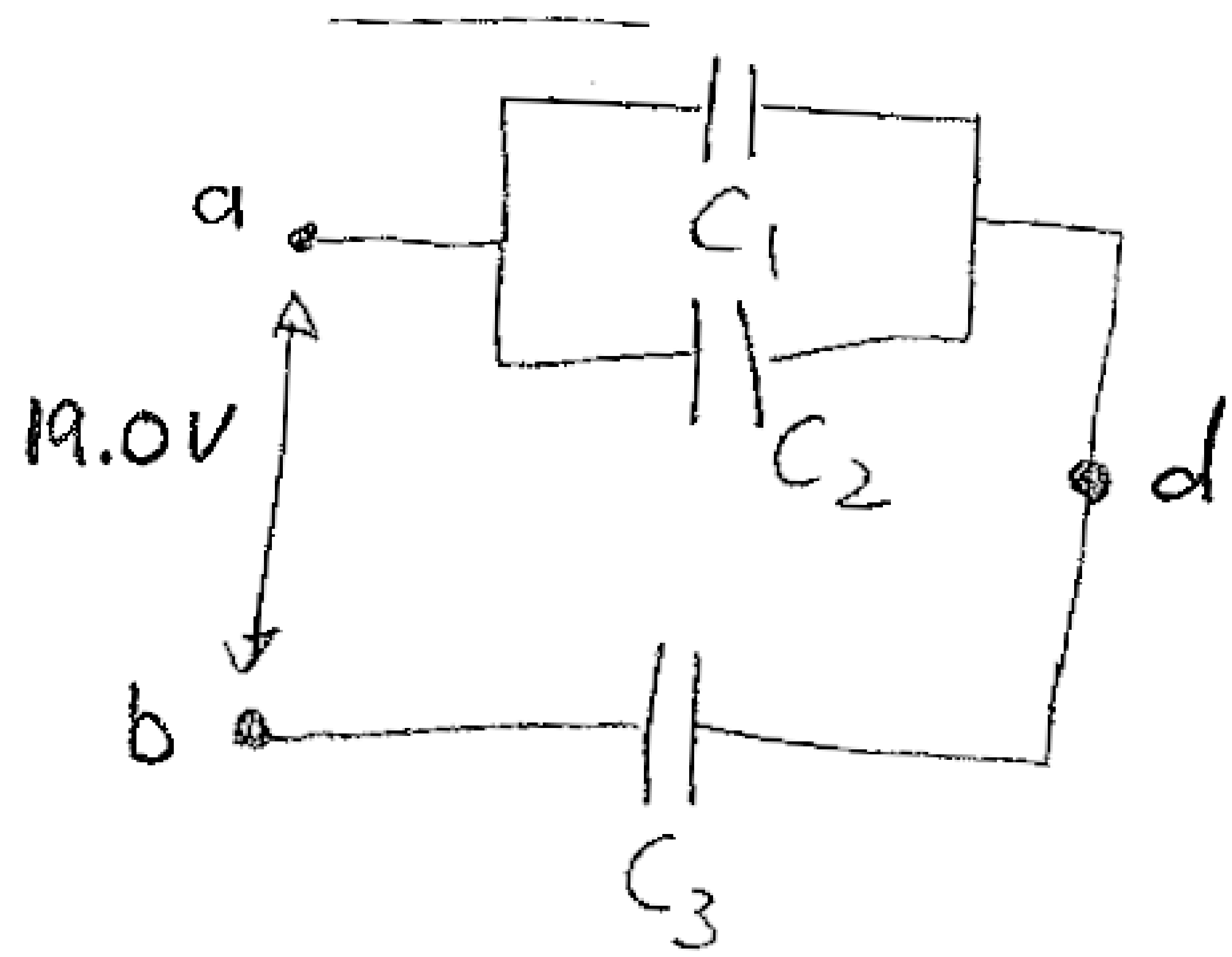


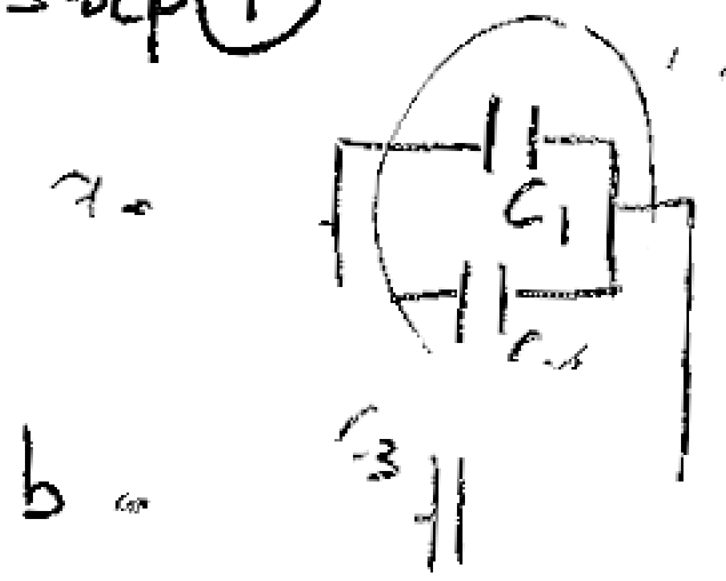
$C_1 = 2.50\mu F \quad q_1 = \quad V_1 =$

