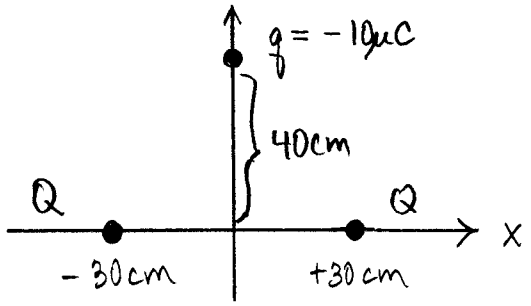
Physics 104 **QUIZ #1** **Fall 2006**

NAME: _____

SECTION # : _____

TA: _____

Two identical charges, Q, are placed on the x axis, one at $x = 30\,\text{cm}$ and the other at $x = -30\,\text{cm}$. In an experiment you find that a 100 gram ball with charge $q = -10\mu\text{C}$ can be suspended (in equilibrium) 40 cm above the origin.



$$E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$$
$$\vec{F} = q\vec{E}$$
$$k_e = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9\,\text{N}\cdot\text{m}^2/\text{C}^2$$
$$g = 9.8\,\text{m/s}^2$$

(*a*) Are the charges Q positive or negative?

Like charges repel, so Q must be **negative**

(*b*) The charges Q produce an electric field at q. What is the direction of that field?

The force on q is upward, and since q is negative $\vec{E}$ must be **downward** ($\vec{F} = q\vec{E}$ means $\vec{E}$ + $\vec{F}$ opposite for negative q)

Alternatively, note that since Q is negative, the fields must point inward towards Q.

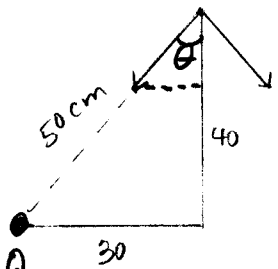
(*c*) Find the magnitude of that same electric field.

$qE = mg$ so

$E = mg/q = (0.1\text{kg})(9.8\,\text{m/s}^2) / (10\mu\text{C})$ ↳ 10^{-5}C

$$\boxed{E = 9.8 \times 10^{+4}\,\text{N/C}}$$

(*d*) Find Q. From Coulomb's law the magnitude of the field is



$E = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2}$ where $r = 0.5\text{m}$

The x-components cancel and the y components add so

$E_y = \left(\frac{1}{4\pi\epsilon_0}\right)\cdot 2\cdot\frac{Q}{r^2}\cos\theta$ $\cos\theta = 40/50 = 0.8$

$Q = E_y \cdot r^2 / 2\left(\frac{1}{4\pi\epsilon_0}\right)\cos\theta = 9.8\times10^4\,\frac{\text{N}}{\text{C}}\,(0.5\text{m})^2 / 2(9\times10^9)(0.8) = \boxed{1.7\times10^{-6}\,\text{C}}$