Exam Final

P208 Fall 2008,
Instructor: Prof. Abanov

12/08/08

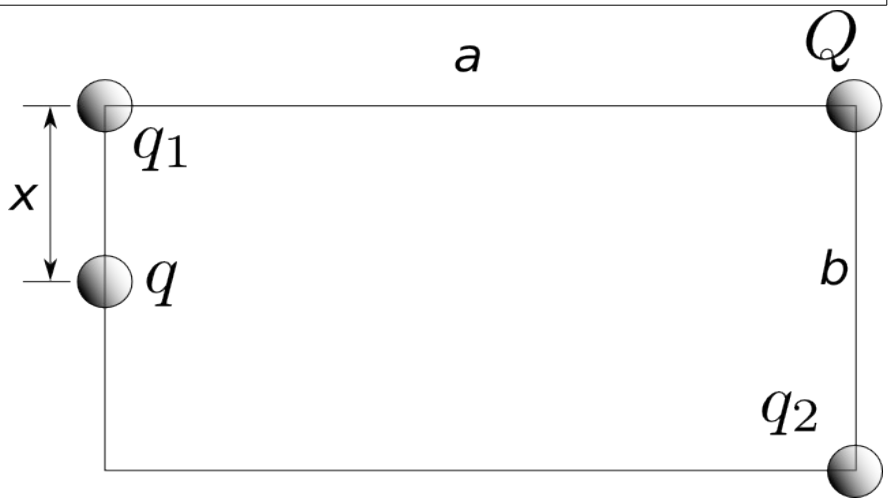
Name_____ Section_____

(print)

Your grade:

Problem 1.

Three charges $Q = 2.0\text{mC}$, $q_1 = 16.0\text{mC}$, $q_2 = 1.0\text{mC}$, are positioned in the corners of a rectangle with sides a=1.0m, and b=0.5m.



What is the magnitude and direction of the force with which charge q_1 acts on charge Q ?_____ (show direction on the figure)

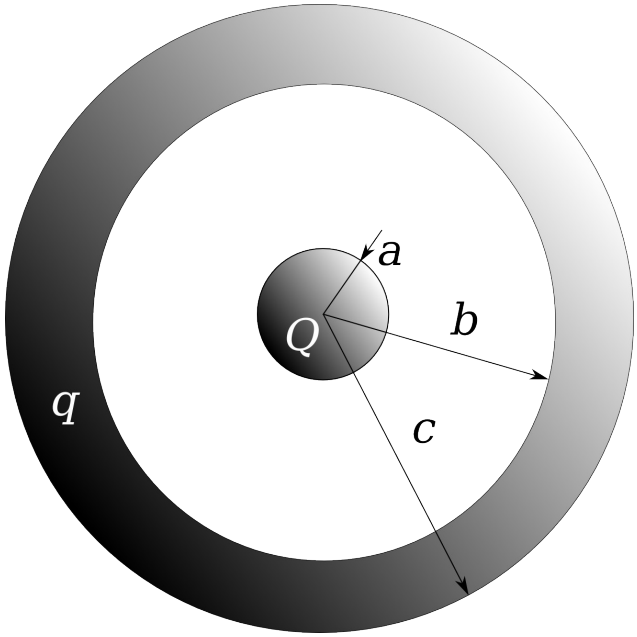
What is the magnitude and direction of the force with which charge q_2 acts on charge Q ?_____ (show direction on the figure)

What must be the distance x be (see figure) where a charge q can be placed in order for the total force acting on Q to be zero?

What must the charge q be?_____

Problem 2.

A solid, conducting sphere of radius $a = 4\text{cm}$ carries an excess charge of $Q = 8.0\,\mu C$. This sphere is located at the center of a hollow, conducting sphere with an inner radius of $b = 10.0\text{cm}$ and an outer radius of $c = 12.0\text{cm}$ as shown. The hollow sphere also carries a total excess charge of $q = -6\,\mu C$.



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 14cm 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?_____

At some point the inner and outer spheres were connected by a wire for a some time.

