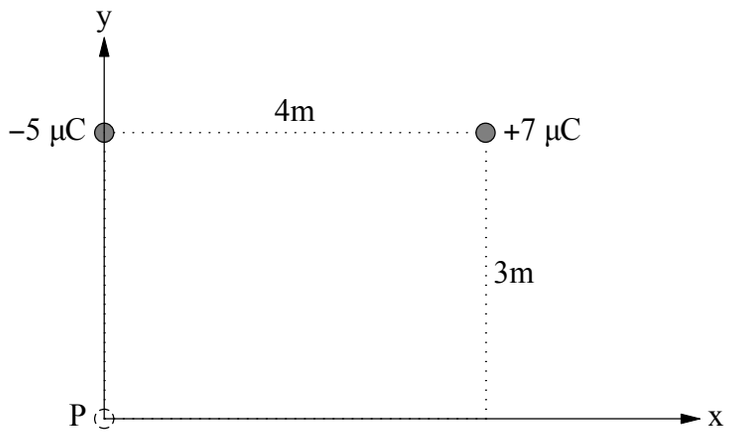
2. (40 pts.) Two charges are arranged as shown in the following figure.



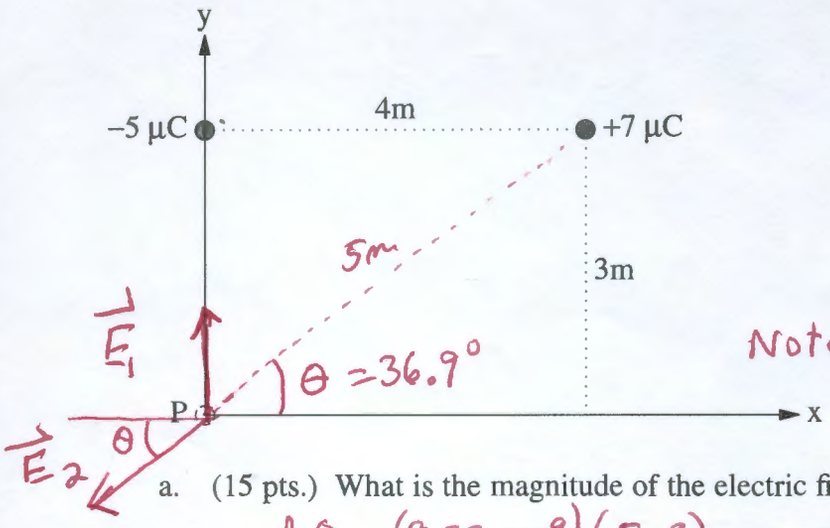
a. (15 pts.) What is the magnitude of the electric field at the point "P" at the origin?

b. (5 pts.) What is the direction of the electric field at point P?

c. (5 pts.) Suppose that a -2 nC charge were placed at the origin. What would be the magnitude and direction of the electric force on the charge?

d. (15 pts.) Lastly, what would be the electrical potential energy of the -2nC charge due to the other two charges?

2. (40 pts.) Two charges are arranged as shown in the following figure.



$\vec{E}_1$ = field due to −5μC

$\vec{E}_2$ = field due to +7μC

Note: the angle is not 45°!

a. (15 pts.) What is the magnitude of the electric field at the point "P" at the origin?

$$E_1 = \frac{kQ_1}{r_1^2} = \frac{(8.99\times10^9)(5\mu C)}{(3)^2} = 4.99\times10^3\ N/C \ @\ 90^\circ$$

$$E_2 = \frac{kQ_2}{r_2^2} = \frac{(8.99\times10^9)(7\times10^{-6})}{(5)^2} = 2.517\times10^3\ N/C \ @\ (180^\circ+36.9^\circ)$$

x-components: $E_x = E_2\cos 216.9^\circ = -2014\ N/C$

y-components: $E_y = E_1 + E_2\sin(216.9^\circ) = +3484\ N/C$

Magnitude $E = \sqrt{E_x^2 + E_y^2} = 4024\ N/C \ @\ 120^\circ$

b. (5 pts.) What is the direction of the electric field at point P? 120°.

$$\tan\theta = \frac{E_y}{E_x} = \frac{3484}{-2014} \Rightarrow \theta = 120^\circ$$ [Note quadrant! See Appendix A-8.]

c. (5 pts.) Suppose that a -2 nC charge were placed at the origin. What would be the magnitude and direction of the electric force on the charge?

$\vec{F} = q\vec{E}$ [Note: No need to repeat vector calculations of part a.]

magnitude

$F = (2\times10^{-9}\,C)(4024\,N/C) = \boxed{8.048\times10^{-6}\,N}$

direction: $120^\circ + 180^\circ = \boxed{300^\circ = -60^\circ}$

because it is a negative charge

d. (15 pts.) Lastly, what would be the electrical potential energy of the -2nC charge due to the other two charges?

1st compute V at P:

$$V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2} = (8.99\times10^9)\left[\frac{-5\times10^{-6}}{3} + \frac{7\times10^{-6}}{5}\right]$$

$V = -2397$ Volts.

Then, compute

$U = q_o V = (-2\times10^{-9}\,C)(-2397\text{ volts}) =$

$\boxed{U = 4795\times10^{-6}\,J}$