$C_2 = 4.60\mu F \quad q_2 = ? \quad V_2 = ? \quad V_{ad} = ?$

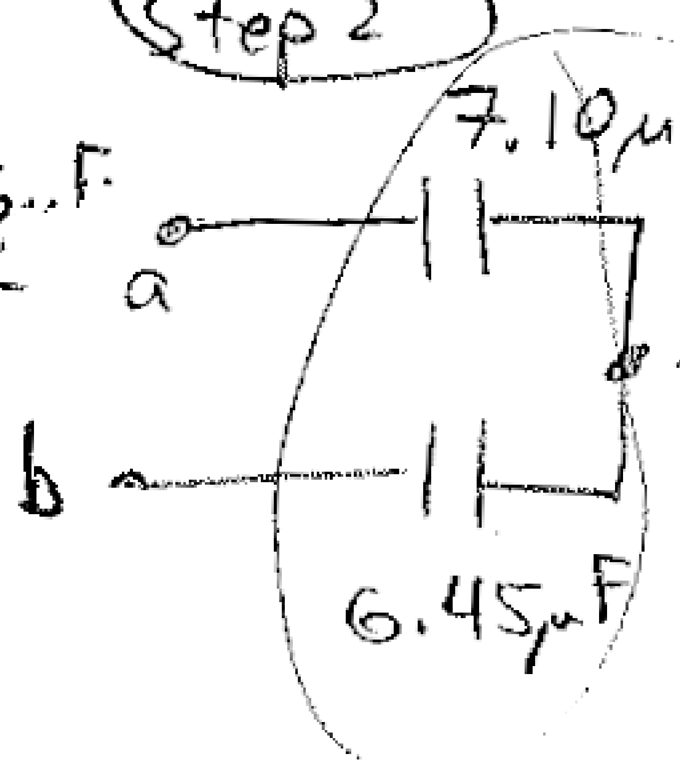
$C_3 = 6.45\mu F \quad q_3 = ? \quad V_3 = ?$

I'll approach this by finding an equivalent capacitance between points a & b & then go backwards

step ①



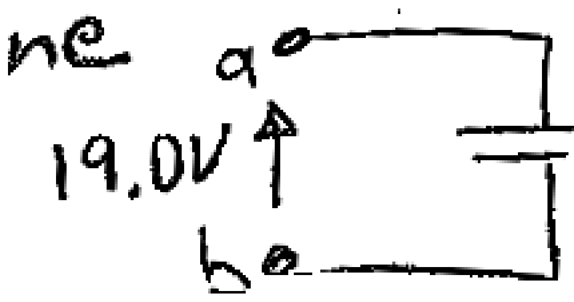
Step 2



$$\frac{1}{C_{equiv}} = \frac{1}{7.10\mu F} + \frac{1}{6.45\mu F}$$

$$C_{equiv} = 3.38\mu F$$

So, if we replace all these capacitor with a single one



$C = 3.38\mu F$

& the charge flowing from the battery $= Q_{tot} = (19.0V)(3.38\times10^{-6}\frac{C}{V})$
$= 6.42\times10^{-5}C$

If we think of this same Q in step ② then there must be Q_{tot} on the $6.45\mu F$ & "$7.10\mu F$" capacitor since they are in series so V across the $6.45\mu F$ capacitor $= \frac{6.42\times10^{-5}C}{6.45\times10^{-6}\frac{C}{V}}$
$= 9.95V$

so $q_3 = 6.42\times10^{-5}C \quad V_3 = 9.95V$

this means that the $V_{ad} = 19.0V - 9.95V = 9.05V$

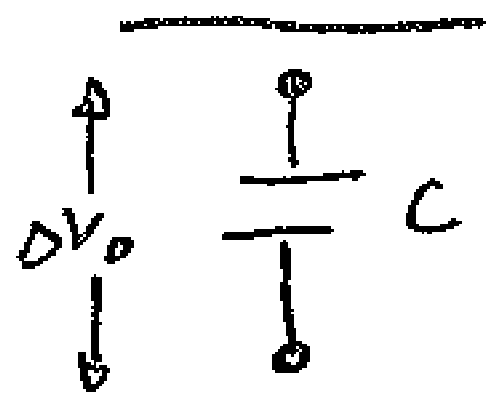
(check $6.42\times10^{-5}C/(7.10\times10^{-6}\frac{C}{V}) = 9.04V$ (agree to last place)