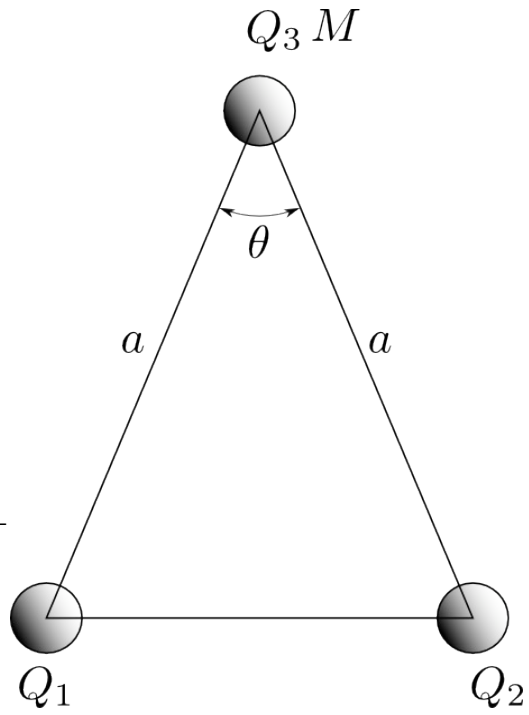
What are the magnitudes and directions of the electric fields
at a distance 2cm_____, 5cm_____, 11cm_____, and 14cm_____
from the center?

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 3.

Three charges Q1, Q2, and Q3 are positioned in the corners of a triangle whose side measures a=0.5m and angle $\theta = 40°$ $Q_1 = -Q_2 = 5.0\text{mC}$ and $Q_3 = 3.0\text{mC}$. The mass of charge Q_3 is $M = 10\text{g}$. At initial time the charge Q_3 is released.



What is initial acceleration of the charge Q_3 ?_____

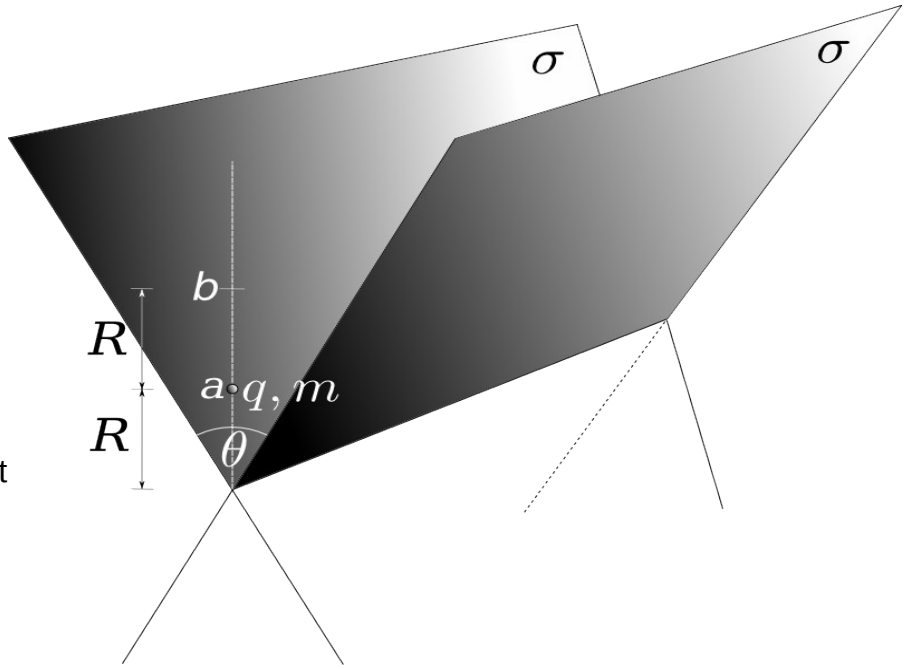
What is the velocity of the charge Q_3 at infinity?_____

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

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

Problem 4.

Two infinite plates with positive uniform charge density $\sigma = 3\text{mC}/m^2$ intersect at an angle $\theta = 30°$. A particle of charge $q = 3\text{mC}$ and mass $m = 10\text{g}$ is positioned at a point a at the center of the angle at distance $R = 10\text{cm}$ from the line of intersection. At the initial moment the particle is released with zero initial velocity.



