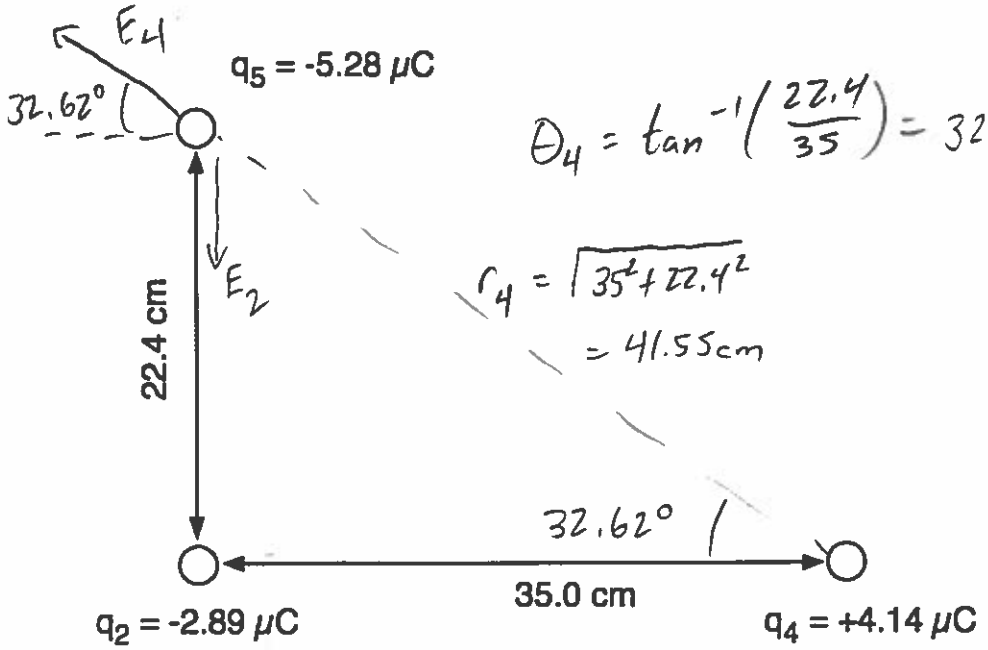
Sp 20 1F #1

A 244-gram mass (q_5) is located in the vicinity of two other charges as shown below.

a) What is the magnitude and direction of the electric field at the location of charge q_5 due to the other charges?
b) What is the magnitude and direction of the acceleration of charge q_5 as a result of the electric force it feels?



$\theta_4 = \tan^{-1}\left(\frac{22.4}{35}\right) = 32.62°$

$r_4 = \sqrt{35^2 + 22.4^2}$

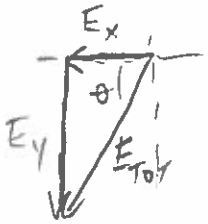
$= 41.55\text{cm}$

$|E_2| = \frac{k_c q_2}{r_2^2} = \frac{(9\times10^9)(2.89\times10^{-6})}{.224^2} = 5,184\times10^5 \frac{N}{C}$, $-y$

$|E_4| = \frac{k_c q_4}{r_4^2} = \frac{(9\times10^9)(4.14\times10^{-6})}{.4155^2} = 2,158\times10^5 \frac{N}{C}$, $32.62°$ above $-x$

$E_{TOT,x} = E_{2x} + E_{4x} = 0 - 1.818\times10^5 = -1.818\times10^5$

$E_{TOT,y} = E_{2y} + E_{4y} = -5.184\times10^5 + 1.163\times10^5 = -4.021\times10^5$



$E_{TOT} = \sqrt{E_x^2 + E_y^2} = \boxed{4.41\times10^5 \frac{N}{C}}$

$\theta = \tan^{-1}\left(\frac{4.021}{1.818}\right) = \boxed{65.7° \text{ below } -x}$

opp direction from $\vec{E}$ since q_5 −

b) $|a| = \frac{qE}{m} = \frac{(5.28\times10^{-6})(4.41\times10^5)}{.244} = \boxed{9.54 \text{ m/s}, 65.7° \text{ above } +x}$

