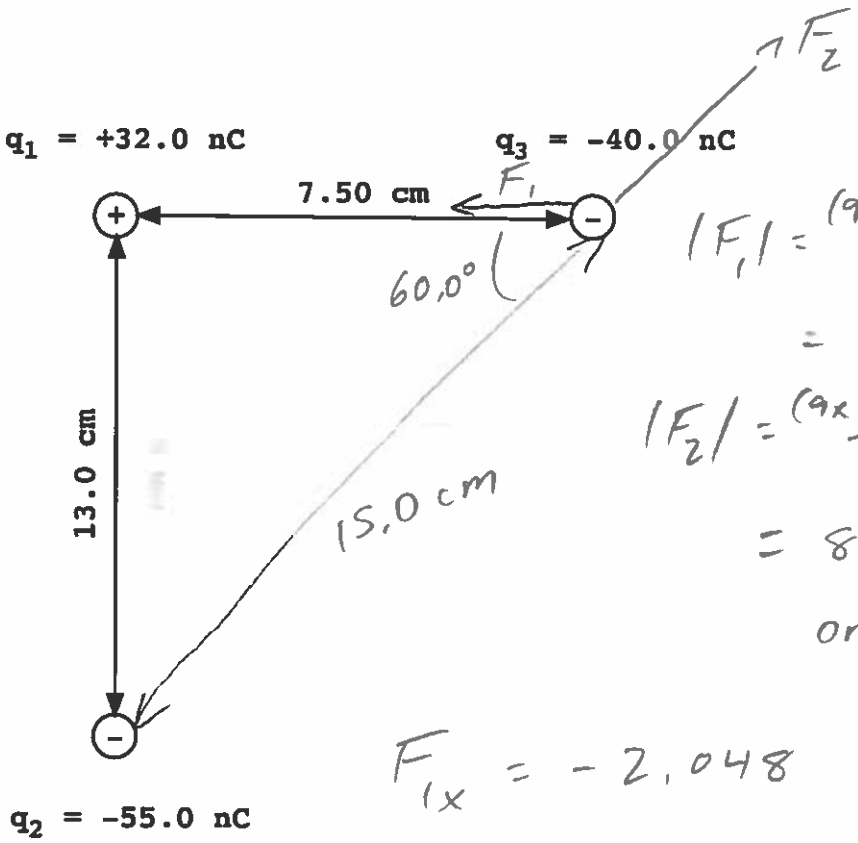
Physics 10164 - Exam 1

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) Three charges are arranged in as shown below and fixed in place. Determine the magnitude and direction of the electric force on charge q_3.



$$|F_1| = \frac{(9\times10^9)(32\times10^{-9})(40\times10^{-9})}{.075^2} = 2.048\times10^{-3}$$

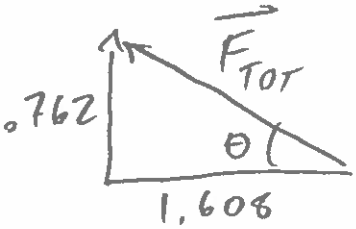
$$|F_2| = \frac{(9\times10^9)(55\times10^{-9})(40\times10^{-9})}{.15^2} = 8.80\times10^{-4}$$

or 0.88×10^{-3}

$F_{1x} = -2.048$ $\quad F_{1y} = 0$

$F_{2x} = .88\cos 60° = 0.44$ $\quad F_{2y} = .88\sin 60° = 0.762$

$= -1.608$ $\quad = 0.762$



$$|F_{TOT}| = \sqrt{1.608^2 + .762^2} = \boxed{1.78\times10^{-3}\ N}$$

$$\theta = \tan^{-1}\left(\frac{.762}{1.608}\right) = \boxed{25.4° \text{ above } -x}$$

2. (35 pts) An electron is released from rest at the negative plate of a capacitor and accelerates toward the positive plate. The plates are separated by a distance of 6.5 mm, and the electron strikes the positive plate with a speed of 4.5×10^6 m/s.

a) What is the magnitude of the (uniform) electric field between the plates?

b) If the plate separation is doubled while the potential difference between the plates remains the same, would your answer to part (a) change? Explain your answer.

c) Would the total charge on the positive plate of the capacitor change if the plate separation were doubled while the potential difference between the plates remains the same? Explain your answer.

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

$$|qEd| = \frac{1}{2}mv^2 - 0$$

$$E = \frac{mv^2}{2qd} = \frac{(9.11\times10^{-31})(4.5\times10^{6})^2}{2(1.6\times10^{-19})(6.5\times10^{-3})}$$

$$= \boxed{8900\ N/C}$$

b) $E = \frac{\Delta V}{d}$, so if ΔV same while $d\uparrow$

then $\boxed{\vec{E} \text{ must decrease}}$

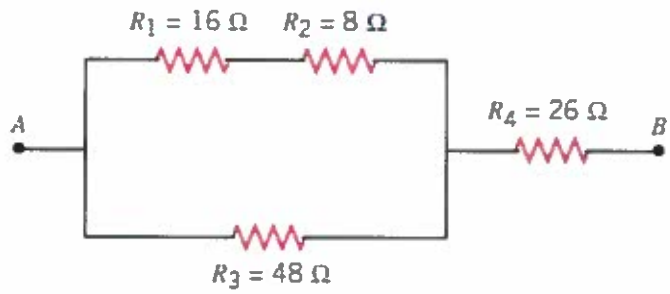
c) New $E = \frac{\Delta V}{d}$ (same) (increase) is smaller

Since $E \propto 4\pi k\sigma$, σ must be smaller

so $\boxed{Q \text{ decreases}}$

#3. (35 pts) For the circuit shown below, assume the voltage difference between points A and B is 480 Volts. Answer with 2 significant figures.

a) Find the current through resistor R_3.
b) Find the total power dissipated by resistor R_4.
c) If energy costs 12 cents per kilowatt-hour, how much does it costs to dissipate the energy from R_4 for one day, to the nearest cent?



$R_{12} = 24\ \Omega$

$\frac{1}{R_{123}} = \frac{1}{24} + \frac{1}{48}$

so $R_{123} = 16\ \Omega$

$R_{TOT} = 42\ \Omega$

$\Rightarrow I_{TOT} = \frac{480}{42} = 11.4\ A$

$I_{123} = I_4 = 11.4\ A$

$\Delta V_{123} = 182.86\ V$

so $\Delta V_3 = 182.86$

$I_3 = \frac{182.86}{48} = 3.8\ A$

b) $I_4 = 11.4\ A$, so $P_4 = (11.4)^2(26) = 3400\ W$

c) $\frac{3400\ J}{s} \cdot \frac{86400\ s}{day} \cdot \frac{1\ kWhr}{3.6 \times 10^6\ J} \cdot \frac{12\ ¢}{kWhr} = 979\ ¢$

or $\boxed{\$9.79}$