now, $V_{ad} = V_1 = V_2$ so we just need q_1 & q_2

$q_1 = (9.05V)(2.50\times10^{-6}\frac{C}{V})$
$= 22.6\times10^{-6}C$

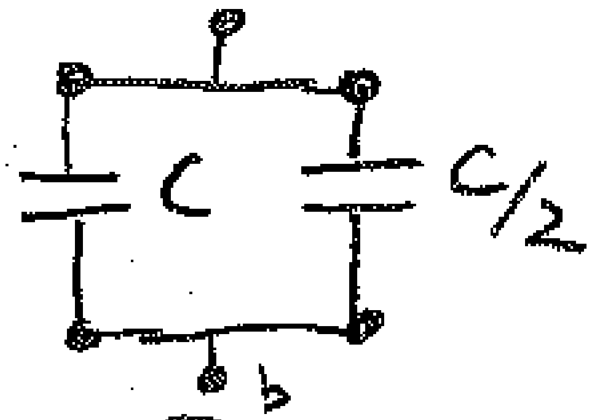
$q_2 = (9.05V)(4.60\times10^{-6}\frac{C}{V})$
$= 41.6\times10^{-6}C$

check
$q_1 + q_2 = 64.2\times10^{-6}C$ ok!



(0)

then connected to



(1)

$Q_0 = ?$

$V_{ab} = ?$

$U_0 = ?$

$U_f = ?$

$\Delta U = ?$

Initially (0) we have V_0 across C

or $Q_0 = C V_0$ then, we

connect another capacitor as shown in (1)

We know;

1) Charge is conserved I E

$$\begin{array}{l} Q \text{ on } C \text{ in } (1) \\ + q \text{ on } \frac{C}{2} \text{ in } (1) \\ \hline Q_0 \end{array}$$

2) $V_{ab} = V_{\text{across } C} = V_{\text{across } C/2}$

put it all together

$$C V_{ab} + \frac{C}{2} V_{ab} = Q_0 = \left(C + \frac{C}{2}\right) V_{ab}$$

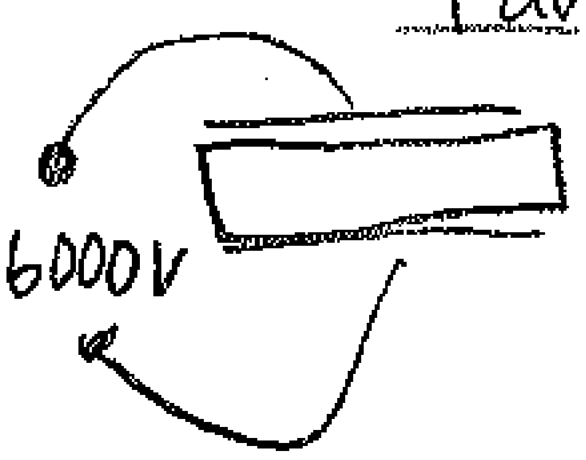
$$V_{ab} = Q_0 / \left(\frac{3}{2} C\right) = C V_0 / \left(\frac{3}{2} C\right) = \frac{2}{3} V_0$$

$$U_0 = \frac{1}{2} C V_0^2$$

$$U_{(1)} = \underbrace{\frac{1}{2} C \left(\frac{2}{3} V_0\right)^2}_{\frac{4}{9}} + \underbrace{\frac{1}{2} \frac{C}{2} \left(\frac{2}{3} V_0\right)^2}_{\frac{1}{2} \frac{4}{9}} = \left(\frac{2}{3}\right) \left(\frac{1}{2} C V_0^2\right)$$

$$\Delta U = \frac{1}{3} \left(\frac{1}{2} C V_0^2\right)$$

24.41



$\Delta V = 6000V$ ← maximum Field $1.20\times10^7 V/m$ $\Delta V = E_{max} d$ (d = gap)

to minimize A, we want d as big as possible

$$d = \frac{\Delta V}{E_{max}} = \frac{6000V}{1.20\times10^7 V/m} = 5.00\times10^{-4} m$$

