

Final Exam

**P208 STEPS Fall 2011,
Instructor: Prof. Abanov**

May 2011

Name_____ Section_____

(print in big block letters)

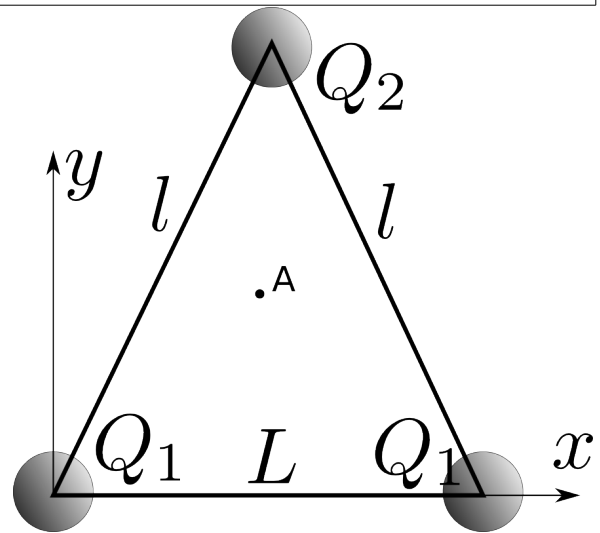
Your grade:

(20pt.) **Problem 1.**

Two charges with charge Q_1 each, and a charge Q_2 , are positioned in the corners of an isosceles triangle with sides l and L as shown.

(4pt.) **What is the magnitude and direction of the electric force which acts on charge Q_2 ?**

(show direction on the figure)



(4pt.) **What is the coordinate of the point A where electric field is zero?**

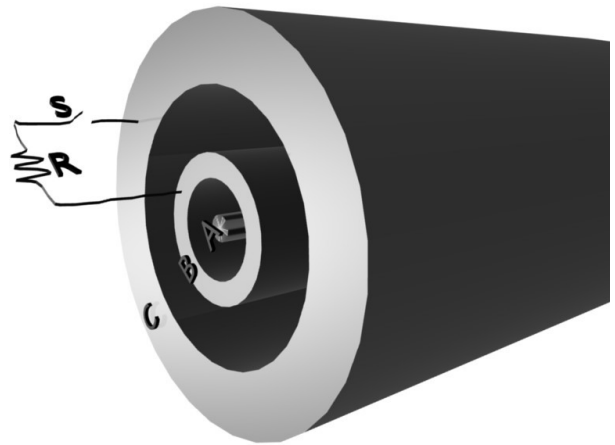
(4pt.) **What will be the acceleration of an object of mass m and charge q if it is in the point A?**

(4pt.) **What will be the velocity of this object at infinity if it starts at point A with velocity v_0 ?**

(4pt.) **What will be the acceleration of this object at infinity?**

(20pt.) **Problem 2.**

Three concentric metallic cylinders A, B, and C have the same large length L and radii: cylinder A – radius R_A , cylinder B has inner radius r_B and outer radius R_B , and cylinder C has inner and outer radii r_C and R_C correspondingly. Cylinder A is charged with charge Q .



(5pt.) **What is the magnitude of the electric field at distance r from the center, if $r_B < r < R_B$?**

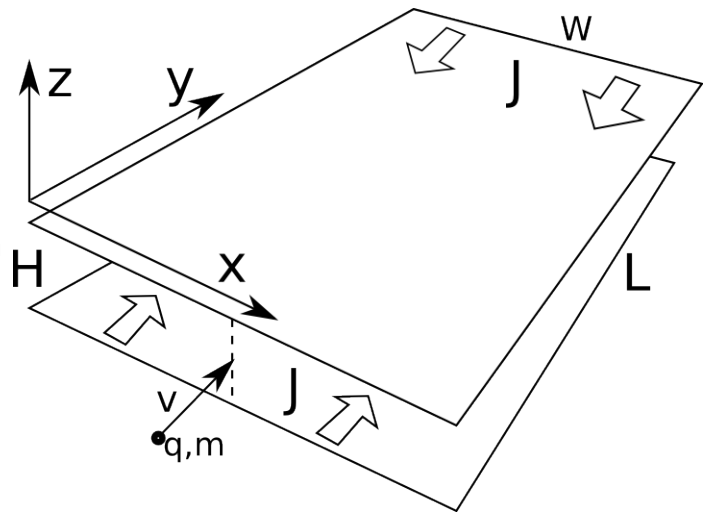
(5pt.) **What is the magnitude of the electric field at distance r from the center, if $R_B < r < r_C$?**

(5pt.) **What is the magnitude of the electric field at distance r from the center, if $R_B < r < r_C$ long time after the switch S is closed?**

(5pt.) **What is characteristic time of the discharge after the switch is closed if the resistance R is known?**

(20pt.) **Problem 3.**

Two parallel plates of dimensions L and W are a small distance H from each other. As shown on the picture. Current J is set to uniformly flow along y direction in the lower plate and back on the upper plate.



