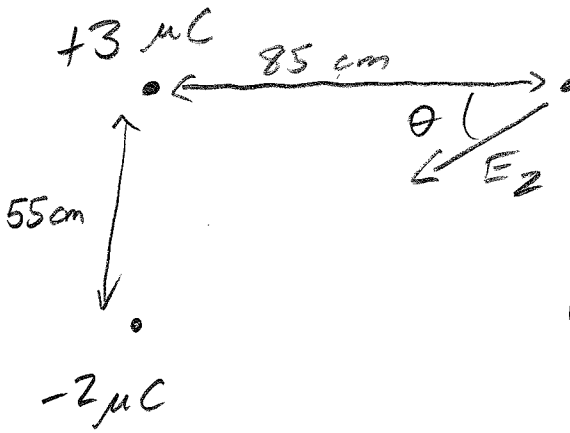
Physics 10164 - Exam 1B

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=0, y = -55 cm. What is the magnitude and direction of the electric field at the coordinate x = 85 cm, y = 0 cm?



$\theta = \tan^{-1}\left(\frac{55}{85}\right) = 32.9°$

$r_2 = \sqrt{.55^2 + .85^2} = 1.01$

$|E_3| = \frac{k q_3}{r_3^2} = \frac{(9\times10^9)(3\times10^{-6})}{.85^2}$

$= 3.74 \times 10^4$

$|E_2| = \frac{k q_2}{r_2^2} = \frac{(9\times10^9)(2\times10^{-6})}{1.01}$

$= 1.78 \times 10^4$

$E_{3,x} = 3.74 \times 10^4$

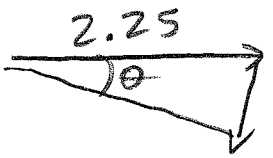
$E_{3,y} = 0$

$E_{2,x} = -(1.78\times10^4)\cos 32.9 = -1.49\times10^4$

$E_{2,y} = -(1.78\times10^4)\sin 32.9 = -0.967\times10^4$

$E_{TOT,x} = 2.25\times10^4$

$E_{TOT,y} = -0.967\times10^4$



$\tan^{-1}\left(\frac{.967}{2.25}\right)$

$E_{TOT} = 2.4\times10^4 \frac{V}{m}$

$\theta = 23°$ below $+x$

2. Parallel plates have equal and opposite charge densities of magnitude 4.5 nC/m^2 and are separated by a distance of 2.5 mm. An electron at rest on the negative plate is allowed to move freely. It accelerates toward and strikes the positive plate at what speed?

$$E = 4\pi k \sigma$$

$$= 4\pi (9\times10^{9})(4.5\times10^{-9}\ \tfrac{C}{m^2})$$

$$= 509\ \tfrac{V}{m}$$

$$\Delta V = Ed = 1.27\ \text{Volts}$$

$$\Sigma W_F = W_E = \Delta K$$

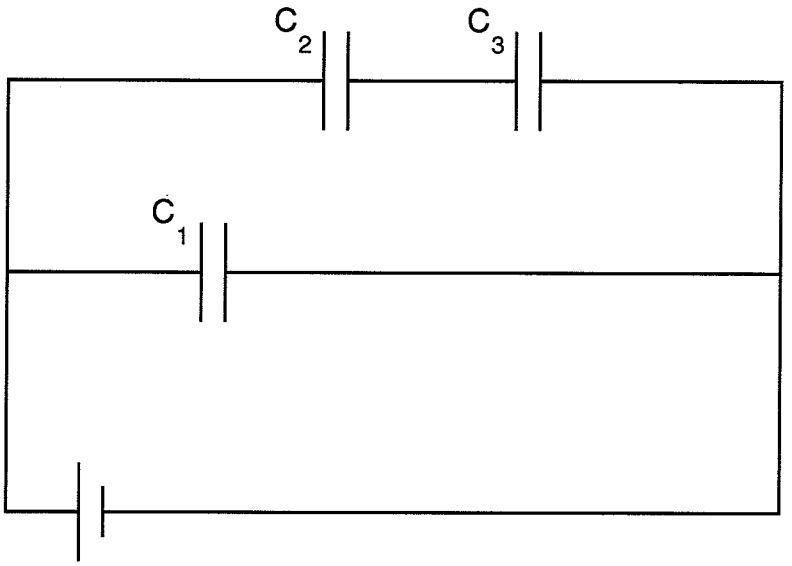
$$-q\Delta V = \tfrac{1}{2}mv^2 - 0$$

$$-(1.60\times10^{-19})(-1.27) = \tfrac{1}{2}(9.11\times10^{-31})v^2$$

$$2.03\times10^{-19} = 4.56\times10^{-31}\ v^2$$

$$\boxed{v = 6.7\times10^{5}\ m/s}$$

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



$$\Delta V_{TOT} = \Delta V_1 = \Delta V_{23} = 12\ V$$

$$\frac{1}{C_{23}} = \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{2\mu F} + \frac{1}{3\mu F}$$

$$C_{23} = 1.2\ \mu F$$

$$Q_{23} = C_{23}\,\Delta V_{23} = 14.4\ \mu C$$

$$Q_{23} = Q_2 = Q_3 = 14.4\ \mu C$$

or $\boxed{14\ \mu C}$

4. The cost of electricity is 14 cents per kilowatt-hour. If you leave home for Spring Break, you are gone for 11 days, let's assume. You leave your computer on, and over the break, it consumes energy at a rate of 35 watts. How much (in cents) does it cost to leave the computer on for this time?

$$\frac{35\ J}{s} \cdot \frac{11\ days}{} \cdot \frac{24\ hr}{day} \cdot \frac{3600\ s}{hr} = 3.33 \times 10^7\ J$$

$$Cost = 3.33 \times 10^7\ J \cdot \frac{14\ c}{kW\ hr} \cdot \frac{kW\ Hr}{3.60 \times 10^6\ J}$$

$$= \boxed{130\ cents}$$