Exam 1

P208 Fall 2009,
Instructor: Prof. Abanov

09/21/09

Name_____ Section_____

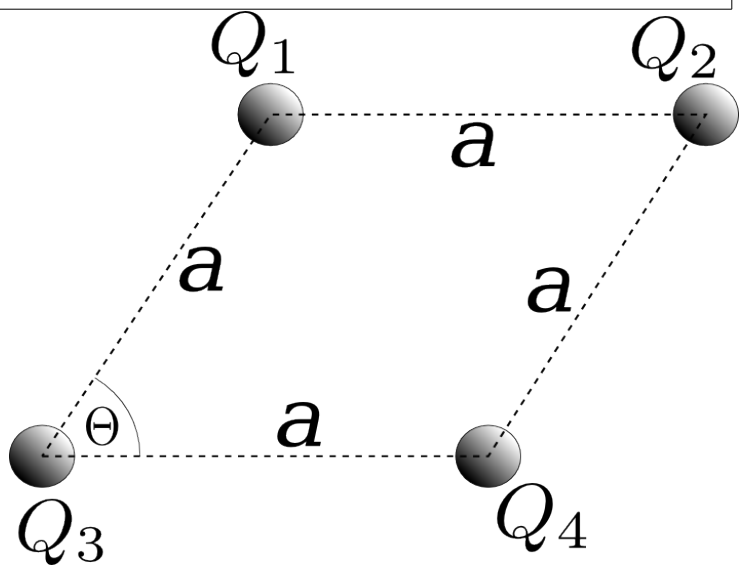
(print clearly in block letters)

501 Fuller, Melissa	**Tues, 2:20-5:10**	**516 Li, Feng**	**Thurs, 8:00-10:50**
502 Mahony, James	**Tues, 3:55-6:45**	**517 Amin, Vivek**	**Thurs, 9:35-12:25**
503 Chen, Jason	**Tues, 4:55-7:45**	**518 Chen, Jason**	**Thurs, 11:10-2:00**
504 Ferguson, Jim	**Tues, 5:55-8:45**	**519 Russell, Charles**	**Thurs, 12:45-3:35**
505 Zhang,Xiwen	**Tues, 6:55-9:55**	**520 Zhang,Xiwen**	**Thurs, 2:20-5:10**

Your grade:

Problem 1.

Four charges Q1, Q2, Q3, and Q4 are positioned in the corners of a rhombus with sides measures a=0.5m and angle $\Theta = 60°$. Q1=+2.0mC, Q4=+ 2.0mC, and Q2= +1.0mC is positive.



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)

If Q3 is zero what is the magnitude and direction of the total force which acts on charge Q2?_____ (show direction on the figure)

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

What will be the total force acting on Q2 if the value of Q3 in the previous question is doubled?_____

Problem 2.

A metallic sphere of radius R has a charge Q .

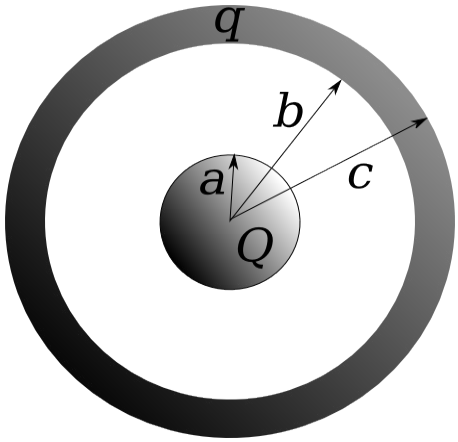
How much work is needed to move a small charge q from the center of this sphere to the surface?_____

How much work is needed to move a small charge q from the center of this sphere to infinity?_____

This sphere is surrounded with a spherical metallic shell of radius $r > R$.

How much work is needed to move a small charge q from the center of the sphere to the shell?_____

Problem 3.



A solid, conducting sphere of radius *a* =3.5cm carries an excess charge of Q=+12.0μC. 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* = 13.0cm as shown. The hollow shell also carries a total excess charge of q=-6.0μC.

What is the total charge at the inner surface of the shell?
_____

What is the total charge at the outer surface of the shell?_____

What is the magnitude and direction of the electric field at a distance 1cm from the center?_____

What is the magnitude and direction of the electric field at a distance 4cm from the center?_____

What is the magnitude and direction of the electric field at a distance 12cm from the center?_____

What is the magnitude and direction of the electric field at a distance 16cm from the center?_____

Problem 4.

Four protons are initially at rest in the corners of a square of side $a = 0.8\text{nm}$. All four are released simultaneously.