Sp20 1F #2

A parallel-plate capacitor has a cross-sectional area of 9.4 cm^2 and a plate separation of 0.35 mm. It is connected to a 12-Volt battery.

a) What is the charge on the positive plate of the capacitor?
b) What is the magnitude of the electric field between the plates?

$$C = \frac{\text{Area}}{4\pi k_c d} = \frac{(9.4\times10^{-4})}{4\pi(9\times10^{9})(.35\times10^{-3})} = 2.4\times10^{-11}\ F$$

a) $Q = C\Delta V = (2.375\times10^{-11})(12) = \boxed{2.8\times10^{-10}\ C}$

b) $E = \frac{4\pi k_c Q}{A} = \frac{4\pi(9\times10^{9})(2.8\times10^{-10})}{9.4\times10^{-4}} = \boxed{34{,}000\ \frac{V}{m}}$

The battery is disconnected, and a K = 7.2 dielectric is inserted between the plates.

c) What is the voltage difference between the plates now?
d) What is the charge on the positive plate now?
e) What is the capacitance of the capacitor with the dielectric inserted?

c) $\vec{E}$ drops by 7.2 due to cancellation of field, since $\Delta V = Ed$, ΔV also drops to $\frac{12}{7.2} = \boxed{1.7\ \text{Volts}}$

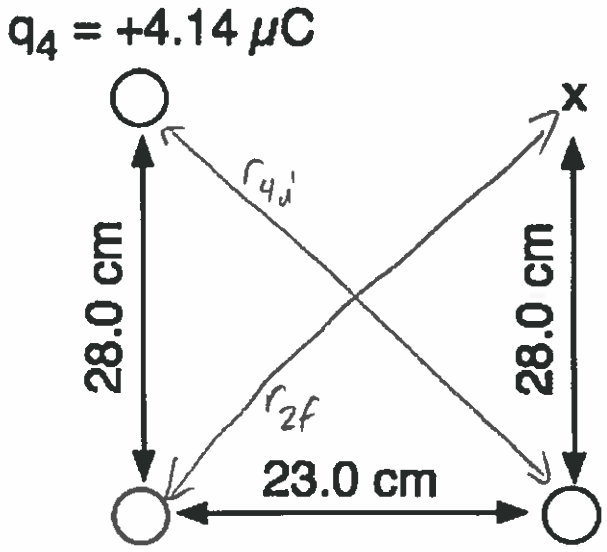
d) Q same (nowhere for charge to go!)

$$\boxed{Q = 2.8\times10^{-10}\ C}$$

e) $C_{new} = KC_{orig} = \boxed{1.7\times10^{-10}\ F}$

Sp 20 1F #3

For the arrangement shown below, calculate the work done by the electric force as charges q_2 and q_4 remain fixed in place while charge q_5 moves from its initial location shown to point x, which is directly above its initial location.



$r_{4i} = r_{2i} = \sqrt{.23^2 + .28^2}$

$= 0.3624$

$V_i = \frac{k_c q_2}{r_{2i}} + \frac{k_c q_4}{r_{4i}} = \frac{(9\times10^9)(-2.89\times10^{-6})}{.23} + \frac{(9\times10^9)(4.14\times10^{-6})}{.3624}$

$= -113087 + 102815 = -10272$ Volts

$V_f = \frac{(9\times10^9)(-2.89\times10^{-6})}{.3624} + \frac{(9\times10^9)(4.14\times10^{-6})}{.23}$

$= -71772 + 162000 = +90228$ Volts

$W_E = -q_5 \Delta V = -(-5.28\times10^{-6})(90228 - (-10272))$

$= \boxed{0.531\ J}$