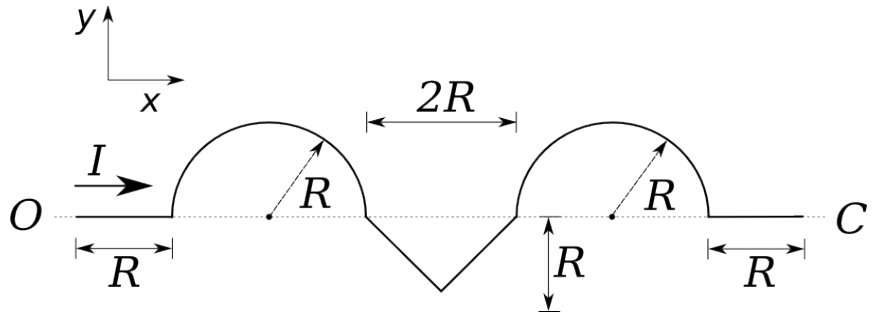
What is initial acceleration (magnitude and direction) of the particle?_____

What is the potential difference between points a and b (point b is the point in the middle of the angle at distance 2R from the line of intersection)_____

What is electric field (magnitude and direction) between the two plates?_____

What will be the velocity of the particle at the point b ?_____

Problem 5.



A wire with a current $I=2\text{mA}$ has the form shown in the figure with dimensions $R=10\text{cm}$. It was placed in the magnetic field $B=0.5\text{T}$ pointing out of the paper perpendicular to the axis x and at the angle $\Theta=30°$ to the z axis.

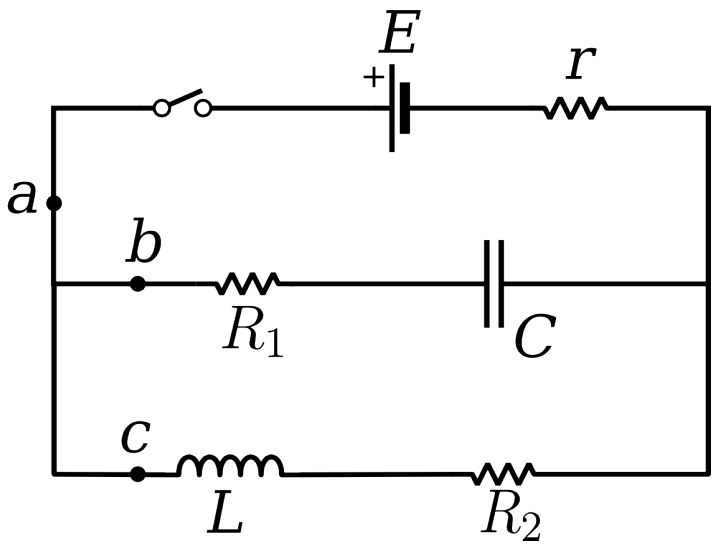
What is x component of the force acting on the wire?___

What is y component of the force acting on the wire?_____

What is z component of the force acting on the wire?_____

What is the torque with respect to the OC axis?_____

Problem 6.



In the circuit shown in the figure $E=12\text{V}$, $r=2\text{k}\,\Omega$, $R_1=4\text{k}\,\Omega$, $R_2=2\text{k}\,\Omega$, $C=4\,\mu F$ and $L=4\,H$. At the moment t_0 the switch is closed.

What is the current at the points a _____, b _____, and c _____ immediately after t_0 ?