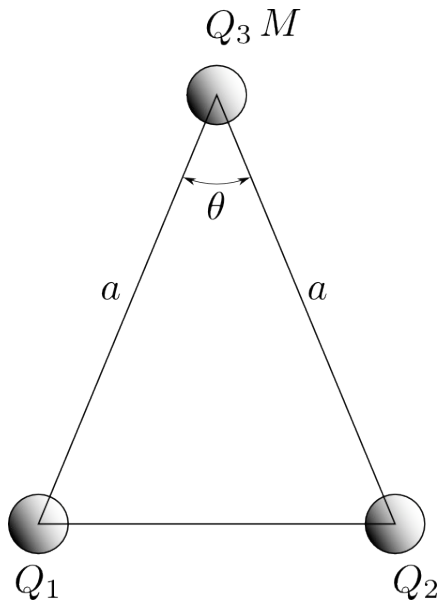
What is the maximum speed each will ever reach?_____

How far will the protons have traveled when this speed is reached?_____

What is the maximum acceleration each will achieve?_____

How far will the protons have traveled when this acceleration is reached?_____

Problem 5.



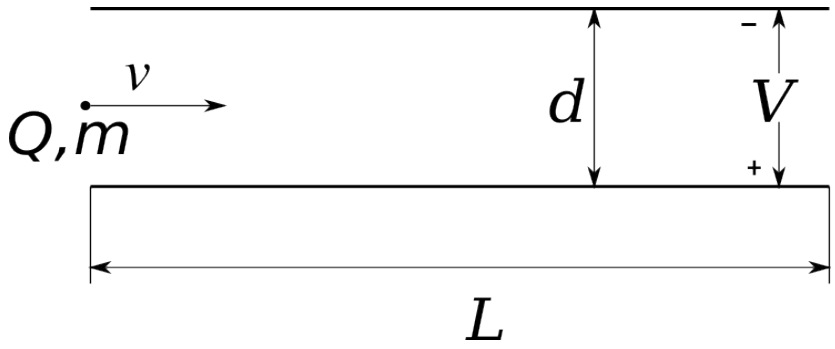
Three charges Q_1 , Q_2 , and Q_3 are positioned in the corners of a triangle whose side measures a=0.5m and angle $\theta = 20^0$ $Q_1 = Q_2 = +6.0\text{mC}$ and $Q_3 = +1.0\text{mC}$. The mass of charge Q_3 is $M = 10\text{g}$. At initial time the charge Q_3 is released.

What is the initial acceleration of the charge Q_3 ?_____

What is the velocity of the charge Q_3 at infinity?_____

What would the velocity at infinity be if charge Q_3 started from the midpoint between charges Q_1 and Q_2 ?_____

Problem 6.



A parallel plate capacitor with length L=10cm is set up horizontally and has a distance between plates d=1cm and the potential difference between the plates V=500Volts. A small object of charge $Q=2\mu C$ and mass m=1g enters the capacitor with horizontal velocity v=20m/s. Neglect the gravitational force.

What is the magnitude and the direction of the electric field between the plates?
_____

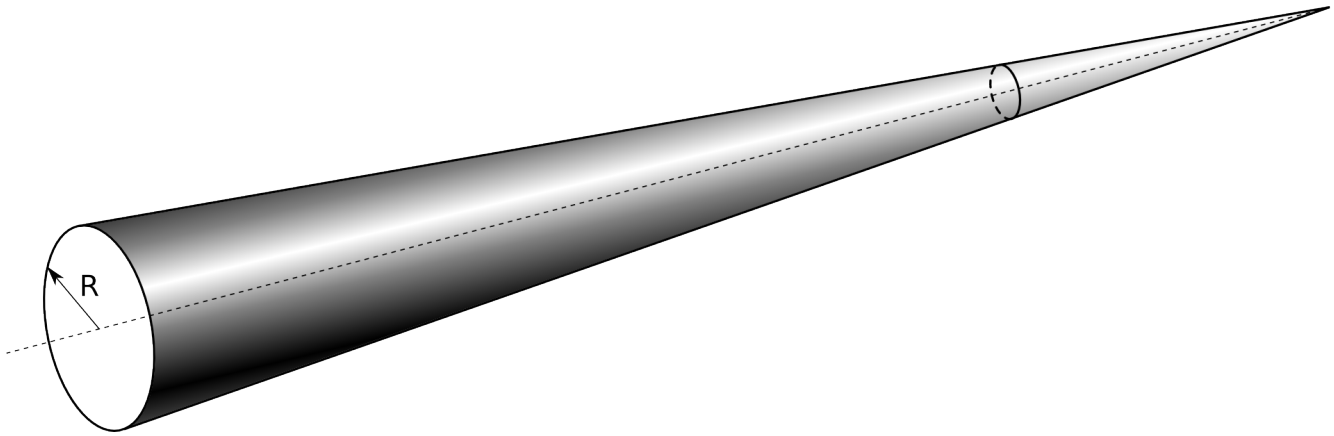
What is the electrostatic force acting on the object?_____

What is the magnitude of the object's velocity when it leaves the capacitor?_____

What is the direction of the object's velocity when it leaves the capacitor?_____

Problem 7.

An infinitely long insulating cylinder of radius R is charged. Its cylindrically symmetric charge distribution has a charge density $\rho(r)=\rho_0\left(1-2r^2/R^2\right)$ for $r<R$ and $\rho=0$ for $r>R$, where r is the distance to the central axis of the cylinder.



What is the total charge per unit length inside the cylinder?_____

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

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

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

Problem 8.

For the distribution of charge given in Problem 7.

