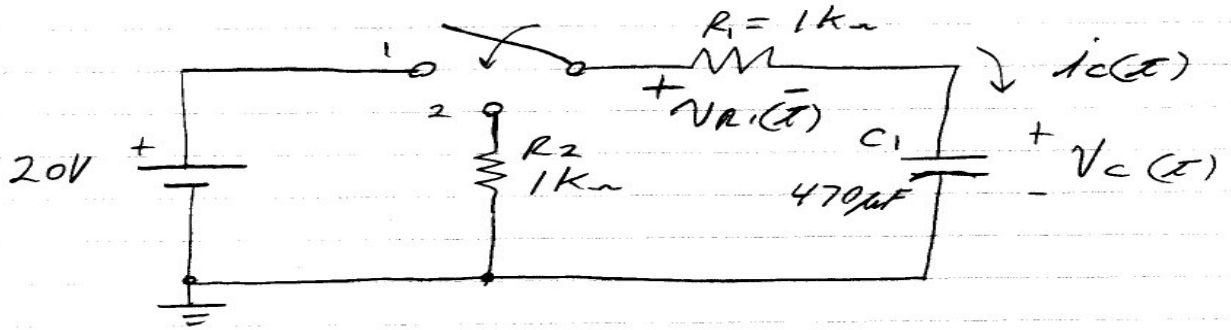
SIMPLE CAPACITOR CIRCUIT (CHARGE / DISCHARGE)

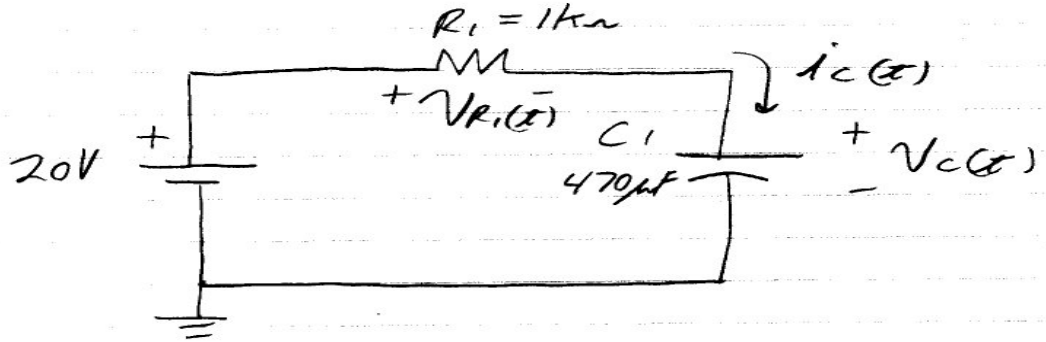


AT $t = 0$, SW → POSITION 1
AT $t = 10$ SEC, SW → POSITION 2

FIND:
a) τ.
b) $i_C(t)$
c) $v_{R_1}(t)$
d) $v_C(t)$
e) t FOR $v_C(t) = 10V$

} FOR BOTH CHARGE & DISCHARGE

CHARGE CIRCUIT



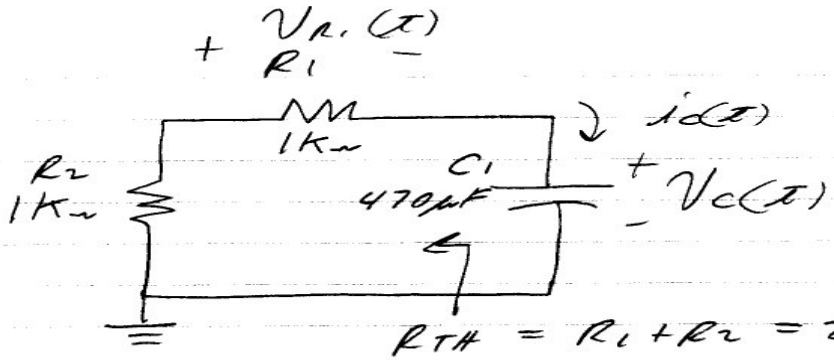
$$\tau = R_{TH} \cdot C_T = R_1 C_1 = (1k\Omega)(470\mu F) = \boxed{0.47 \text{ SEC}}$$

