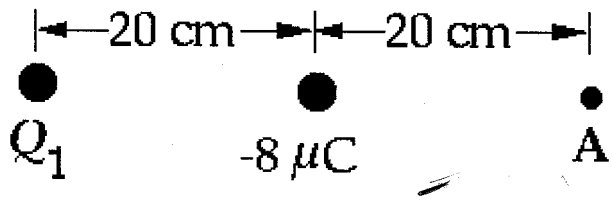
September 21, 2007
Physics 272 Exam 1:

Name: Solution

The value of the electric constant $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$

Solve the four problems in the exam.

1.-



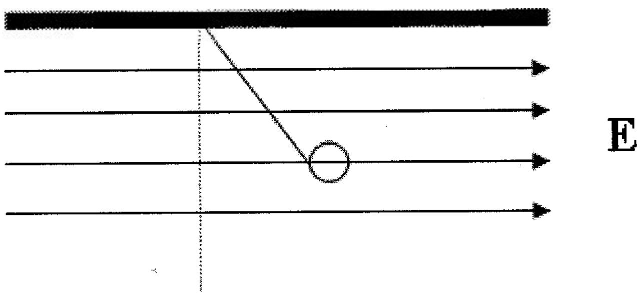
The electric field at point A is zero. What is charge Q_1?

in the x direction only

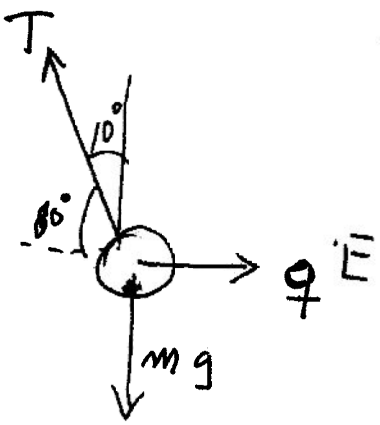
$$\frac{Q_1}{(40)^2} + K\frac{(-)8\times10^{-6}}{(.2)^2} = 0$$

$$Q_1 = \left(\frac{.4}{.2}\right)^2 \times 8\times10^{-6}$$

$$Q_1 = 32\times10^{-6}\ C \quad \text{positive}$$



2.-
A bob of mass m (m = 0.500 g), and charge magnitude Q (Q = 50.0 μC) is held by a massless string in a uniform electric field E. If the bob makes an angle of 10.0 degrees with the vertical, then calculate the magnitude of the electric field E and the sign of the bob charge Q.



Forces y direction

$$T_y = mg$$

$$T\cos\theta = mg$$

$$T = \frac{mg}{\cos\theta}$$

Forces x direction

$$T_x = qE$$

$$T\sin\theta = qE$$

$$mg\tan\theta = qE$$

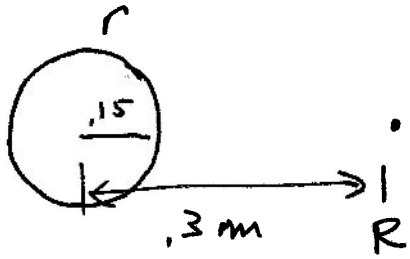
$$\frac{mg}{q}\tan\theta = E$$

$$\frac{.5\times10^{-3}\times 9.81}{50\times10^{-6}}\tan 10 \;(.176) = \oplus\ \text{[crossed out]}$$

↑ 17,27 N/C

The Field lines point towards negative charges. The bob is attracted → ⊕

3.- A solid spherical conductor has a radius of 15 cm. The electric field 30 cm from the center of this sphere has a magnitude of 800 N/C. What is the surface charge density σ on the sphere?



800 N/C

$$\frac{Q}{\varepsilon_0} = E \times 4\pi R^2$$

$$\sigma = \frac{Q}{A}$$

$$Q = \varepsilon_0 \times 4\pi R^2 E$$

$$\sigma = \varepsilon_0 \times \frac{4\pi}{4\pi}\left(\frac{R}{r}\right)^2 E$$

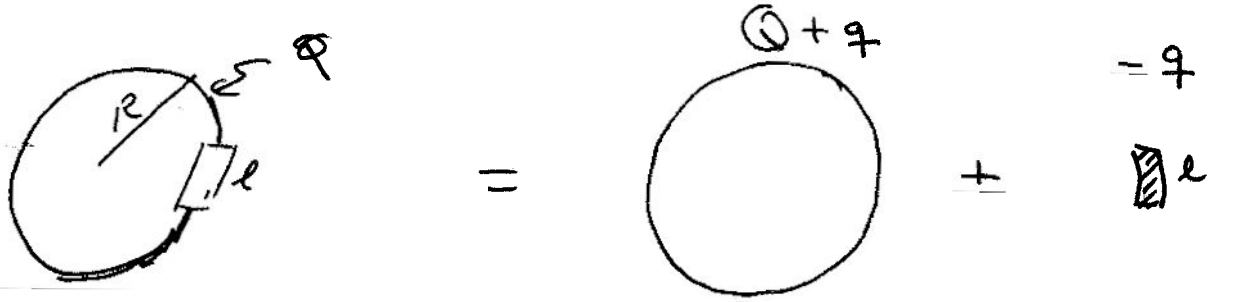
$$\sigma = 4\ 800 \cdot 8.85 \times 10^{-12}$$

$$= 2.83 \times 10^{-8}\ C/m^2$$

4.- A long, thin, nonconducting plastic rod is bent into a loop with radius R. Between the ends of the rod, a small gap of length l ($l<R$) remains. A charge Q is equally distributed on the rod.

a) Indicate the direction of the electric field at the center of the loop.

b) Find the magnitude of the electric field at the center of the loop.



pointing out towards the gap

direction for Q positive

⟶ towards gap

magnitude

$2\pi R - l = L \qquad \lambda = \frac{Q}{L}$

$$q = \lambda l = \frac{Q l}{L} = \frac{Q l}{2\pi R - l} \simeq \frac{Q l}{2\pi R}$$

Treat as point charge.

$$E = \frac{1}{4\pi\epsilon_0} \frac{\frac{Q l}{2\pi R - l}}{R^2} \simeq \frac{1}{4\pi\epsilon_0} \frac{Q l}{2\pi R^3}$$