PHYS 111
1ST semester 1439-1440

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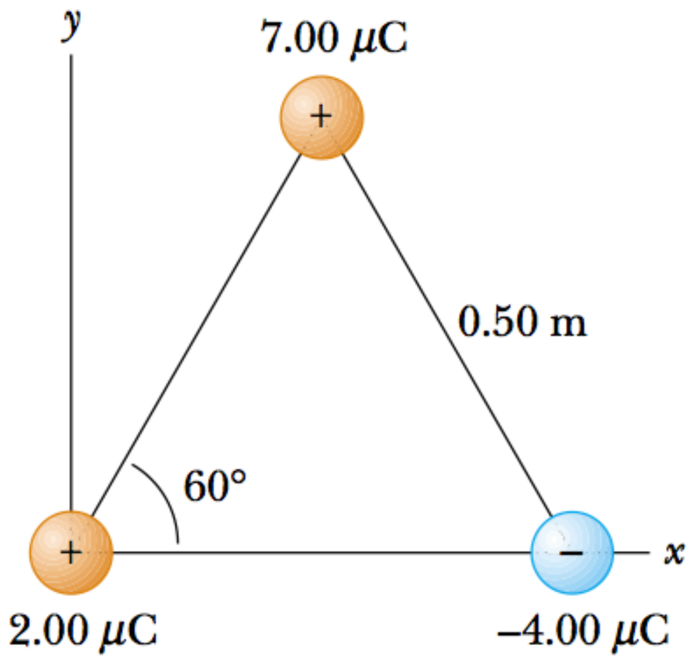
Lecture 6

HW Problem (Electric Force)

- Three point charges are located at the corners of an equilateral triangle as shown in the Figure. Calculate the resultant electric force on the 7.00μC charge.



23.4 The Electric Field

- $$\mathbf{E} = k_e \frac{q}{r^2}\,\hat{\mathbf{r}}$$

Quick Quiz 23.6 A test charge of $+3\ \mu C$ is at a point P where an external electric field is directed to the right and has a magnitude of 4×10^6 N/C. If the test charge is replaced with another test charge of $-3\ \mu C$, the external electric field at P (a) is unaffected (b) reverses direction (c) changes in a way that cannot be determined

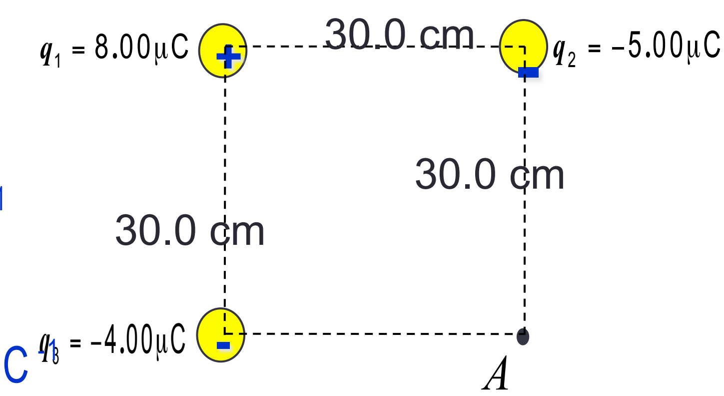
Example

- Three charges are placed on three corners of a square, as shown in the figure. Each side of the square is 30.0 cm. Calculate the electric field strength at point A. What would be the force on a 6.00 μC charge placed at the point A?

$$E_{A1} = \frac{kq_1}{r_1^2} = \frac{(9.0\times10^{9})(8.00\times10^{-6})}{(42.4\times10^{-2})^2} = 4.00\times10^{5}\ \mathrm{N\ C^{-1}}$$

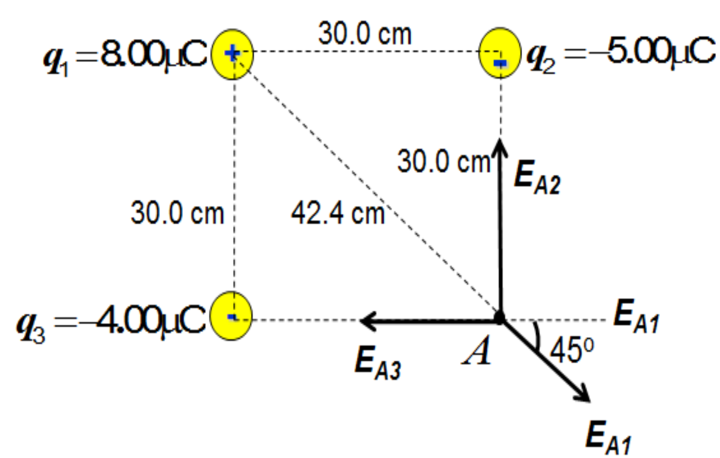
$$E_{A2} = \frac{kq_2}{r_2^2} = \frac{(9.0\times10^{9})(5.00\times10^{-6})}{(30.0\times10^{-2})^2} = 5.00\times10^{5}\ \mathrm{N\ C^{-1}}$$