(5pt.) **What is the direction of the magnetic field in between the plates?** (use the provided coordinate system)

(5pt.) **What is the magnitude of the magnetic field in between the plates?**

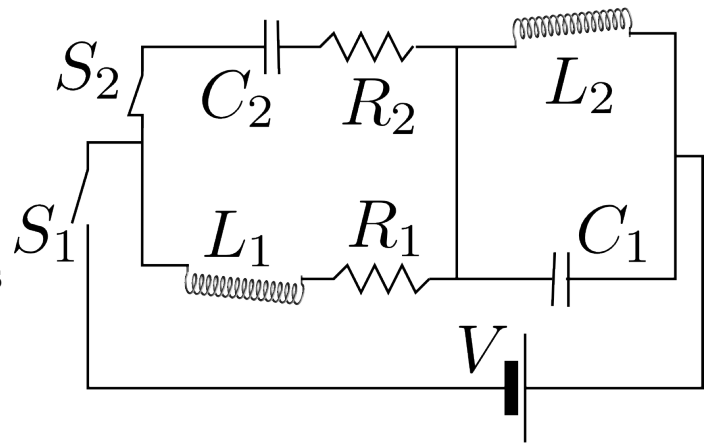
(5pt.) **An object of mass m and charge q enters at the center between the plates with the velocity v parallel to the plates as shown. What should be its velocity in order for the object to get out on the other side?**

(5pt.) **What is the self-inductance of such system of two plates?**

(20pt.) **Problem 4.**

In the circuit shown on the figure at time $t < 0$ the switch S_1 is open and S_2 is closed.

(5pt.) **At time $t = 0$ the switch S_1 is closed. What are the currents through resistors R_1 and R_2 right after $t = 0$?**



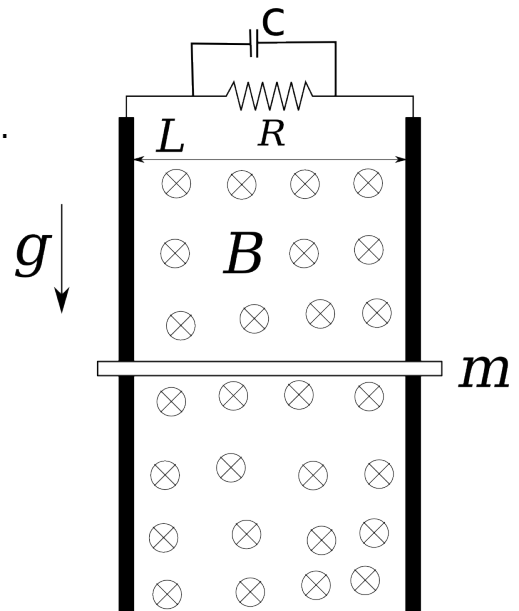
(5pt.) **What are the currents through resistors R_1 and R_2 after a very long time?**

(5pt.) **What energy is stored in the inductor L_2 in the steady state?**

(5pt.) **After a very long time both switches are open. What will be the amplitude of the charge oscillations on the capacitor C_1 ?**

(20pt.) **Problem 5.**

A bar of mass m can move along two vertical straight rails which are L apart from one another. The bar and the rails are made of an ideal metal (zero resistance). The resistor R connects the rails. Magnetic field is B is uniform. After a long time the bar falls with constant velocity.



(4pt.) **What is the direction of electric current induced by the motion?(show on the figure)**

(4pt.) **What is the direction of the magnetic force acting on the bar?(show on the figure)**

(4pt.) **What is the velocity of the bar after a long time?**

(4pt.) **What will be the charge stored in the capacitor after a long time?**

(4pt.) **What would be the acceleration of the bar if $R = \infty$?**