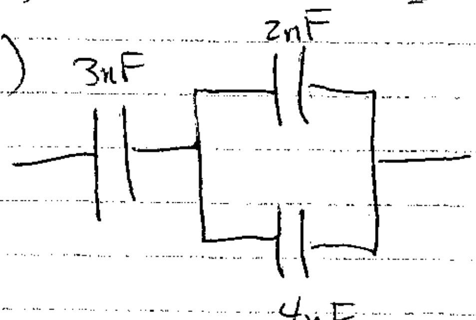
Session V.2

1)



2 & 4 in parallel gives 6nF.

This plus 3nF is series give

$$\frac{1}{C_T} = \frac{1}{3nF} + \frac{1}{6nF}$$

$$= \frac{3}{6nF} = \frac{1}{2nF}$$

So $\boxed{C_T = 2nF}$

2) a) Connect above to 5V $\Rightarrow Q = CV = 2nF \cdot 5V = 10nC = \boxed{10^{-8}C}$

b) 3nF is in series, so, it is charged to full 10nC

2 & 4nF share the 10nC. Since they are in parallel, they have the same $V = \frac{Q}{C}$, so $\frac{Q_2}{C_2} = \frac{Q_4}{C_4}$, so $\frac{Q_2}{Q_4} = \frac{C_2}{C_4} = \frac{1}{2}$. So

$\boxed{Q_2 = \frac{10}{3} nC}$ & $\boxed{Q_4 = \frac{20}{3} nC}$ (Ratio of 2:1 & add to 10nC)

Phy 132 HW V–VI

V.3 3) So, C is leaky

Real Capacitor

← so even discharge like this has a time constant of $R_{int} \cdot C$.

If it takes a few seconds to discharge nearly completely (which must be at least 2-3 lifetimes of $\tau = RC$), then we can guess $RC \approx 1\,sec$

So if $C = .5\,F$, then $\boxed{R \approx 2\,\Omega}$

4) $.005\,F$ to $8V$. Discharge thru $10^4\,\Omega$.

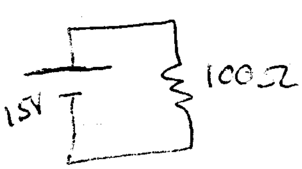
So $\tau = RC = 50\,sec$

Dropping to <u>2V</u> takes 2 half lives (one to 4V, two to 2V), and we found

$T_{1/2} = \ln 2 \cdot \tau = 35\,sec$

Take $2 \times T_{1/2} = \boxed{70\,sec}$ to drop from 8V to 2V

VI.1 5)



$I = \frac{dQ}{dt} = \frac{V}{R} = \frac{1.5V}{100\Omega} = .015\,A$

$Q = \int \frac{dQ}{dt}\,dt = \underset{\uparrow\ \text{const } I}{I\Delta t} = .015\,A \cdot 60\,sec = \boxed{0.9\,C}$

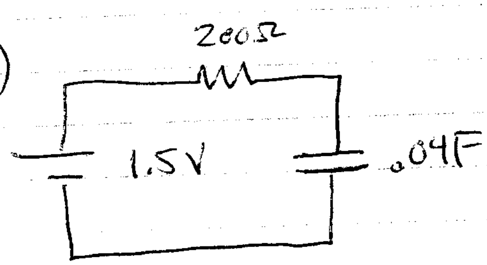
6) .5F charged to 2V over 20 sec

$$I_{avg} = \frac{\Delta Q}{\Delta t}$$

$$\Delta Q = CV = .5F \cdot 2V = 1C$$

$$I_{avg} = \frac{1C}{20\,sec} = \boxed{.05A}$$

7)



a) V/R is the initial charging current (when $V_c = 0$). Since final charge is never achieved (takes infinite time), then average charging current is zero! So, this is as plausible a "typical" current as any. $\frac{V}{R} = \frac{1.5V}{200\Omega} = \boxed{.0075A}$

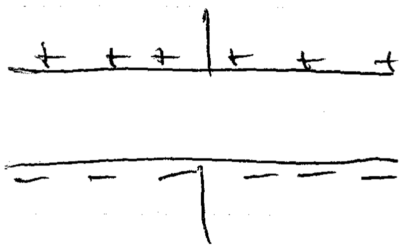
b) $Q_{final} = CV = .04F \cdot 1.5V = .06C$

$$I_{typ} = \frac{\Delta Q}{\Delta t} \Rightarrow \Delta t = \frac{\Delta Q}{I_{avg}} = \frac{.06C}{.0075A} = 8\,sec$$

c) $I_{typ} = \frac{V}{R} \Rightarrow \Delta t = \frac{Q}{I_{typ}} = \frac{CV}{V/R} \boxed{= RC}$ (no V dependence)

This is the same as τ – the characteristic time!

8(e) We always store equal and opposite



charges on the opposing plates — $+Q$ on one & $-Q$ on the other. So this always tends to pull the plates together. In fact, the capacitor never stores any <u>net</u> charge, simply separates the + and − charges slightly.