$$E_{A3} = \frac{kq_3}{r_3^2} = \frac{(9.0\times10^{9})(4.00\times10^{-6})}{(30.0\times10^{-2})^2} = 4.00\times10^{5}\ \mathrm{N\ C}$$



$$\sum E_{AX} = E_{A1}\cos 45^o - E_{A3}$$
$$= -1.17\times10^{5}\mathrm{N/C}$$

$$\sum E_{AY} = E_{A2} - E_{A1}\sin 45^o$$
$$= 2.17\times10^{5}\mathrm{N/C}$$

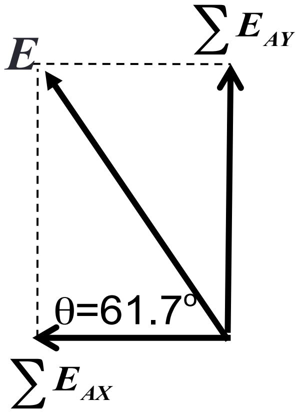


Example

- $$E = \sqrt{\sum E_{AX}{}^2 + \sum E_{AY}{}^2}$$
  $$E = 2.46 \times 10^5 \text{ N/C}$$

$$\tan\theta = \frac{\sum E_{AY}}{\sum E_{AX}}$$

$$\theta = 61.7°$$



23.6 Electric Field Lines

- **40.** Figure P23.40 shows the electric field lines for two point charges separated by a small distance.
- (a) Determine the ratio $q1/q2$.
- (b) What are the signs of $q1$ and $q2$?

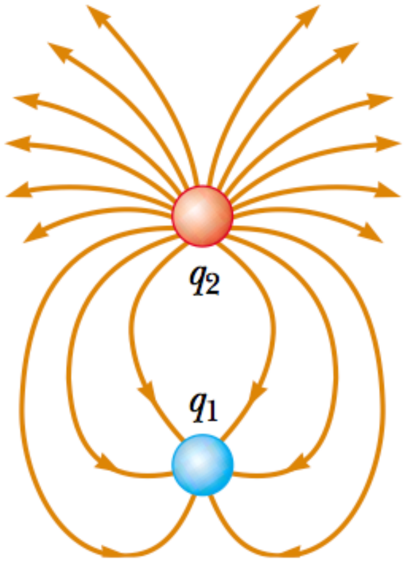
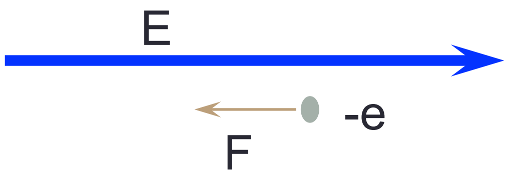


Figure P23.40

23.7 Motion of Charged Particles in a Uniform Electric Field

- **Example:** Determine the final velocity and kinetic energy of an electron released from rest in the presence of a uniform electric field of 300 N/C in the x direction after a period of 0.5 ms.



$$\vec{F} = q\vec{E} = -eE\hat{i}$$

$$\vec{F} = -\left(1.60\times10^{-19}\,C\right)\left(300\,\frac{N}{C}\right)\hat{i}$$

$$\vec{F} = -\left(4.80\times10^{-17}\,N\right)\hat{i}$$

$$\vec{a} = \frac{\vec{F}}{m} = \frac{-\left(4.80\times10^{-17}\,N\right)\hat{i}}{9.11\times10^{-31}\,kg} = -\left(5.3\times10^{+13}\,\frac{m}{s^2}\right)\hat{i}$$

$$\vec{v} = \vec{v}_o + \vec{a}t$$

$$\vec{v} = 0 - \left(5.3\times10^{+13}\,\frac{m}{s^2}\,\hat{i}\right)\left(0.5\times10^{-3}\,s\right)$$

$$\boxed{\vec{v} = -2.6\times10^{10}\,\frac{m}{s}\,\hat{i}}$$

$$K = \frac{1}{2}mv^2 \quad K = \frac{1}{2}\left(9.11\times10^{-31}\,kg\right)\left(-2.6\times10^{10}\,\frac{m}{s}\right)^2$$

$$\boxed{K = 3.16\times10^{-10}\,J}$$

Questions

- Q23.22 **Consider two equal point charges separated by some distance *d*. At what point (other than infinity) would a third test charge experience no net force?**

  At a point exactly midway between the two changes.

- Q23.19 **Explain what happens to the magnitude of the electric field created by a point charge as *r* approaches zero.**

  The electric field around a point charge approaches infinity as r approaches zero.

- Q23.20 **An object with negative charge is placed in a region of space where the electric field is directed vertically upward. What is the direction of the electric force exerted on this charge?**

  Vertically downward.