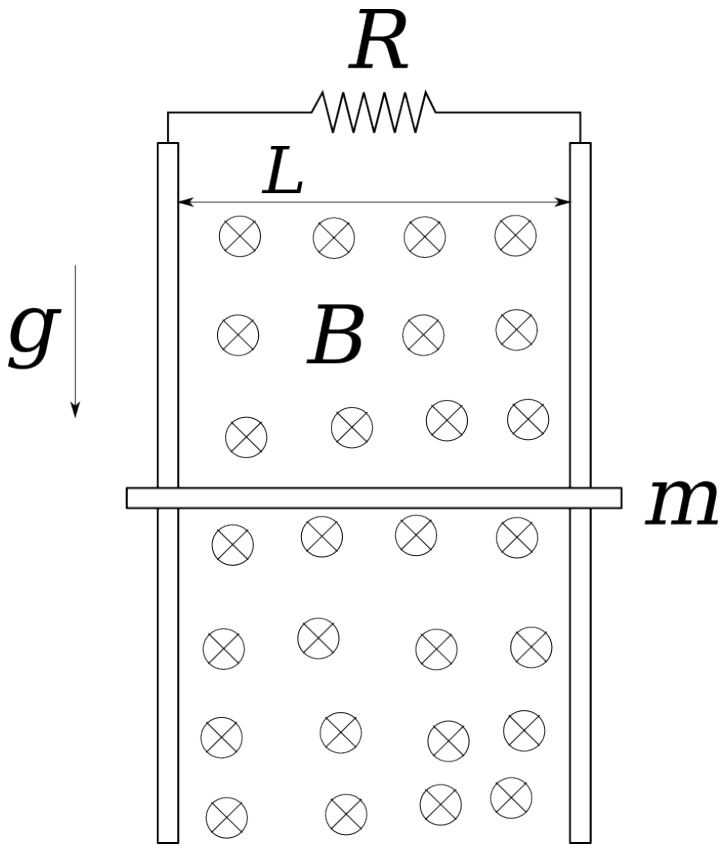
What is the voltage across the inductor L immediately after t_0 ?_____

What is the current at the points a _____, b _____, and c _____ after a very long time?

What is the charge on the capacitor C long time after t_0 ?_____

Problem 7.

A metal bar of mass $m=10\text{kg}$ can move along two vertical straight rails which are $L=1\text{m}$ apart from one another. The total friction force between the bar and the rails is proportional to the velocity $F_f=kv$, where $k=1\text{Ns}/m$. The resistor $R=2\,\Omega$ connects the rails. Magnetic field is $B=1.41\text{T}$. After a long time the bar falls with constant velocity.



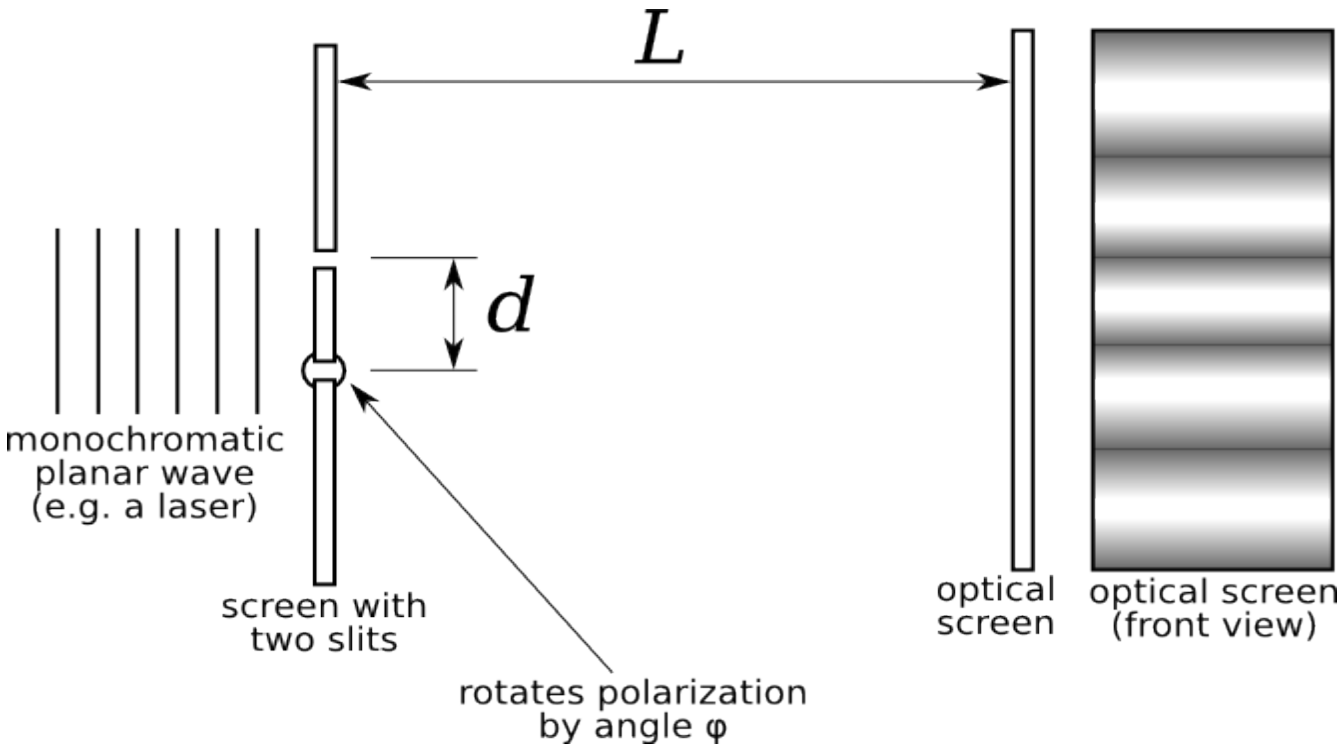
What is the direction of electric current induced by the motion?(show on the figure)