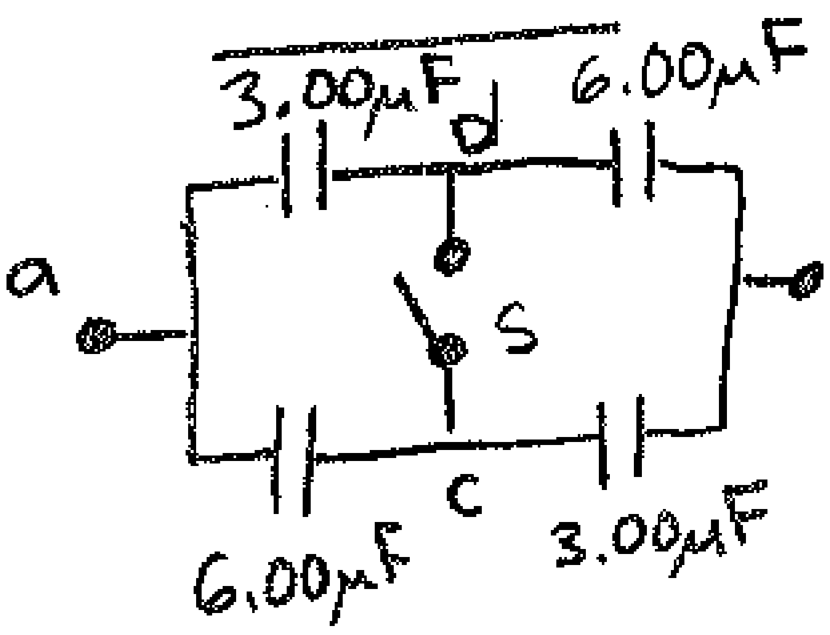
$$C = \frac{\kappa \varepsilon_0 A}{d} = 1.10\times10^{-9} F \quad A \propto C$$

note: not a good idea to design right at the limit!

$$A = \frac{dC}{\kappa\varepsilon_0} = \frac{(5.00\times10^{-4} m)(1.1\times10^{-9} \frac{C}{V})}{3.70(8.85\times10^{-12}\frac{C}{Vm})}$$

$$= 0.0168 m$$

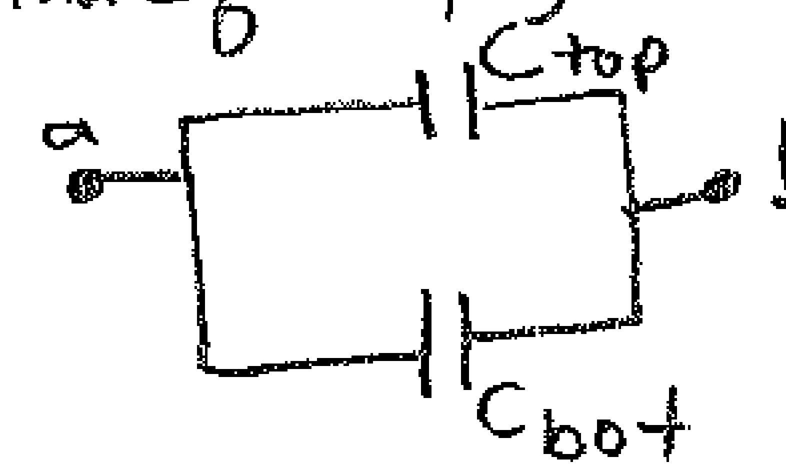
24.60



$V_{ab} = 210V$

$V_{CD} = ?$

→ Find equiv & go backwards



$$\frac{1}{C_{top}} = \frac{1}{3\mu F} + \frac{1}{6\mu F}$$

$$C_{top} = 2\mu F = C_{bot}$$

since $V_{top} = V_{Bot}$ & $Q_{top} = Q_{bot} = (210V)(2\mu F)$ $(= 4.2\times10^{-4}C)$

$$V_{ad} = \frac{420\mu C}{3.00\mu\frac{C}{V}} = 140 V$$

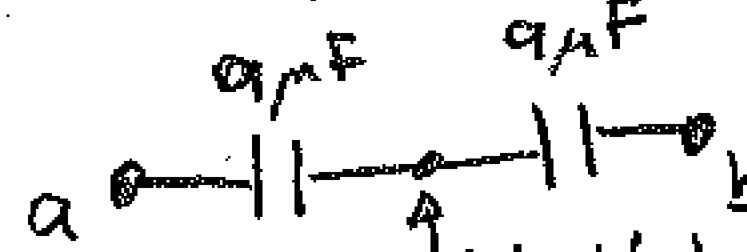
so $V_{db} = 210V - 140V = 70.0 V$

$V_{ad} = V_{cB}$ & $V_{db} = V_{ac}$ from symmetry of problem

so if V_a sits@ 210V, point d sits 140 V below

or $V_d = 70.0 V$ (means $V_c = 140 V$) $V_{cd} = V_c - V_d = 140V - 70.0 = 70.0V$

