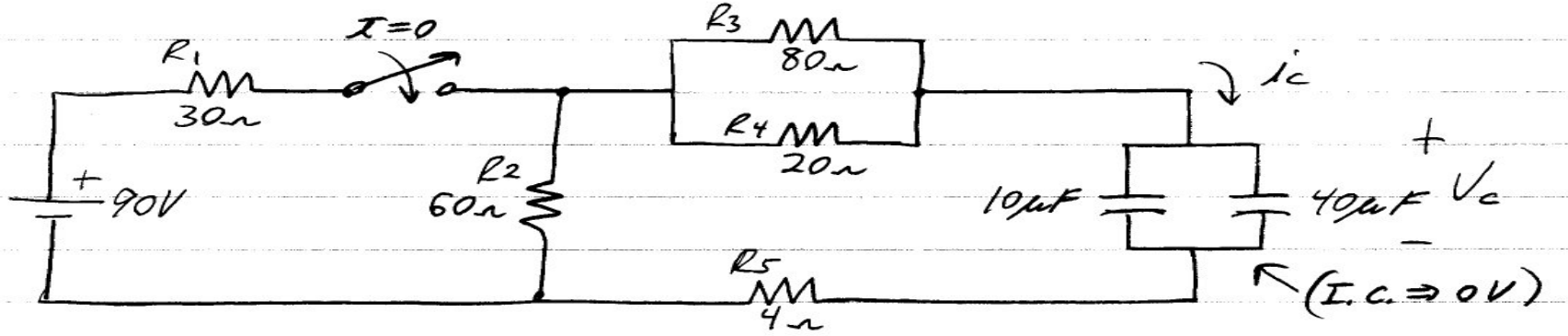
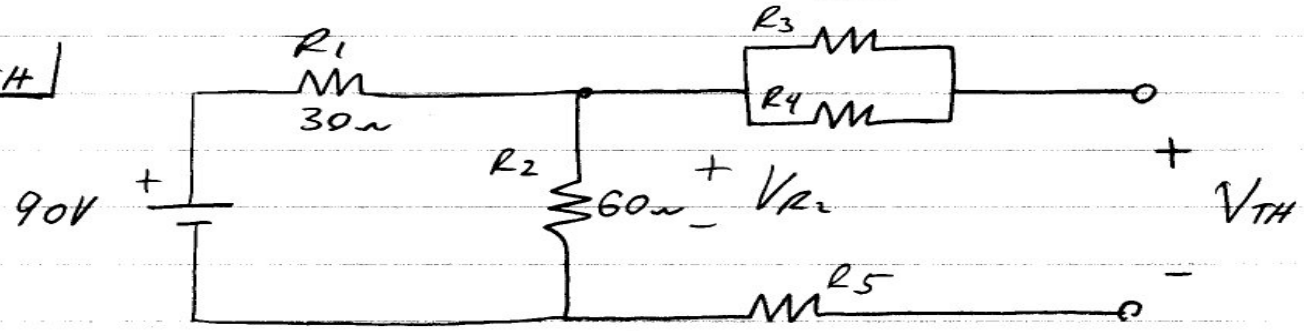
(EXAMPLE 3) Find $V_c$ + Q at $t = 1ms$ + $t = 1$ hour:




THÉVENIN EQUIVALENT SEEN BY $C_{EQ} = 50\mu F$:
(FOR $t \geq 0$)

$$R_{TH} = (R_1 // R_2) + (R_3 // R_4) + R_5$$
$$= 20\Omega + 16\Omega + 4\Omega = \underline{\underline{40\Omega}}$$

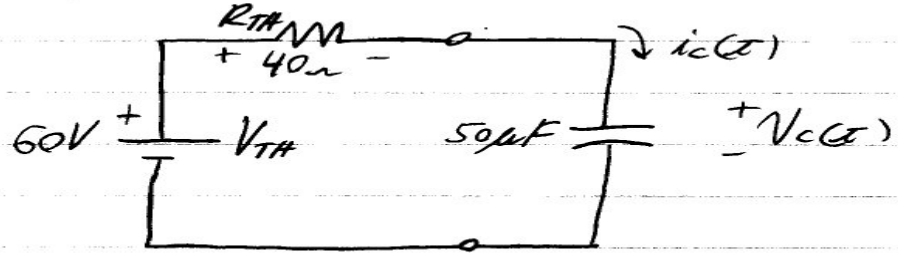
$V_{TH}$




NO CURRENT THROUGH $R_3, R_4$ OR $R_5$

$$\therefore V_{TH} = V_{R_2} = 90V\left(\frac{60\Omega}{60\Omega + 30\Omega}\right) = \underline{\underline{60V}}$$

WE HAVE C FOR $t \geq 0$):




$$i_c(t) = i_{cMAX}\, e^{-t/\tau}$$

$$i_{cMAX} = \frac{(60-0)V}{40\Omega} = \underline{1.5A}$$

$$\tau = R_{TH} \cdot C_{EQ} = (40\Omega)(50\mu F) = \underline{2ms}$$

$$\therefore\ \underline{i_c(t) = 1.5\, e^{\frac{-t}{2\times10^{-3}}}\ A,\ t > 0}$$

FIND $v_c(t)$

KVL: $V_{TH} - i_c(t) R_{TH} - v_c(t) = 0$

$$\therefore\ v_c(t) = V_{TH} - i_c(t) R_{TH}$$

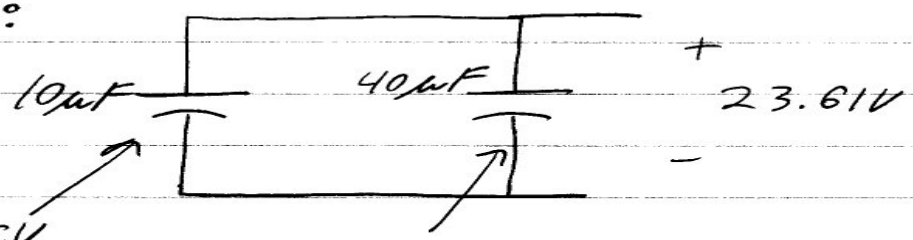
$$v_c(t) = 60 - 60\, e^{-\frac{t}{2\times10^{-3}}}$$

OR

$$\boxed{v_c(t) = 60\left(1 - e^{\frac{-t}{2\times10^{-3}}}\right)\ V,\ t \geq 0}$$

@ $t = 1ms$: $v_c(1\times10^{-3}) = 60\left(1 - e^{\frac{-1\times10^{-3}}{2\times10^{-3}}}\right) = \boxed{23.61V}$

WE HAVE:




$Q = CV$

$= \boxed{236.1\mu C}$

$\therefore\ Q = CV$

$\boxed{Q = 944.4\mu C}$