Exam 1

P208 Fall 2008,
Instructor: Prof. Abanov

09/17/08

Name_____   Section_____
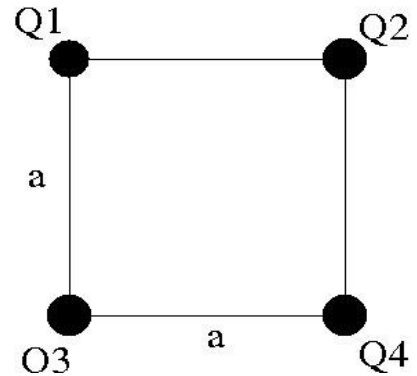
(print clearly in block letters)

Problem 1.

Four charges Q1, Q2, Q3, and Q4 are positioned in the corners of a square whose side measures a=0.5m. Q1=+3.0mC, Q4=+3.0mC, and Q2= +1.0mC are all positive.

Q1   Q2

a

O3   a   Q4

What is the magnitude and direction of the force with which charge Q1 acts on charge Q2?_____ (show direction on the figure)
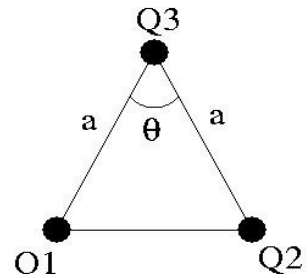
What is the magnitude and direction of the force with which charge Q4 acts on charge Q2?_____ (show direction on the figure)

What does Q3 have to be so that the total force on Q2 to be zero?_____

What will be the total force acting on Q2 if we double Q3?_____

Problem 2.

Three charges Q1, Q2, and Q3 are positioned in the corners of a triangle whose side measures a=0.5m and angle $\theta = 60°$ Q1=Q2=+3.0mC and Q3= +1.0mC.

What is the magnitude and direction of the force with which charge Q1 acts on charge Q3?_____ (show direction on the figure)
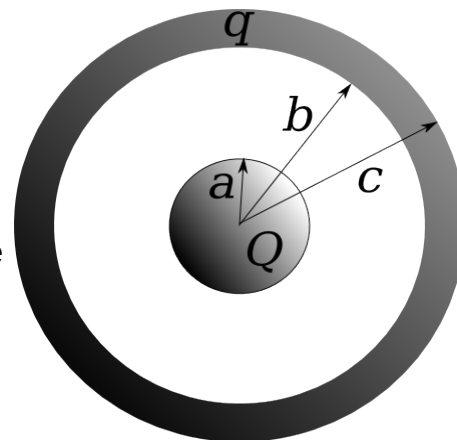
What is the magnitude and direction of the force with which charge Q2 acts on charge Q3?_____ (show direction on the figure)

What is the magnitude and direction of the total force which acts on charge Q3? _____ (show direction on the figure)

What would be the magnitude and direction of the total force which acted on charge Q3, if charge Q2= -3.0mC (negative 3.)?_____ (show direction on the figure)

Problem 3.

A solid, conducting sphere of radius a =3.5cm carries an excess charge of Q=+6.0μC. This sphere is located at the center of a hollow, conducting sphere (shell) with an inner radius of b = 10.0cm and an outer radius of c = 12.0cm as shown. The hollow sphere also carries a total excess charge of q=+6.0μC.

What is the magnitude and direction of the electric field at a distance 2cm from the center?_____

What is the magnitude and direction of the electric field at a distance 5cm from the center?_____

What is the magnitude and direction of the electric field at a distance 11cm from the center?_____

What is the magnitude and direction of the electric field at a distance 15cm from the center?_____

What is the total charge at the outer surface of the hollow sphere?_____

What is the potential difference between the solid and the hollow spheres?_____

Problem 4.

Two protons are released from the rest when they are 0.8nm apart.

What is the maximum speed they will reach?_____

When does this speed occur?_____

What is the maximum acceleration they will achieve?_____

When does this acceleration occur?_____

Problem 5.

Three charges Q1, Q2, and Q3 are positioned in the corners of a triangle whose side measures a=0.5m and angle $\theta=60°$ Q1=Q2=+3.0mC and Q3= +1.0mC. The mass of charge Q3 is M=10g. At initial time the charge Q3 is released.

