_1}$

Bulb2 $\rightarrow (P_2, V) \rightarrow$ Resistance $= \dfrac{V^2}{P_2}$

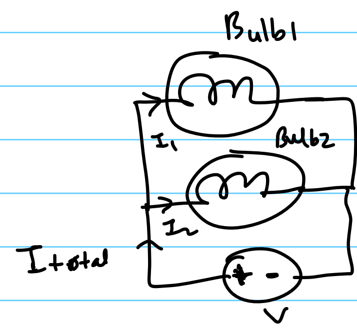
a) In series :- resistances add



$$R_{eff} \Rightarrow \frac{V^2}{P_1} + \frac{V^2}{P_2}$$

$$\text{Power consumed} \Rightarrow \frac{V^2}{R_{eff}} \Rightarrow \frac{V^2}{\frac{V^2}{P_1} + \frac{V^2}{P_2}} \Rightarrow \frac{P_1 P_2}{P_1 + P_2}$$

b) In parallel :- currents add



$$I_{total} = I_1 + I_2 = \frac{P_1}{V} + \frac{P_2}{V}$$

$$\text{power consumed} \Rightarrow V \cdot I_{total} \Rightarrow V \cdot \left[\frac{P_1}{V} + \frac{P_2}{V}\right] = P_1 + P_2$$

Ans.5 a) In Series

$$R_{series} \Rightarrow R_{10}(1 + \alpha_1 T) + R_{20}(1 + \alpha_2 T)$$

$$\Rightarrow R_{10} + R_{20} + R_{10}\alpha_1 T + R_{20}\alpha_2 T$$

$$\Rightarrow R_{10} + R_{20}\left[1 + \frac{R_{10}\alpha_1 T + R_{20}\alpha_2 T}{R_{10} + R_{20}}\right]$$

$$\text{effective temp coeff.} \Rightarrow \frac{R_{10}\alpha_1 + R_{20}\alpha_2}{R_{10} + R_{20}}$$

b) In parallel, let effective resistance be

$$R_{par}(T) = R_{par0}(1+\alpha_{par}T)$$

$$\frac{1}{R_{par0}(1+\alpha_{par}T)} = \frac{1}{R_{10}(1+\alpha_1 T)} + \frac{1}{R_{20}(1+\alpha_2 T)}$$

Using binomial expansion, assuming $|\alpha T| \ll 1$

$$\frac{1-\alpha_{par}T}{R_{par0}} = \frac{1-\alpha_1 T}{R_{10}} + \frac{1-\alpha_2 T}{R_{20}}$$

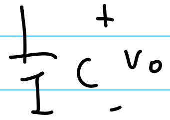
$$\frac{1}{R_{par0}} - \frac{\alpha_{par}T}{R_{par0}} = \frac{1}{R_{10}} + \frac{1}{R_{20}} - \left(\frac{\alpha_1 T}{R_{10}} + \frac{\alpha_2 T}{R_{20}}\right)$$

We know that $R_{par0} = \frac{R_{10}R_{20}}{R_{10}+R_{20}}$

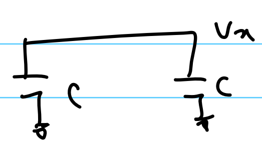
$$\frac{\alpha_{par}T(R_{10}+R_{20})}{R_{10}R_{20}} = \frac{\alpha_1 T \cdot R_{20} + \alpha_2 T R_{10}}{R_{10} \cdot R_{20}}$$

$$\boxed{\alpha_{par} \Rightarrow \frac{\alpha_1 R_{20} + \alpha_2 R_{10}}{R_{10} + R_{20}}}$$

Ans.6

1) 

$Q_{initial} = CV_0$



Assuming the potential after closing the switch is V_x.

From charge conservation

$$C v_0 = 2 C v_x \; ; \quad \boxed{v_x = \frac{v_0}{2}}$$

2) Initial energy $= \frac{1}{2} C v_0^2$

Final energy $\Rightarrow 2 \times \frac{1}{2} C \left(\frac{v_0}{2}\right)^2 \Rightarrow \frac{1}{4} C v_0^2$

$$\boxed{\text{Energy lost} \Rightarrow \frac{1}{2} C v_0^2 - \frac{1}{4} C v_0^2 = \frac{1}{4} C v_0^2}$$