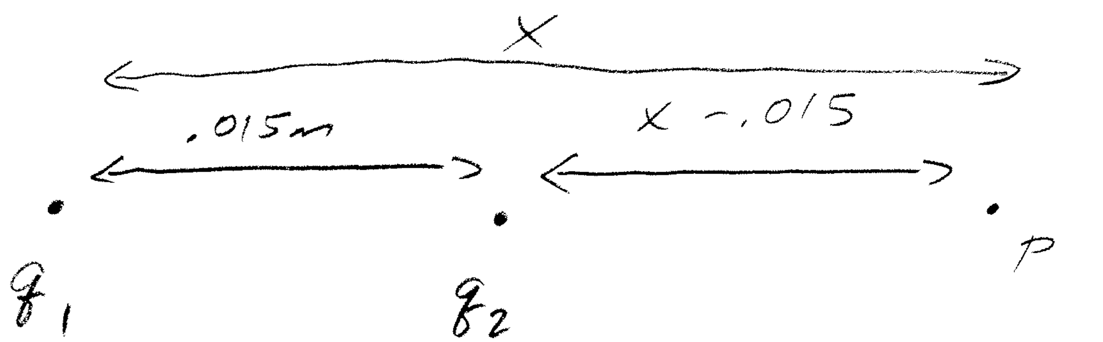
Physics 10164 - Exam 1C

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. (30 pts) A +3.5 μC charge is located at the origin. A -2.2 μC charge is located on the x-axis as x = 1.5 cm. Find the coordinate along the x-axis at which the magnitude of the total electric field is equal to zero (besides infinity).

Since q_2 smaller, $\vec{E}_{TOT} = 0$ closer to q_2



$$|E_1| = |E_2|$$

$$\frac{k(3.5 \times 10^{-6})}{x^2} = \frac{k(2.2 \times 10^{-6})}{(x-0.015)^2}$$

$$\frac{3.5}{2.2} = \frac{x^2}{(x-.015)^2}$$

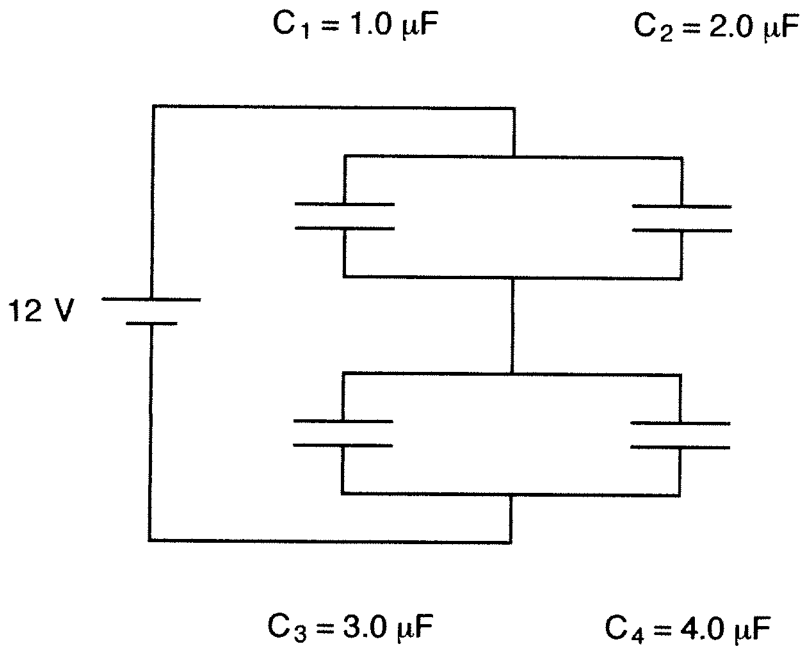
$$1.26 = \frac{x}{x-.015} \qquad 1.26x - .0189 = x$$

$$0.26x = .0189$$

$$x = .073$$

or **7.3 cm**

2. (40 pts) A system of four capacitors is arranged as shown below. Find the charge carried by each capacitor.



$C_{12} = 3.0\ \mu F$

$C_{34} = 7.0\ \mu F$

$$\frac{1}{C_{TOT}} = \frac{1}{3} + \frac{1}{7} \qquad C_{TOT} = 2.1\ \mu F$$

$$Q_{TOT} = C_{TOT}\,\Delta V_{TOT} = 25.2\ \mu C$$

$$\text{so } Q_{12} = Q_{34} = 25.2\ \mu C$$

$$\Delta V_{12} = \frac{25.2\ \mu C}{3\ \mu F} = 8.4\ V = \Delta V_1 = \Delta V_2$$

so $Q_1 = (1.0\ \mu F)(8.4) = 8.4\ \mu C$

$Q_2 = (2.0\ \mu F)(8.4) = 16.8\ \mu C$

$$\Delta V_{34} = \frac{25.2}{7} = 3.6\ V = \Delta V_3 = \Delta V_4$$

$Q_3 = (3.0)(3.6) = 10.8\ \mu C$

$Q_4 = (4.0)(3.6) = 14.4\ \mu C$

3. (30 pts) The resistivity of copper is 1.7 x 10-8 Ohm-m. Suppose you have a household wire with a diameter of 1.0 mm and length 45 meters and current of 11 Amps running through it. If the cost of energy is 12 cents/kW-hr, find out how much money is being lost due to the power dissipated by the resistance of the wire each day, to the nearest penny.

$$A = \frac{\pi(.001)^2}{4} = 7.854 \times 10^{-7}\, m^2$$

$$R = \rho \frac{l}{A} = 0.974\, \Omega$$

$$P = I^2 R = 117.9 \text{ Watts}$$

$$E(1\text{ day}) = \frac{117.9\text{ J}}{s} \cdot \frac{86400\text{ s}}{\text{day}} = 1.02 \times 10^7\ \text{J/day}$$

$$\text{Cost} = \frac{1.02 \times 10^7\text{ J}}{\text{day}} \cdot \frac{1\text{ kWhr}}{3.6 \times 10^6\text{ J}} \cdot \frac{12\text{ c}}{\text{kWhr}} = \boxed{34\ ¢}$$