Q3

a θ a

Q1   Q2
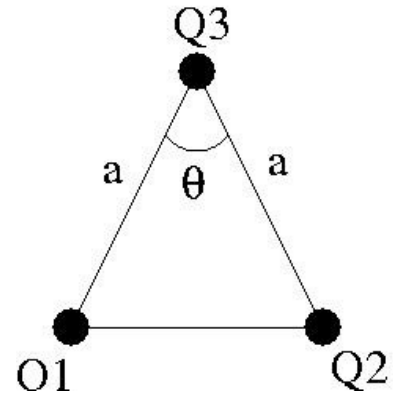
What is initial acceleration of the charge Q3?_____

What is the velocity of the charge Q3 at infinity?_____

What would the velocity at infinity be if charge Q3 started slightly off the midpoint between charges Q1 and Q2?_____

Problem 6.

For two equal in magnitude but opposite charges $+Q$ and $-Q$ we can define a vector of dipole moment $\vec{p}$, with the magnitude $|\vec{p}|=dQ$, where d is the distance between the charges. The direction of $\vec{p}$ is the direction from negative to positive charge – see figure.

$\vec{E}$

$\vec{p}$ $+Q$

$-Q$
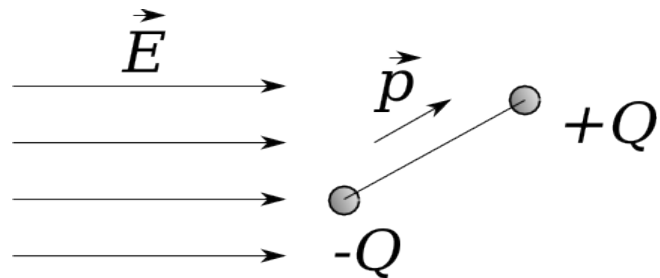
What force acts on the dipole in a uniform electric field $\vec{E}$?_____

What torque is acting on the dipole?_____

Problem 7.

A spherically symmetric charge distribution has a charge density $\rho(r)=\rho_0\left(1-5r^2/3R^2\right)$ for $r<R$ and $\rho=0$ for $r>R$.

What is the total charge inside a sphere of radius 1 and center in the origin?_____

What is the electric field magnitude for points $r>R$?_____

What is the electric field magnitude for points $r<R$?_____

At what distance r_0 the magnitude of the electric field is the largest?_____

Problem 8.

For the distribution of charge given in Problem 7.

What is the electric field potential for points $r>R$?_____

What is the electric field potential for points $r<R$?_____

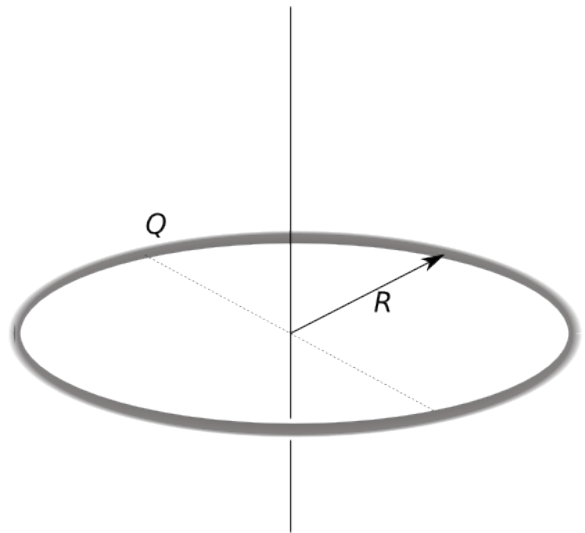**At what distance r_1 the potential is the largest?**_____

Problem 9.

A uniformly charged ring of radius R has a total charge Q .

What is the magnitude and direction of the electric field along the axis of the ring?_____

What is electric field potential along the axis of the ring?_____

What is the electric field at the center of the ring?_____

What is the electric potential at the center of the ring?_____

Problem 10.

A uniformly charged sphere of radius R has a spherical cavity of radius r and center O at distance $L < R - r$ from the center of the sphere as shown on the picture.

What is the electric field at the point O ?_____

What would be the electric field at the point O if we double the radius r , but still entire cavity is inside the big sphere?_____