$$i_C(t) = i_{CMAX} \, e^{-t/\tau}$$

$$i_{CMAX} = \frac{20V}{R_1} = \frac{20V}{1k\Omega} = \underline{20mA}$$

DISCHARGE

VALID FOR $t > 10$



I.C.
$V_C(t=10) = 20V$

$R_{TH} = R_1 + R_2 = 2K\Omega$

$\tau = R_{TH} \cdot C_T = (2K\Omega)(470\mu F) = \boxed{940ms}$

$i_C(t) = -i_{CMAX}\, e^{-t/\tau}$ ← GENERAL FORM

$i_{CMAX} = \frac{20V}{2K\Omega} = 10mA$

SWITCH CLOSED AT $t = 10$

$\therefore \boxed{i_C(t) = -10\times10^{-3}\, e^{-(t-10)/0.94}\ A}$

$V_{R_1}(t) = i_C(t) \cdot R_1 = \boxed{-10\, e^{-(t-10)/0.94}\ V}$

$V_C(t) = V_{CMAX}\, e^{-(t-10)/0.94}\ V$

$\boxed{V_C(t) = 20V\, e^{-(t-10)/0.94}\ V}$

t FOR $V_C(t) = 10V$?

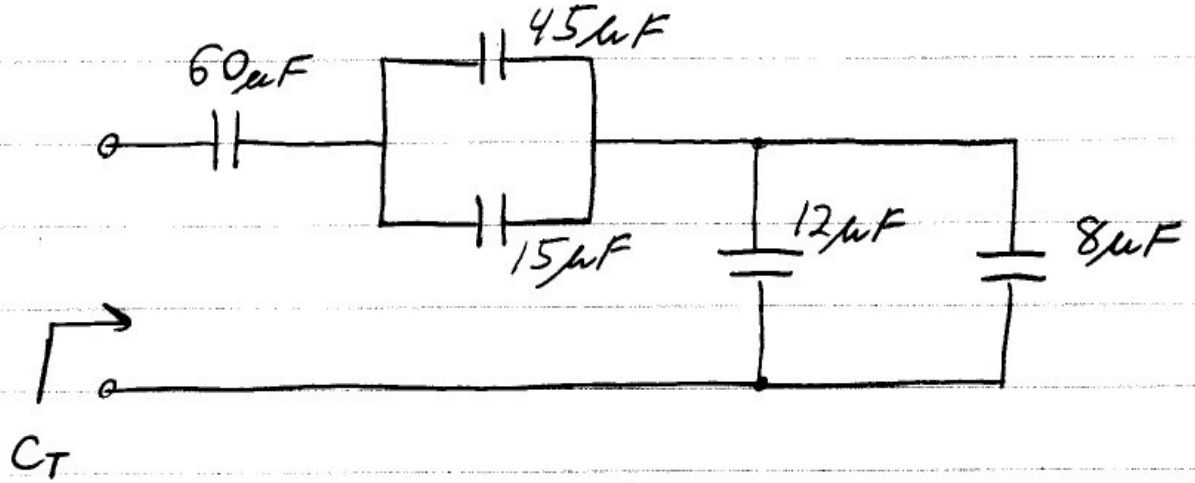
$10 = 20\, e^{-(t-10)/0.94}$

$-0.693 = -(t-10)/0.94$

$0.652 = (t-10)$

$\therefore \boxed{t = 10.65 \text{ SECONDS}}$

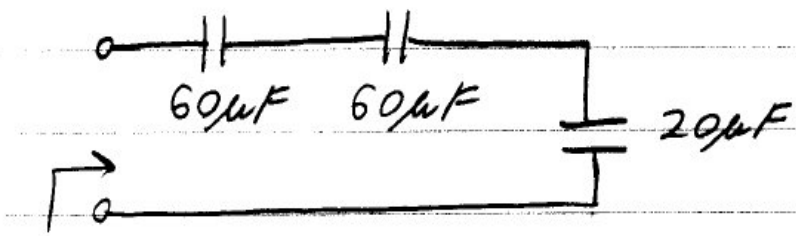
(EXAMPLE 1) FIND C_T:



$12\mu F \,//\, 8\mu F = 20\mu F$

$45\mu F \,//\, 15\mu F = 60\mu F$

REDRAWN:



$$\therefore C_T = \frac{1}{\frac{1}{60\mu F} + \frac{1}{60\mu F} + \frac{1}{20\mu F}} = \boxed{12\mu F}$$