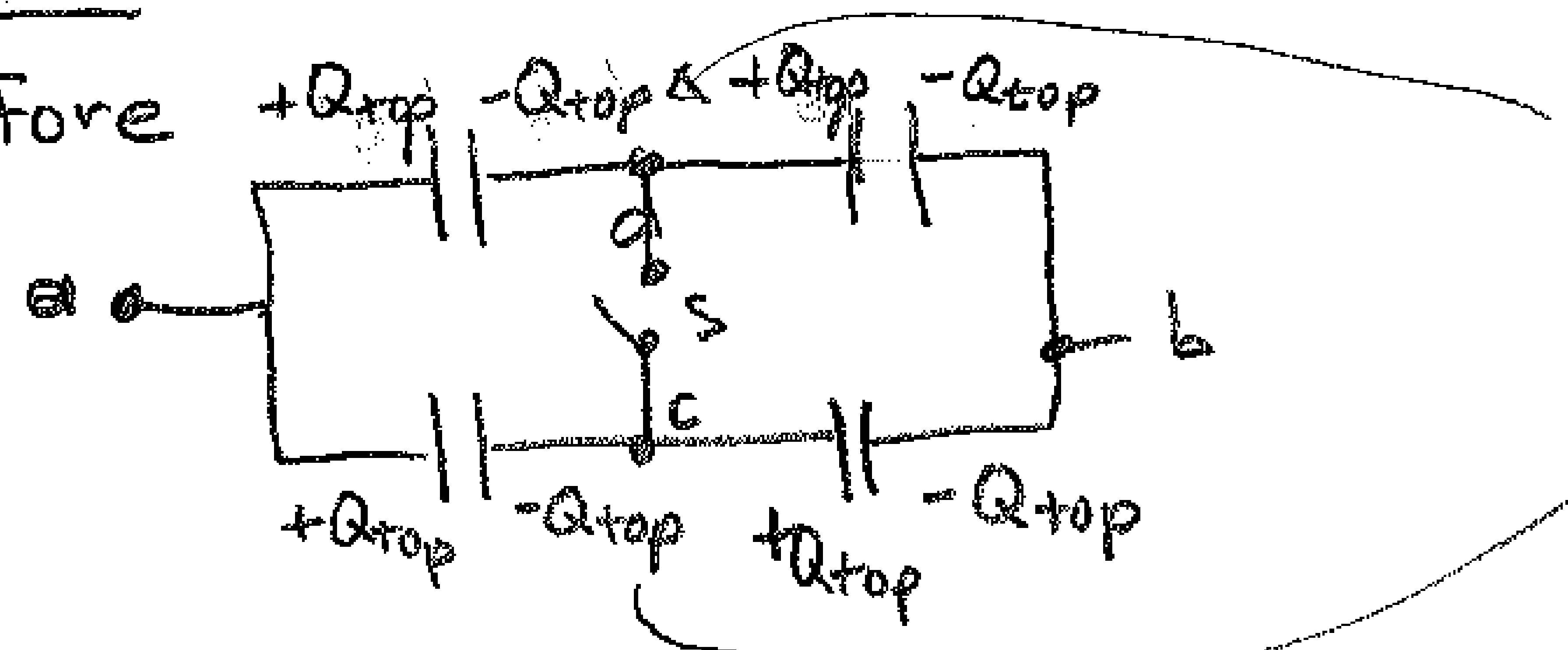
After switch S is closed, have



$\frac{1}{2} V_{ab} = 105V$

24.60

before



$Q_{tot} = 0$

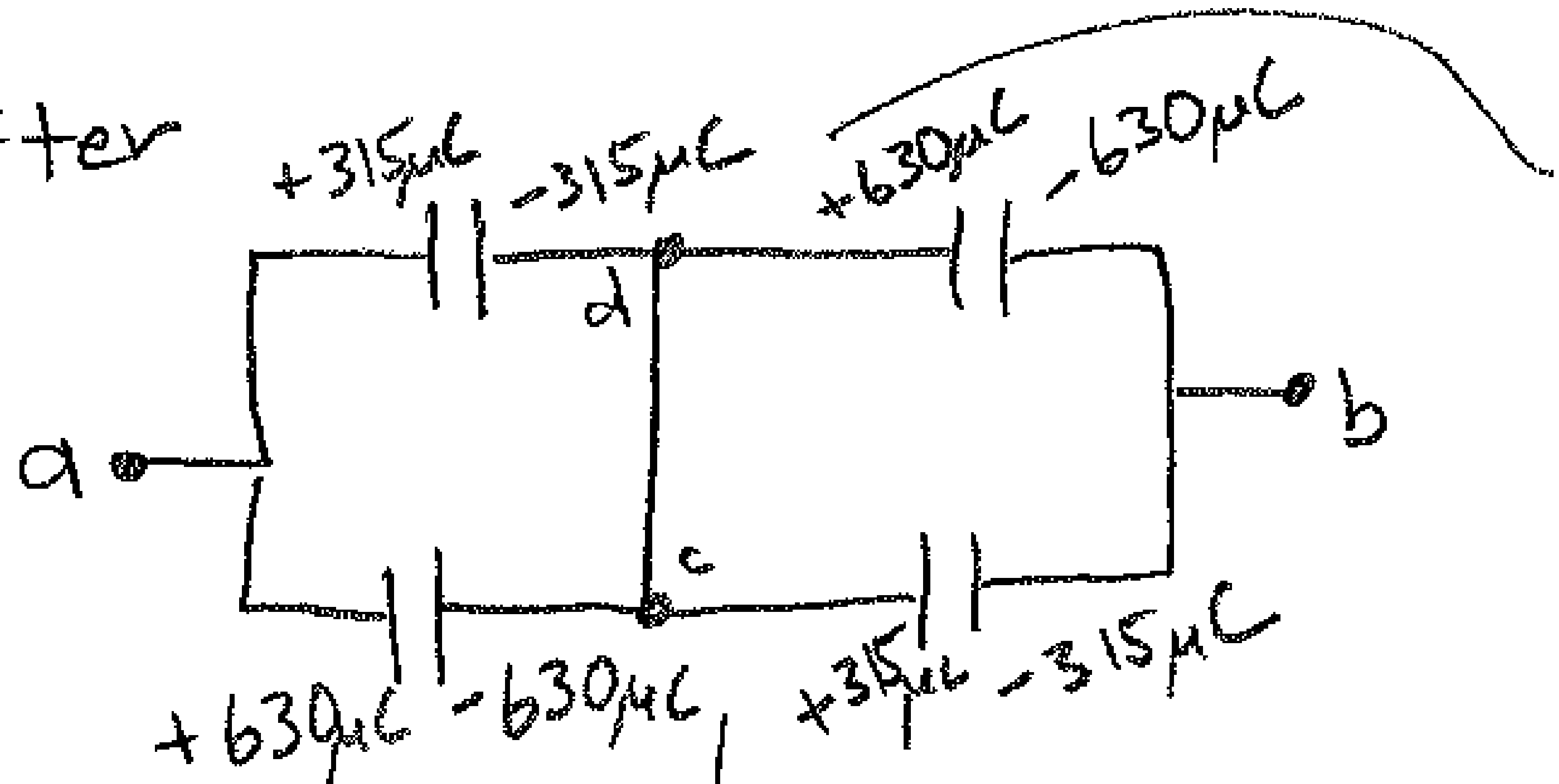
$Q_{tot} = 0$

After Q across $3\mu f$ capacitors $= 105V(3.00\mu F)$

$= 315\mu C$

" $6\mu f$ " $= 630\mu C$

So After



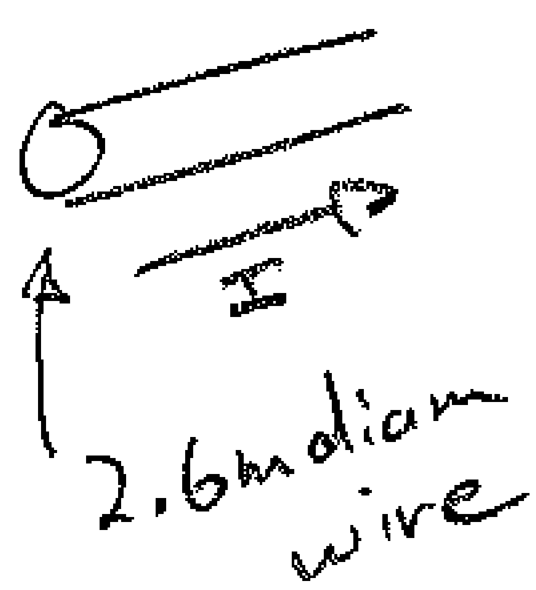
$Q_{tot} = 630\mu C - 315\mu C$
$= 315\mu C$

$Q_{tot} = -630\mu C + 315\mu C = -315\mu C$

so, looks like $315\mu C$ flowed from $c \to d$

25.2

420C get transfered in 80 min



$I = \frac{\Delta Q}{\Delta t} = \frac{420C}{80\,min \cdot \frac{60s}{min}} = \underbrace{0.088\,C/s}_{Amp}$

$J = n q v_D$

$v_D = \frac{J}{nq} = \frac{I/A}{nq} = \frac{(0.0875\,\frac{C}{s}) / (\pi (\frac{0.0026m}{2})^2)}{(\frac{5.8 \times 10^{28}}{m^3})(1.6 \times 10^{-19} C)}$

