Coulomb's Law, Electric Field

Lecture 7

PH-122

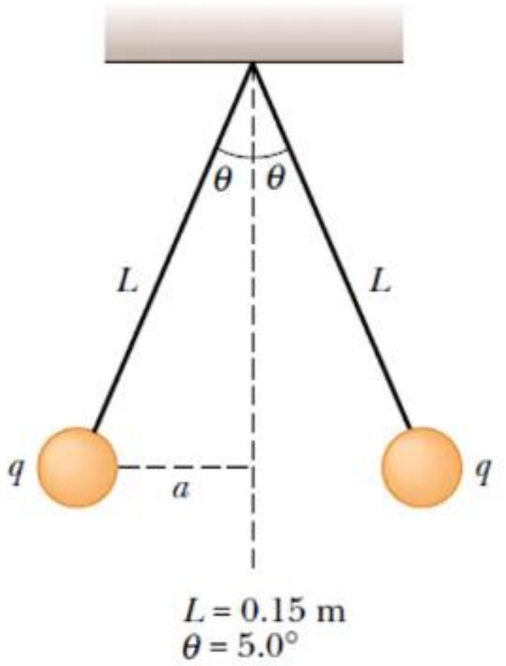
Coulomb's Law

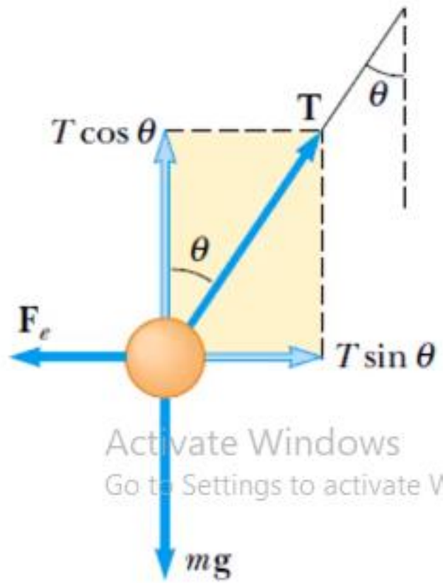
- $F = kqq_0/r^2$ (magnitude of force)
- $\vec{F}_{12} = \frac{kq_1q_2}{r_{12}}\hat{r}_{12}$(vector from of Coulomb's law)
- For multiple charges net force is found by vector addition of all forces through super-position principle.

$$\vec{F} = \sum_{i=1}^{n} \overrightarrow{F_i}$$

Problem

Two identical small charged spheres, each having a mass of $3X10^{-2}$kg, hang in equilibrium as shown in Figure. The length of each string is 0.15 m, and the angle θ is 5.0°. Find the magnitude of the charge on each sphere.