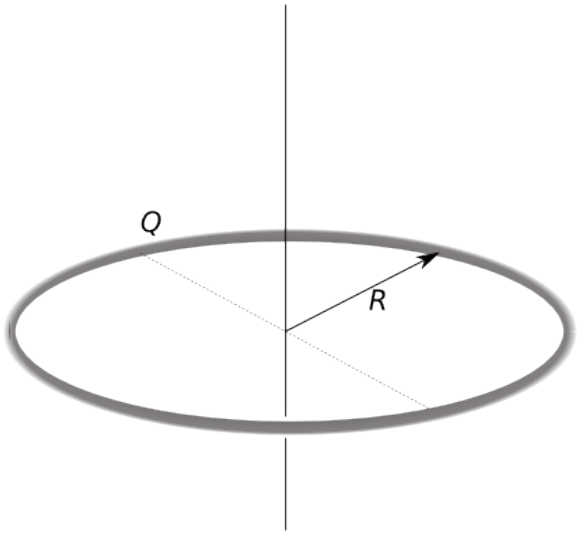
What is the electric field potential for points $r > R$ **?**_____

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

At what distance r_{max} **is the potential 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?_____

What velocity will a small charge q of mass m have at infinity if it was released just a little bit off from the center of the ring?_____

Problem 10.

A very thin stick of length L has a charge density $\rho(x)=\rho_0 x^2/L^2$

What is the direction and the magnitude of the electric field at the point $x=0$?

_____

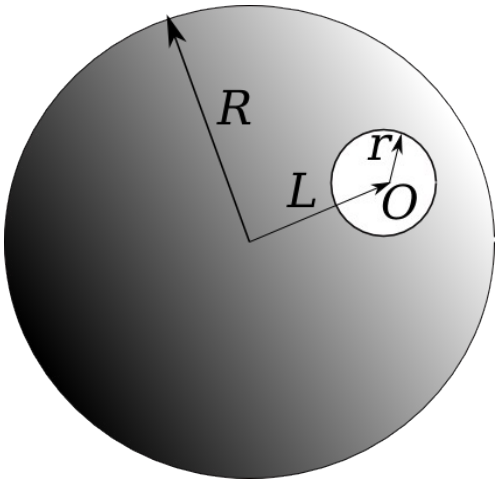
What is the potential of the electric field at the point $x=0$?_____

What velocity will a charge q of mass m have at infinity if released from rest at the point $x=0$?_____

Extra Problems.

(Please, take this page home with you. The first student who solves any of these problems gets extra points for the problem on their exam grade.)

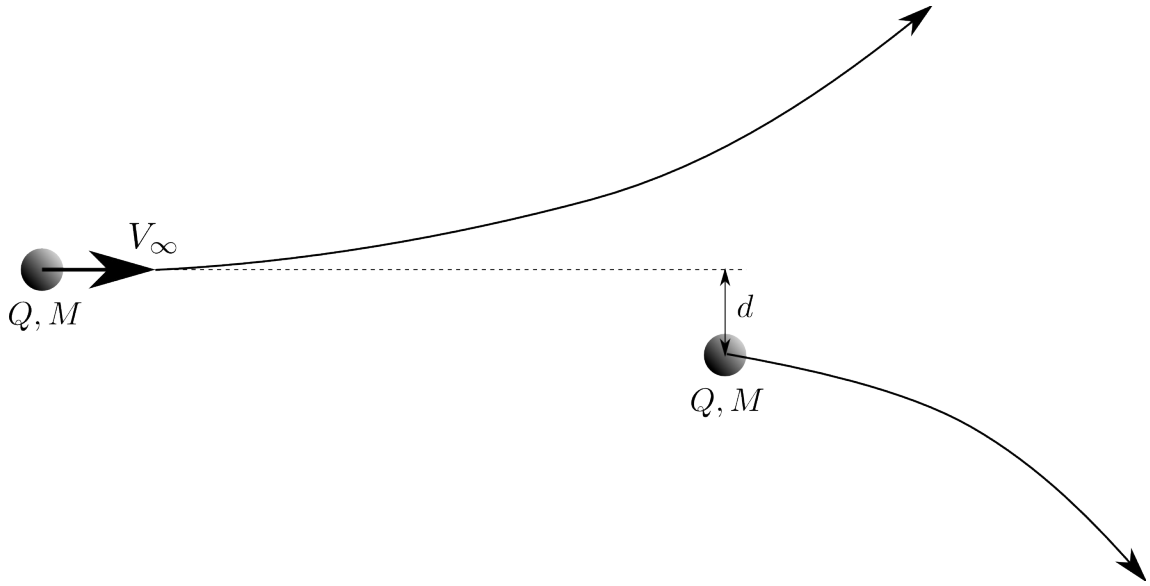
Extra Problem 1. (5 extra points)



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 points inside the cavity?_____

Extra Problem 2. (5 extra points)



A charged point-like particle with charge Q and mass M has velocity V_∞ at infinity and impact parameter d. It scatters off an identical particle which is initially at rest.

What will be the closest distance between the particles?_____