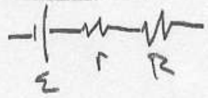
PHYS 115 HW#3

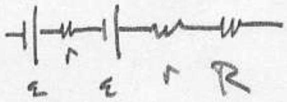
19.47| The only way for the current to be less then double is if one of the batteries has internal res. We can calculated this (assume $\mathcal{E}=1.5V$)

single :



$$I_1=\frac{\mathcal{E}}{r+R}$$

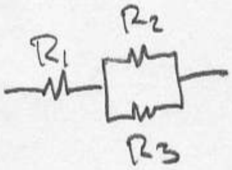
double :

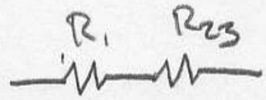


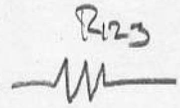
$$I_2=\frac{2\mathcal{E}}{2r+R}$$

With $I_1=.2A$, $I_2=.33A$, $\mathcal{E}=1.5V$ gives $R=5.9\Omega$, $r=1.6\Omega$

19.52|





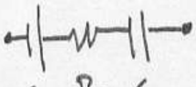


$$R_{23}=\frac{1}{1/R_2+1/R_3}=\frac{1}{1/5+1/20}=4\Omega$$

$$R_{123}=R_1+R_{23}=14\Omega$$

19.66|

a]

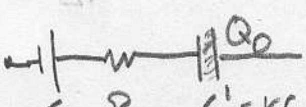


$\mathcal{E}-IR-Q/C=0$ when fully charged $I\to 0$

$$|Q_{max}|=\mathcal{E}C$$

b] Placing a dielectric of strength K changes C as the material inside becomes polarized leading to a greater potential.

c] $C'=KC$ hence $Q'_{max}=K\mathcal{E}C$ and I' can be found by

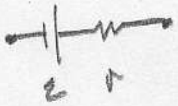


let $Q_0\equiv Q_{max}$ before the dielectric

$$\mathcal{E}-IR-Q_0/C'=0$$

$$I=\frac{-Q_0/KC+\mathcal{E}}{R}$$

19.67

a] 

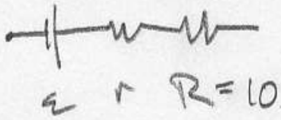
$\varepsilon - Ir = 0$

$r = \frac{\varepsilon}{I} = \frac{9}{18} = \frac{1}{2}\,\Omega$

b] $P = I\Delta V = (18)(9) = 162\,W$

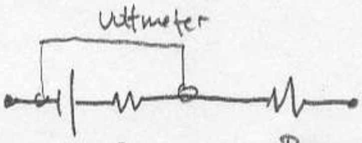
c] $P = I\Delta V = I^2 r = (18)^2\, 2 = 162\,W$

$P\Delta t = E = (162)(15) = 162\,J$

d] 

e] $I = \frac{\varepsilon}{r+R} = \frac{9}{\frac{1}{2}+10} = \frac{9}{12} = 6/7\,A$

$P_R = I^2 R = (3/4)^2\, 10 = 7.3\,W$

f] 

$\Delta V = \varepsilon - Ir = 9 - 3/4 \cdot \frac{1}{2} = 9 - 3/8 = 8.60\,V$

19.71

node:

$I_2 + I_1 - I_3 - I_4 = 0$

$I_4 + I_5 - I_1 = 0$

loop:

$-I_2R_2 - I_4R_4 + I_5R_5 + \mathcal{E}_2 = 0$

$\mathcal{E} - I_1R_1 - I_3R_3 - I_5R_5 = 0$

$I_4R_4 - I_3R_3 - I_5R_5 = 0$

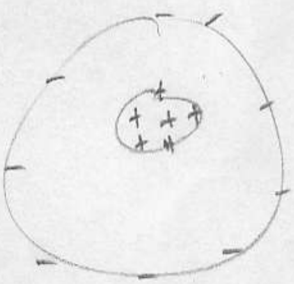
$\Delta V_{D\to A}$ can take any path! I took $D \to E \to F \to G \to H \to A$

$\Delta V_{D\to A} = -\left[-\mathcal{E}_2 - I_5R_5\right]$ another path DCHA gives

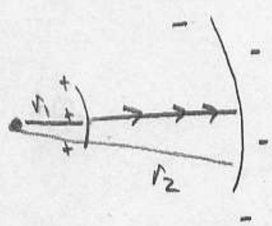
$= -\left[-I_2R_2 - I_4R_4\right]$

$P_2 = I_2\Delta V = I_2\mathcal{E}_2$

19.73



Replace inner shell by point charge (spherical conductor!)



Integrate along path shown

$$\Delta V = -\int \vec{E}\cdot d\vec{l}$$

$$\vec{E} = \vec{E}_{inner} + \cancel{\vec{E}_{outer}}$$ → inside conductor

$$= \frac{kQ}{r^2}\hat{r}$$

Q=CV

$$\Delta V = -\int_{r_1}^{r_2} \frac{kQ}{r^2}\,dr = -kQ\left(\frac{-1}{r}\right)\Bigg|_{r_1}^{r_2} = kQ\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

$$C = Q/\Delta V = \left(Q\left[1/r_2 - 1/r_1\right]\right)^{-1}$$

part b comes from the taylor expansion of $\frac{1}{r_2+s} = \frac{1}{r_2}\left[\frac{1}{1+s/r_2}\right] \approx \frac{1}{r_2}\left(1 - s/r_2 + \ldots\right)$