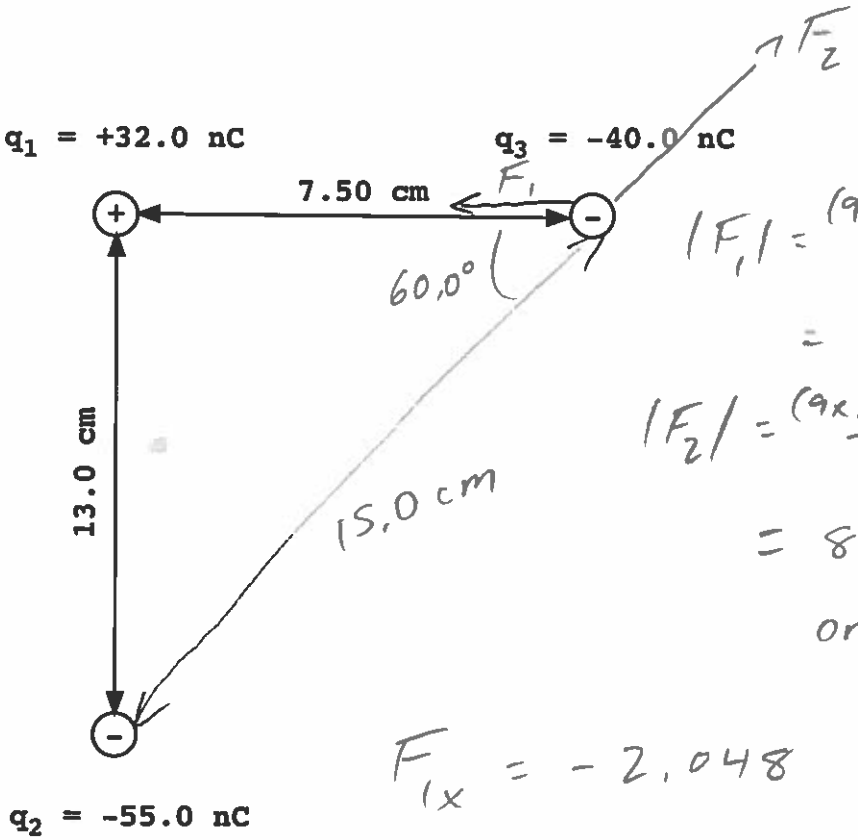
Physics 10164 - Exam 1B

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.



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

$$= 2.048\times10^{-3}$$

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

$$= 8.80\times10^{-4}$$

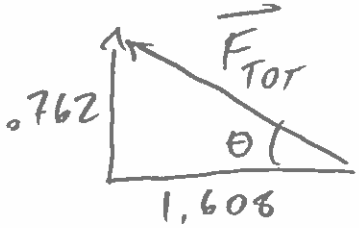
or 0.88×10^{-3}

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

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

$= 0.44$ $\quad = 0.762$

$= -1.608$ $\quad = 0.762$



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

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

2. (35 pts) Starting at the origin, a 23.0-gram particle with a net charge of -472 μC is moving in the +y direction with a velocity of 4.40 m/s. By the time the particle reaches a coordinate y = +1.45 m, it has slowed to 1.80 m/s. The electric potential at the origin is 240 Volts. + uniform $\vec{E}$

a) Assuming the electric force is the only relevant force in the problem, how much work is done by the electric force?
b) What is the electric potential at y = +1.45 N/C?
c) What is the magnitude and direction of the electric field that this particle is moving through?

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

$W_E = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$

$= \frac{1}{2}(.023)(1.80^2 - 4.40^2)$

$= \boxed{-0.185\ J}$

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b) $W_E = -q\Delta V$

negative charge slows when moving in same dir as $\vec{E}$, so V_f should be lower than V_i ✓

$-0.185 = -(-472 \times 10^{-6})\Delta V$

$\Delta V = -393\ V = V_f - V_i$

$-393 = V_f - 240$

$\boxed{V_f = -153\ Volts}$

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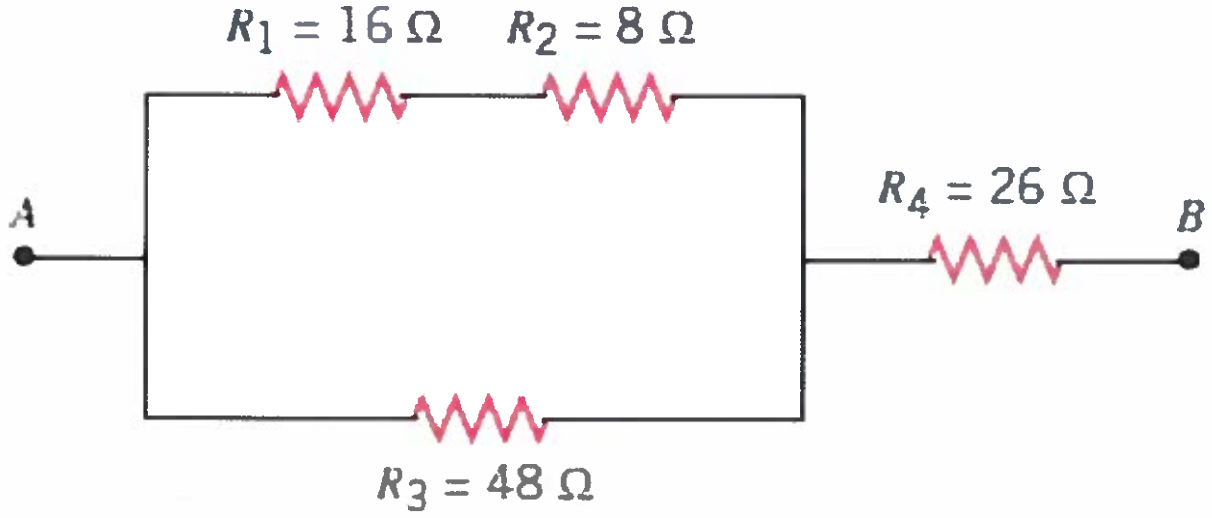
c) $|E| = \frac{\Delta V}{d} = \frac{393}{1.45} = 271\ N/C$

Since negative charge is slowing, $\vec{E}$ must point in same direction as motion.

$\boxed{\vec{E} = 271\ N/C, +y\ dir}$

#3. (35 pts) For the circuit shown below, assume the voltage difference between points A and B is 240 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?



a) $R_{12} = 24\ \Omega$

$$\frac{1}{R_{123}} = \frac{1}{24} + \frac{1}{48} \Rightarrow R_{123} = 16\ \Omega$$

$$R_{TOT} = 16 + 26 = 42\ \Omega$$

$$I_{TOT} = \frac{240}{42} = 5.71\ A$$

$$\Rightarrow I_{123} = 5.71\ A \Rightarrow \Delta V_{123} = (5.71)(16) = 91.4\ V$$

b) $P_4 = I_4^2 R_4$

$= (5.71)^2(26) =$ **848 Watts** $\Rightarrow \Delta V_3 = 91.4\ V$

$\Rightarrow I_3 = \frac{\Delta V_3}{R_3} =$ **1.90A**

c) $E = (848\ \frac{J}{s})(86400\ s) = 7.3 \times 10^7\ J$

$$7.3 \times 10^7\ J \cdot \frac{1\ kW \cdot hr}{3.6 \times 10^6\ J} \cdot \frac{12\ ¢}{kW\ hr} =$$ **244 cents**