Physics 152
Exam 1

1. Three charges are arranged as shown. The line joining charge 1 and 2 is on the y axis. Charge 1 is a +4nC (4x10^{-9} C), charge 2 is a -3nC charge, and charge three is a proton, mass 1.67x10^{-27} kg, and charge +1.6x10^{-19} C. Find the speed of the proton after it has moved far from the initial point.

\[ q_1 = 4 \times 10^{-9} \text{ C} \]
\[ q_2 = -3 \times 10^{-9} \text{ C} \]
\[ q_3 = 1.6 \times 10^{-19} \text{ C} \]
\[ 15 \text{ cm} \]
\[ 20 \text{ cm} \]

\[ V_3 = 9 \times 10^9 \left( \frac{4 \times 10^{-9}}{1.5} + \frac{-3 \times 10^{-9}}{\sqrt{1.2^2 + 1.5^2}} \right) \]
\[ = 132 \text{ volts} \]

\[ q_p V_3 - 0 = \frac{1}{2} m_p v_\infty^2 \]

\[ v_\infty = \sqrt{2 q_p V_3} \]
\[ = 1.59 \times 10^5 \text{ m/s} \]

2. Two square parallel plates, 20 cm. on a side, are separated by 2 cm. of vacuum. A charge of +10 nanocoulombs (10x10^{-9} C) is on each plate (equal but opposite charge on each plate). If an electron moving at 10^6 m/sec very near the positive plate toward the negative plate, will it reach the negative plate? If so how fast is it moving? If not how far from the plate will it be when speed is 0.

\[ C = \frac{\varepsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \text{ m}^2}{1.77 \times 10^{-11}} = 565 \text{ volts} \]

\[ C = \frac{Q}{V} \quad V = \frac{Q}{C} = \frac{10 \times 10^{-9}}{565} = 0.02 \text{ volts} \]

\[ \frac{1}{2} m_e (10^6)^2 = K E_1 \]
\[ \frac{1}{2} m_e (10^6)^2 - K E_2 = 1.6 \times 10^{-19} \text{ (At } \Delta V) \]

Assume \( K E_2 = 0 \) (electron doesn't get to negative plate)

\[ \frac{1}{2} (9.1 \times 10^{-3} \times 10^6)^2}{1.6 \times 10^{-19}} = \Delta V = 2.85 \text{ volts} \]

\[ x = \frac{\Delta V d}{V} = \frac{2.85}{565} \approx 1 \times 10^{-4} \text{ m from positive plate} \]

b) what is the potential difference between the plates?

565 volts
3. If you make a resistor using copper wire with a 1x10^{-4}m diameter and find that it has a resistance of 1.5 ohm at room temperature,

a) what is the length of the wire

\[ L = \frac{1.5(\pi)(5 \times 10^{-4})^2}{1.7 \times 10^{-8}} = 0.693 \text{ meters} \]

b) You measure its resistance after it has heated up from use and find it has increased to 2 ohm. What is the temperature of the wire at that time?

\[ R_T = 1.5(1 + 3.9 \times 10^{-3} \Delta T) \]
\[ \Delta T = \frac{R_T - R_0}{1.5(3.9 \times 10^{-3})} = 85.5^\circ \]
\[ T = 85.5 + 20 = 105.5^\circ \]

4. In the circuit shown find the equivalent resistance of the circuit.

\[ R_1 = \frac{1}{30} \]
\[ R'' = 2.5 \]
\[ R_c = 10 + 2.5 + 10 + 20 = 42.5 \text{ ohm} \]

5. In the complex circuit shown, find the current through the 6 ohm resistance.

\[ I_1 = I_2 + I_3 \]
\[ I_3 + I_6 = I_5 \]
\[ I_2 + I_4 = I_6 \]
\[ I_5 = I_1 + I_4 \]
- \sigma 0 - l_1, 4 - l_3(10) = 0 \quad l_1 = \frac{10l_3 - 20}{-4}

- l_1, 4 - l_2, 6 + l_4, 3 = 0

- 4l_1 - 10l_3 + 7l_6 + 3l_4 = 0

- 10l_3 + 7l_6 + 6l_2 = 0

\frac{3}{4} - 4\left(5 - 2.5l_3 - 10l_3\right) + l_4 = -7l_6