What is the direction of the magnetic force acting on the bar?(show on the figure)

What is the velocity of the bar?_____

What will be the velocity if the magnetic field is zero?_____

Problem 8.



In the two slit experiment the polarization of the light from one of the slits is at angle $\phi = 30°$ to the polarization of the light from the other slit. The light from both slits have equal intensities. The distance between the slits is $d = 0.46\text{mm}$. The screen is at distance $L = 2.54\text{m}$. The adjacent bright fringes are separated by 2.82mm.

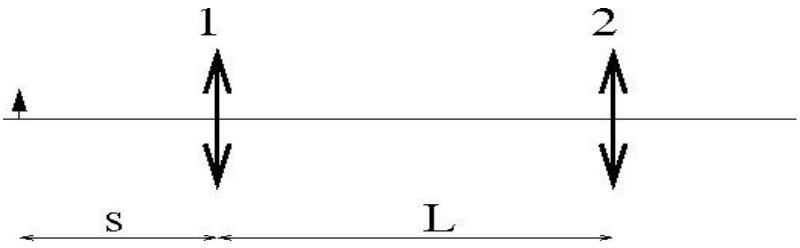
What is the wavelength of light?_____

What will be the separation between the fringes if we double the frequency of the light? _____

What is the ratio of intensities of light in the dirk and bright fringes?

Problem 9.

The object is s=30cm from the first lens. The distance between lenses is L=50cm. The focal length of the first lens is $f_1=20\text{cm}$ and of the second lens it is $f_2=20\text{cm}$.



What is the distance between the first lens and the first image?_____

What is the distance between the second lens and the final image?____

What is the magnification of the first lens?_____

What is the magnification of the second lens?_____

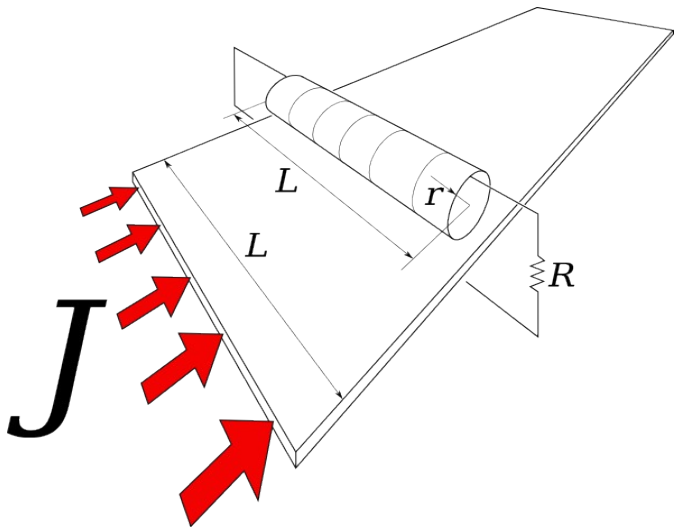
What is the final magnification?_____

Is the final image virtual?_____

Is the final image inverted?_____

Problem 10.

A current $J=1\mathrm{A}$ flows trough the plane of dimension $L=1\mathrm{m}$. A solenoid of length L , radius $r=1\mathrm{cm}$, and the density of turns $n=10^4 m^{-1}$ is positioned close and parallel to the plane and perpendicular to the current. The terminals of the solenoid are connected through resistor $R=1\mathrm{k}\,\Omega$.



What is the magnetic field close to the plane?_____

What is the total magnetic field flux through the solenoid?_____

What charge have gone through the resistor during the time the current through the plane changed from J to $2\mathrm{J}$?_____