Solution

$$\sum F_x = T\sin\theta - F_e = 0$$

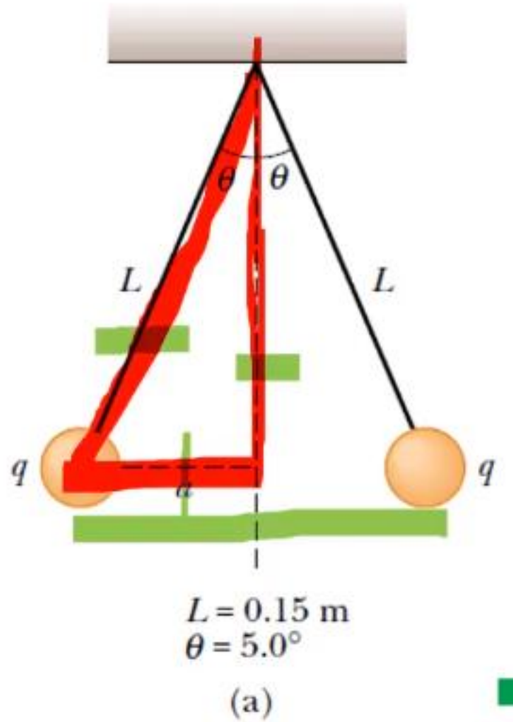
$$\sum F_y = T\cos\theta - mg = 0$$

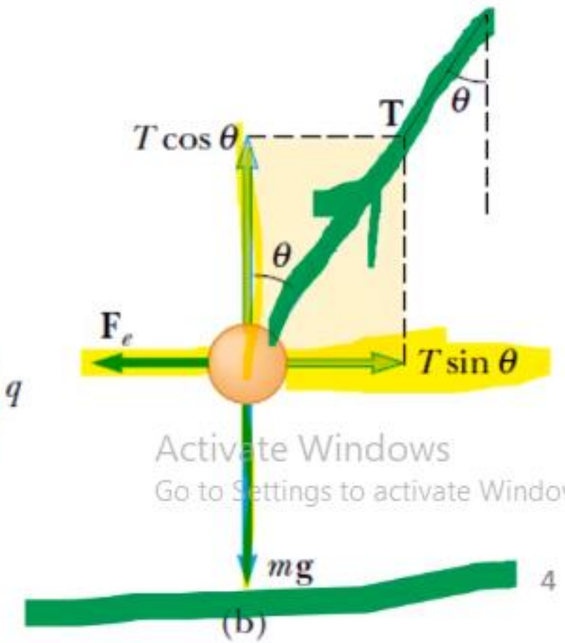
$$F_e = mg\tan\theta = (3.0\times10^{-2}\ \text{kg})(9.80\ \text{m/s}^2)\tan(5.0°)$$

$$= 2.6\times10^{-2}\ \text{N}$$

$$a = L\sin\theta = (0.15\ \text{m})\sin(5.0°)$$

$$= 0.013\ \text{m}$$





Continued....

$$|q|^2 = \frac{F_e r^2}{k_e} = \frac{(2.6 \times 10^{-2}\ \mathrm{N})(0.026\ \mathrm{m})^2}{8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2}} = 1.96 \times 10^{-15}\ \mathrm{C^2}$$

$$|q| = 4.4 \times 10^{-8}\ \mathrm{C}$$

Electric Field

- Force exerted per unit positive unit test charge

$$E = \frac{F}{q_0}$$

- Similar to force due to multiple charges, electric field due to multiple charges is also given by super-position principle.

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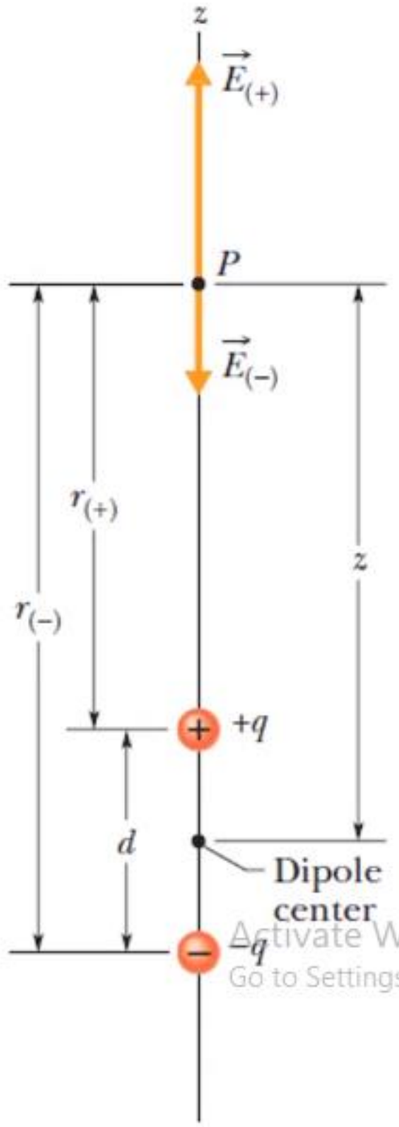
Electric Field due to Electric Dipole



or

Problem

Find the electric field at the center of square shown in figure. Assume that $q_1 = 11.8nC, q_2 = -11.8nC$ $q_3 = 23.6nC, q_4 = -23.6nC$ and $a = 5.2cm.$