$= 1.8 \times 10^{-6}\,m/s$

Stretchable Resistor

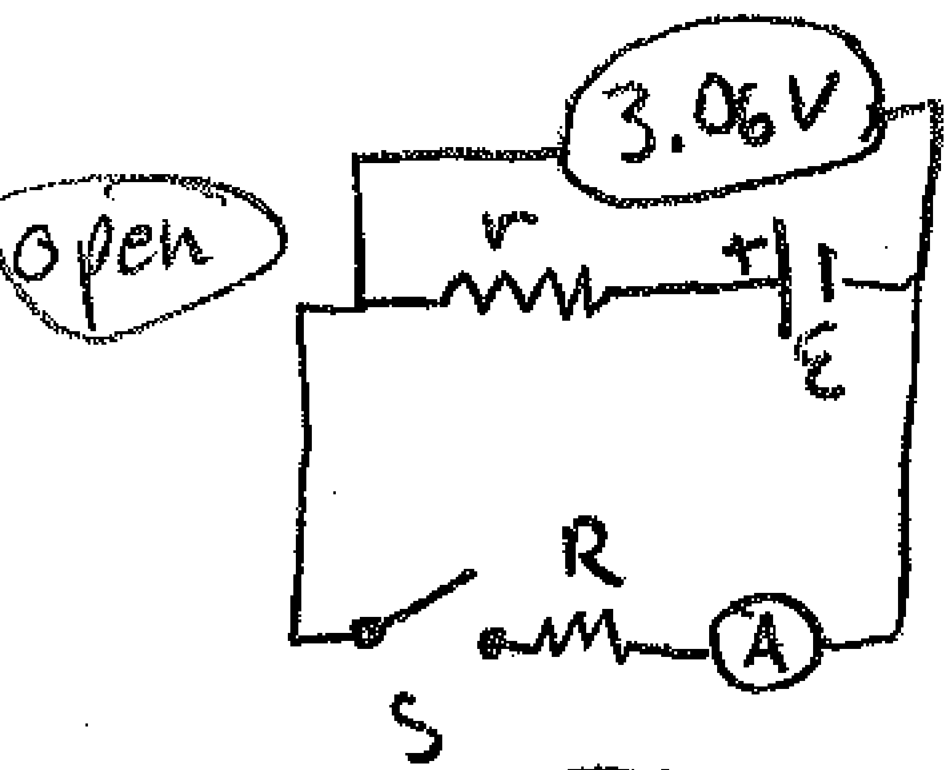
$R_0 = \frac{\rho l}{A}$ In the stretch, Vol is constant

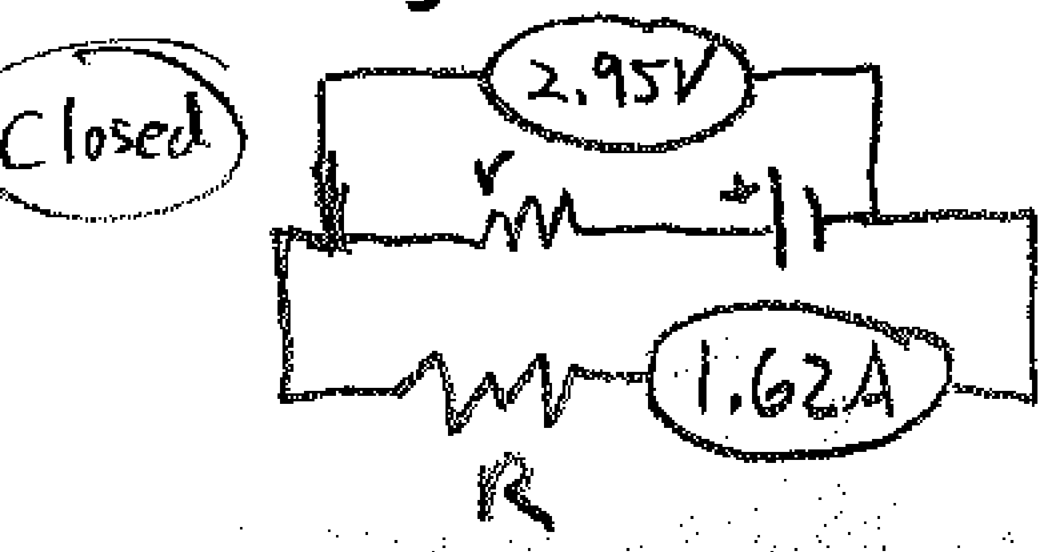
$Vol_{before} = lA = (2l)A_{new}$

$A_{new} = \frac{A}{2}$

$R = \rho \frac{(2l)}{(A/2)} = 4 \frac{\rho l}{A} = 4R_0$

EMF





$\mathcal{E} = ?$ in the open config. very little current flows in r, so ΔV on r is tiny $\mathcal{E}$ is pretty close to 3.06V

