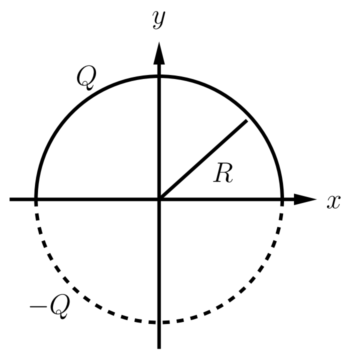
Name: .... Section:.................

Physics 208 Quiz 2

January 25, 2008 (due: February 1, 2008)

Problem 1 (50 points)



A circle (radius, R) is located in the center of a Cartesian coordinate system (see figure). The upper half is uniformly charged with charge, Q, the lower half with charge, $-Q$

(a) Calculate the electric field, $\vec{E}$, at the center of the circle!

(b) What is the force on a test charge, q_0, located in the center?

Problem 2 (50 points)

A particle with mass, m, and charge, $q < 0$, moves in the field of a point charge, $Q > 0$, which is fixed in the origin of a Cartesian coordinate system. The particle starts at rest in a distance, R, on the x axis of a Cartesian coordinate system: $\vec{r}_0 = R\vec{i}_x$, $\vec{v}_0 = 0$.

(a) What is the force, acting on the particle with charge, q. Write down its equation of motion:

$$m\vec{a} = m\frac{\mathrm{d}^2\vec{r}}{\mathrm{d}t^2} = \vec{F}(\vec{r}).$$

(b) Show that the particle moves in a straight line along the x axis!

(c) Prove the energy-conservation law:

$$\frac{m}{2}\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2 + \frac{qQ}{4\pi\epsilon_0|x|} = E = \text{const.} \tag{1}$$

What is E (in terms of m, q, Q, and R)?

Hint: Take the time derivative of the expression above and use the equation of motion for x to show that it vanishes, i.e., $\mathrm{d}E/\mathrm{d}t = 0$. To find E, plug the initial condition into Eq. (1). For simplification, you can assume that $x > 0$.

(d) (for extra credit): How long does it take for the particle to reach the center (where the charge, Q, sits).

Hint: use the energy-conservation law from part (c)! You can use the following integral:

$$\int_0^R \mathrm{d}x\sqrt{\frac{x}{R-x}} = \frac{\pi R}{2}.$$