Massachusetts Institute of Technology *Spring Term 2005*

8.02X Electricity and Magnetism

Quiz #1

Tuesday, Feb 22 10:05-10:55am

The quiz has four questions. It is a closed book quiz. No calculators are allowed.
A letter-size formula sheet can be used, but has to be signed and submitted together with the quiz.

LAST NAME

FIRST NAME

MIT ID#

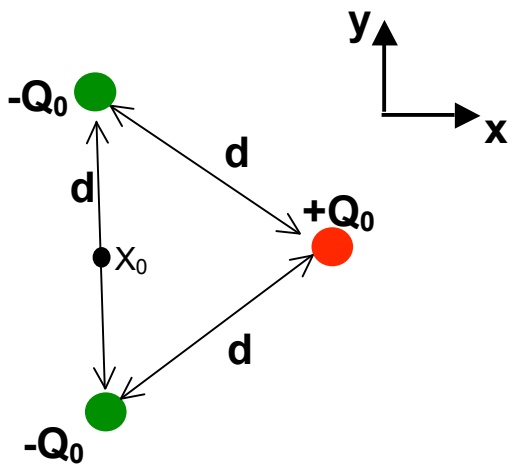
Problem 1 (25 points)

Consider the configuration of point charges shown below, with two negative charges $-Q_0$ and a positive charge $+Q_0$ forming a equilateral triangle (all sides have length d) in the x-y plane.

(a) What is the direction and magnitude of the force on the positive charge $+Q_0$ in terms of the given quantities?

(b) What is the direction and magnitude of the electric field at point x_0 halfway in between the two negative charges?

(c) Now, assume that the two negative charges are fixed in space and that $+Q_0$ is freely movable. Describe the motion $+Q_0$ would undergo if released from rest from the original position shown below (2-3 sentences)



Problem 2 (25 points)

In lecture, you saw that an electrically charged plexiglass rod could be used to attract electrically neutral objects like a balloon made out of conducting foil.

(a) In a few sentences, explain the origin of the force between a charged object like the rod and an electrically neutral conducting object.

(b) Attraction can also be seen between a charged object and electrically neutral insulators. For example, the rod can be used to pick up pieces of confetti. How does this differ from the process described in (a)?

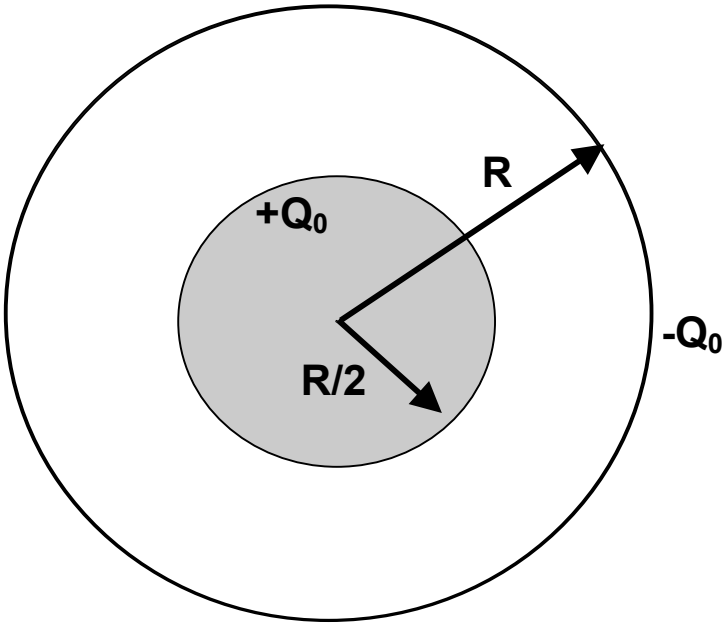
Problem 3 (25 points)

Shown below is the cross-section of a conducting sphere of radius R/2, surrounded by a very thin conducting spherical shell of radius R. The inner sphere carries a charge $+Q_0$ and the outer shell carries a charge $-Q_0$.

(a) On the figure, indicate the distribution of charge on the inner sphere.

(b) Using Gauss's Law, find the strength of the electric field E(r) as a function of r from r=0 to r > R, where r is the distance from the center of the sphere. Results without work will not receive credit.

(c) On the figure, show your solution to (b) using field lines



Problem 4 (25 points)

Shown below is the cross-section of two large parallel plates carrying charges +Q (top) and -Q (bottom). Each plate has area A. Vertically between the plates, a small charged particle with charge q and mass m is suspended at y=d/2, i.e. the force of gravity F_G = -m*g and the electrostatic force on the particle cancel.

(a) What is the sign of the small particles charge q?

(b) Determine q in terms of the other quantities given. Neglect fringe effects for the electric field created by the two plates.

(c) Sketch the electric potential energy U_E of the charged particle as a function of y from y=0 to y=d, assuming U_E = 0 at y=0.

(d) Sketch the total potential energy U_T of the particle as a function of y from y=0 to y=d.

(e) Sketch the electric potential V between the plates (ignore the charge q) from y=0 to y=d.