$r = ?$ in Closed position ΔV across r drops 3.06V to 2.95V or $\Delta V = 0.11V$. since 1.62A flows in the circuit

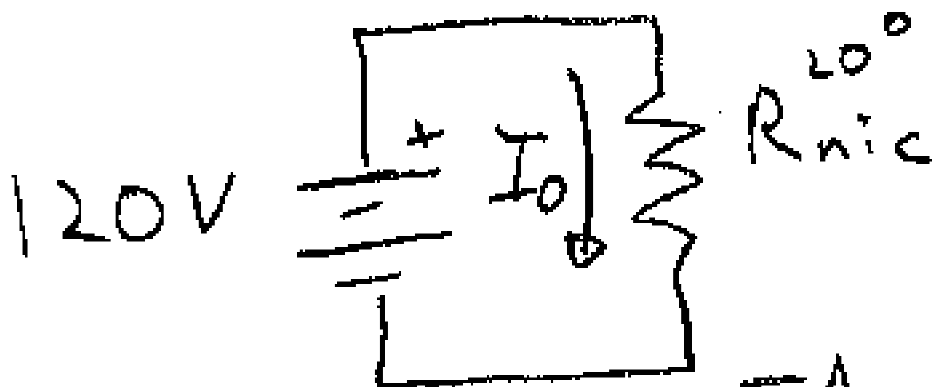
$r = 0.11V/1.62A = 6.79 \times 10^{-2}\,\Omega$

$R = ?$ well 2.95V goes across R so

$R = 2.95V/1.62\,A = 1.82\,\Omega$

25.74 Toaster

Initially @ 20°C



$I_0 = 1.35A$

$R_{nic}^{20°} = \dfrac{120\,V}{1.35A}$

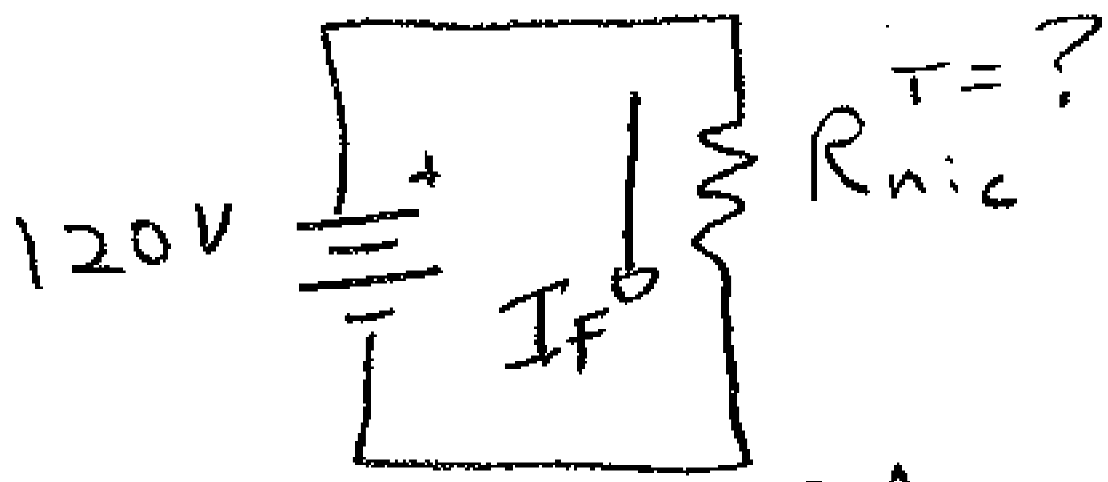
$= 88.9\,\Omega$

$P_{nic}^{20°} = I_0 V$

$= (1.35A)(120\,V)$

$= 162\,W$

After a few secs



$I_F = 1.23A$

$R_{nic}^{T=?} = \dfrac{120\,V}{1.23A} = 97.6\,\Omega$

$P_{nic}^{T=?} = (120V)(1.23A) = 147.6$

Assume volume change of nichrome is small

$R_{new} = R_0 \alpha (T - T_0) + R_0$

problem gives α over the ΔT, look @ ΔR

$R_{new} - R_0 = R_0 \alpha (T - T_0)$

$\dfrac{R_{new} - R_0}{\alpha R_0} = T - T_0 \qquad T = \dfrac{R_{new} - R_0}{\alpha R_0} + T_0$

$T = \dfrac{97.6\,\Omega - 88.9\,\Omega}{(4.5\times10^{-4}/C°)(88.9\,\Omega)} + 20\,C° = 235\,C°$