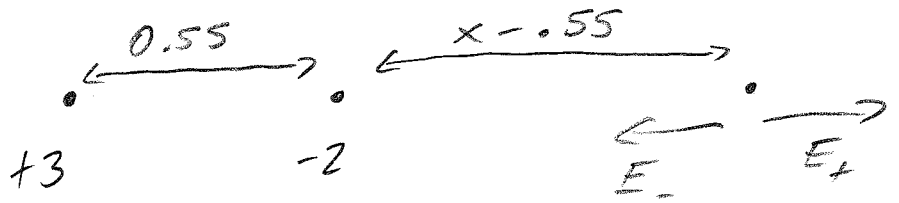
Physics 10164 - Exam 1A

Each problem is worth 25 points. Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. A 3.0 μC charge is fixed at the origin. A -2.0 μC charge is fixed at the coordinate x = 55 cm. At what x coordinate is the net electric field equal to zero?



Need $|E_+| = |E_-|$

$$\frac{k(3\times10^{-6})}{x^2} = \frac{k(2\times10^{-6})}{(x-.55)^2}$$

$$\frac{3}{2} = \frac{x^2}{(x-.55)^2}$$

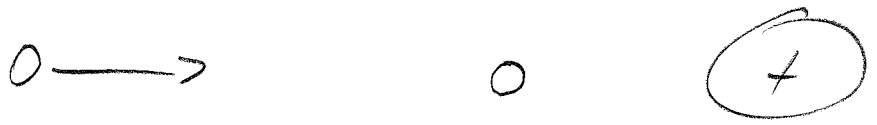
$$1.22 = \frac{x}{x-.55}$$

$$1.22x - 0.674 = x$$

$$0.22x = 0.674$$

$$\boxed{x = 3.1\ m}$$

2. A proton starts at infinity with an initial speed of 1.5 x 10^7 m/s. It approaches a fixed charged particle with a total charge of +26e (4.16 x 10^{-18} C). What minimum distance from the fixed particle does the proton reach before stopping and turning around?



$V_0 = 1.5 \times 10^7$ m/s

$V = 0$

$V_i = 0$.

$V_f = \frac{k(26e)}{r}$

$\Sigma W_F = \Delta K$

$-q\Delta V = \Delta K$

1.60×10^{-19}

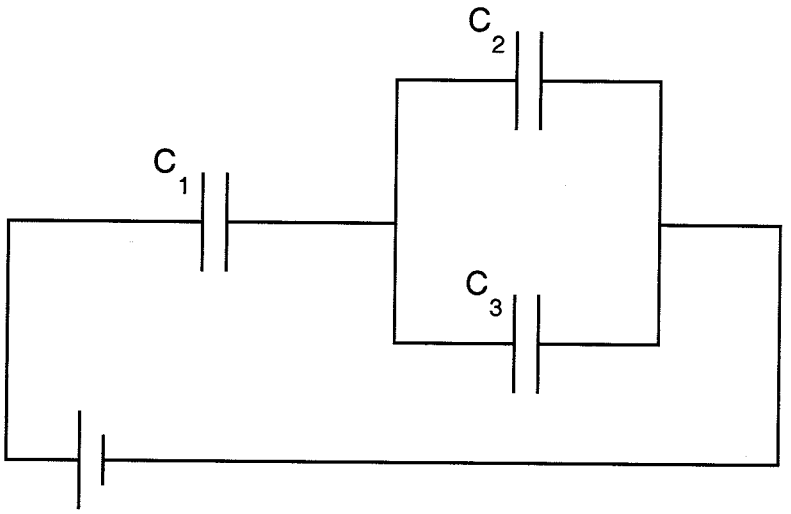
↑ due to +26e charge

$$-(1.60\times10^{-19})\left(\frac{(9\times10^9)(26)(1.60\times10^{-19})}{r} - 0\right) = \frac{1}{2}m(0)^2 - \frac{1}{2}mv_0^2$$

$$-\frac{5.99\times10^{-27}}{r} = -\frac{1}{2}(1.67\times10^{-27})(1.5\times10^7)^2$$

$$r = \frac{5.99\times10^{-27}}{1.88\times10^{-13}} = \boxed{3.2\times10^{-14}\ m}$$

3. In the circuit below, $C_1 = 1.0\ \mu F$, $C_2 = 2.0\ \mu F$, $C_3 = 3.0\ \mu F$. The battery supplies a voltage of 12 Volts. What is the charge stored by the capacitor C_2?



$$C_{23} = C_2 + C_3 = 5.0\ \mu F$$

$$\frac{1}{C_{123}} = \frac{1}{C_1} + \frac{1}{C_{23}} = \frac{1}{1} + \frac{1}{5} \qquad C_{123} = 0.83\ \mu F$$

$$Q_{123} = (0.83\ \mu F)(12) = 10\ \mu C$$

$$\text{So } Q_1 = Q_{23} = 10\ \mu F$$

$$\Delta V_{23} = \frac{Q_{23}}{C_{23}} = 2\ \text{Volts}$$

$$\Delta V_2 = \Delta V_3 = \Delta V_{23} = 2\ \text{Volts}$$

$$Q_2 = C_2 \Delta V_2 = (2.0\ \mu F)(2.0\ V) = \boxed{4.0\ \mu C}$$

4. A wire has a resistivity of 1.6×10^{-8} Ohm-meters, a length of 2.0 meters, and a diameter of 1.0 mm.

a) What is the resistance of the wire?

b) If the voltage applied across the ends of the wire is 36 Volts, how many watts does the resistance of the wire dissipate (this comes off as heat from the wire)?

a) $R = \rho \frac{\ell}{A}$ $\quad A = \pi (0.5 \times 10^{-3})^2$

$= 7.85 \times 10^{-7} m^2$

$= \frac{(1.6 \times 10^{-8})(2.0)}{7.85 \times 10^{-7}} = .041\ \Omega$

b) $P = \frac{\Delta V^2}{R} = \frac{36^2}{.041} =$ 32,000 Watts

or $I = \frac{\Delta V}{R} = \frac{36}{.041} = 87.8\ A$

$I^2 R = 32{,}000\ W$