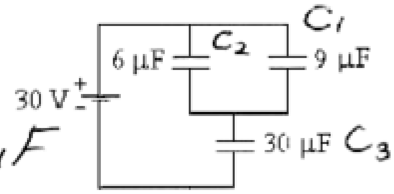
Name: KEY

PHYSICS 2220 - EXAM #2 - SPRING 2009

1. a. Find the equivalent capacitance and the charge on the 9 μF capacitor.



$$C_{12} = C_1 + C_2 = 9\mu F + 6\mu F = 15\mu F$$

$$C_{eq} = \frac{C_{12} C_3}{C_{12} + C_3} = \frac{(15\mu F)(30\mu F)}{15\mu F + 30\mu F} = \boxed{10\mu F}$$

The charge on each series capacitor (C_{12} and C_3) is

$$Q_{12} = Q_3 = C_{eq} V = (10\mu F)(30V) = 300\mu C$$

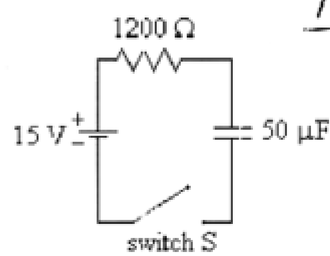
So

$$Q_1 + Q_2 = 300\mu C \text{ and } V_1 = V_2 \Rightarrow \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

$$\Rightarrow Q_2 = Q_1 \frac{C_2}{C_1} = Q_1 \frac{6\mu F}{9\mu F} = \frac{2}{3} Q_1$$

$$\Rightarrow Q_1 + \frac{2}{3} Q_1 = 300\mu C \Rightarrow \frac{5}{3} Q_1 = 300\mu C \Rightarrow \boxed{Q_1 = 180\,\mu C}$$

b. The switch S is closed at $t = 0$. Find the energy stored by the capacitor when $t = 3.5 \times 10^{-2}$ s.



$$q = q_0 (1 - e^{-t/RC})$$

with $q_0 = CV = 50\mu F(15V) = 750\mu C$

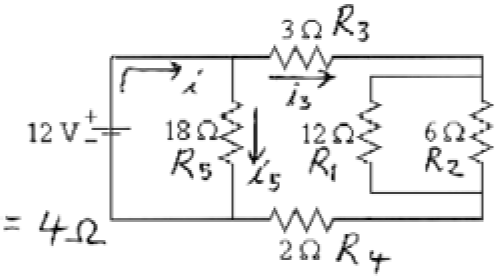
$$\text{So } q = 750\mu C \left(1 - e^{-(3.5\times10^{-2}\,sec)/(1200\Omega)(50\times10^{-6}F)}\right)$$

$$= 331.5\mu C$$

$$\text{Thus } U = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2}\frac{(331.5\times10^{-6}C)^2}{50\times10^{-6}F}$$

$$= \boxed{1.10\times10^{-3}\,J}$$

2. a. Find the equivalent resistance and the power dissipated by the 3 Ω resistor.



$$R_{12} = \frac{R_1 R_2}{R_1 + R_2} = \frac{(12\,\Omega)(6\,\Omega)}{12\,\Omega + 6\,\Omega} = 4\,\Omega$$

$$R_{1234} = R_{12} + R_3 + R_4 = 4\,\Omega + 3\,\Omega + 2\,\Omega = 9\,\Omega$$

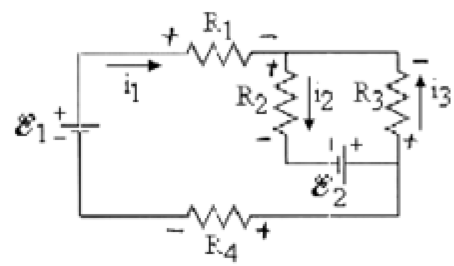
$$R_{eq} = \frac{R_{1234} R_5}{R_{1234} + R_5} = \frac{9\,\Omega(18\,\Omega)}{9\,\Omega + 18\,\Omega} = \boxed{6\,\Omega}$$

$$i = \frac{V}{R_{eq}} = \frac{12\,V}{6\,\Omega} = 2\,A \quad \text{and} \quad i_5 = \frac{12\,V}{18\,\Omega} = \frac{2}{3}A$$

So $i_3 = i - i_5 = 2A - \frac{2}{3}A = \frac{4}{3}A$

Thus $P_3 = i_3^2 R_3 = \left(\frac{4}{3}A\right)^2 (3\,\Omega) = \boxed{5.33\,W}$

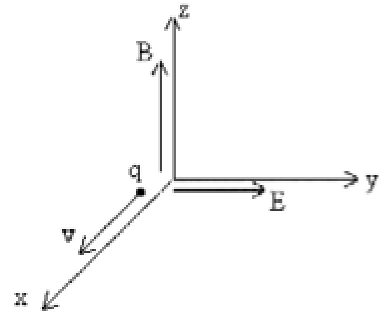
b. Use Kirchhoff's rules to write down <u>three</u> equations that can be solved for the currents i_1, i_2, and i_3. *You do not have to solve the equations!* (If you use another system, label your current loops and clearly explain how the values of i_1, i_2, and i_3 are related to your currents.)



$$i_1 + i_3 = i_2$$

$$\left.\begin{array}{l} \mathcal{E}_1 - i_1 R_1 - i_2 R_2 + \mathcal{E}_2 - i_1 R_4 = 0 \\ \mathcal{E}_1 - i_1 R_1 + i_3 R_3 - i_1 R_4 = 0 \\ \mathcal{E}_2 - i_3 R_3 - i_2 R_2 = 0 \end{array}\right\} \text{any two}$$

3. In a laboratory, there is a uniform electric field of 3000 N/C in the positive y-direction, and a uniform magnetic field of 0.12 T in the positive z-direction. A positively charged particle travels in the positive x-direction (out of the page).



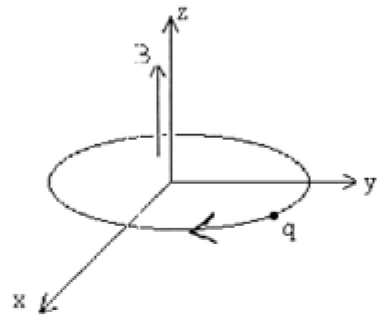
a. If the electric and magnetic forces on the particle cancel so there is no net force, find the speed of the particle.

$$qvB\sin\phi = qE \quad \text{with } \phi = 90^\circ$$

$$vB = E$$

$$v = \frac{E}{B} = \frac{3000\,\frac{N}{C}}{0.12\,T} = \boxed{2.5\times10^{4}\,\frac{m}{sec}}$$

b. If the electric field is suddenly turned off, the positively charged particle moves in a circle of radius 4.35 millimeters in the x-y plane. If the particle's mass is 6.68×10^{-27} kg, find the charge of the particle. <u>Draw the direction of the particle's motion on the diagram</u>.



$$r = \frac{mv}{qB}$$

$$\text{so} \quad q = \frac{mv}{rB} = \frac{(6.68\times10^{-27}\,kg)(2.5\times10^{4}\,\frac{m}{sec})}{(4.35\times10^{-3}\,m)(0.12\,T)}$$

$$\boxed{q = 3.20\times10^{-19}\,C}$$