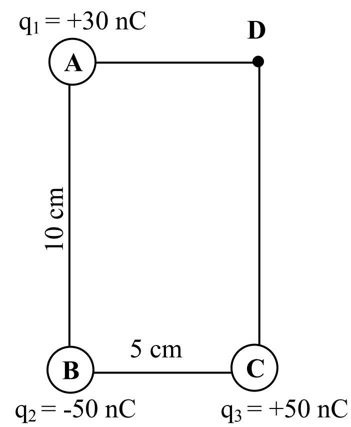
1	2	3	4	5	6	7	8	9	Total

Phys 2102 Final Examination **Fall 2008** **Duration 3 hours**

ID :	**Name:**

Full mark: 60 **Please check that your test paper has 8 pages.**

Q1. Three charges q_1 = +30 nC, q_2 = -50 nC and q_3 = +50 nC are placed on the three corners A B and C of a rectangle of length 10 cm and width 5 cm as shown on the figure.



a. Find the magnitude and direction of the net electrostatic force exerted by the charges q_2 and q_3 on the charge q_1.

b. Draw on the figure the direction of the net electrostatic force on the charge q_1. Indicate clearly the angle of the force.

c. Calculate the electrostatic potential created by the three charges at the point D.

d. Calculate the work needed to move the charge q_3 from C to the point D.

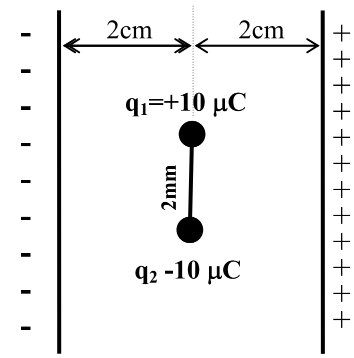
Q2. A rigid insulating rod of length 2 mm has a charge $q_1 = 10\ \mu C$ at one end and a charge $q_2 = -10\ \mu C$ at the other end. The rod is placed half way between two parallel plates as shown in the figure. The distance between the two plates is 4 cm. A potential difference of 700 V is applied to the plates.

a. Calculate the total electrostatic potential energy of the charge q_2.

b. What is the net electrostatic force on the rod?

c. What is the net torque on the rod?

d. Draw on the figure in which direction the rod will rotate.



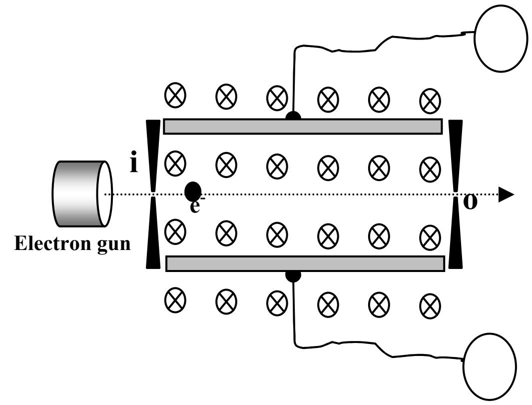
Q3. The area of the plates of a parallel plate capacitor is 0.1 m^2 and the gap between the plates is 0.1 mm. The gap between the plates is filled with paraffin (dielectric constant 2.2).

a. Calculate the capacitance of the capacitor.

b. The capacitor is connected in series with a 300 kΩ resistor and a 50 V battery. What is the energy stored in the capacitor 5 ms after the capacitor has been connected?

c. What will be the charge in the capacitor a long time after it has been connected?

Q4 The figure shows an electron velocity selector. Electrons are emitted by the electron gun in the direction indicated by the arrow in the figure. The electrons enter through the hole i with different velocities and come into a region between two parallel plates. There is a uniform magnetic field B = 0.01 T directed into the page as shown in the figure.



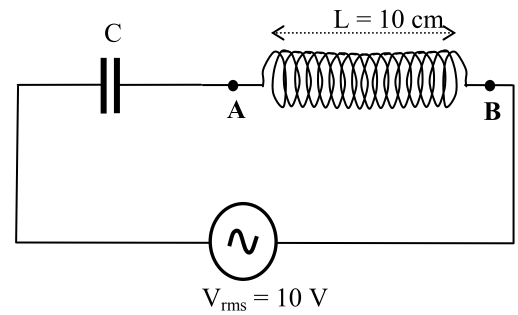
a. Draw on the figure the direction of the magnetic force on the electrons.

b. The path of the electrons in the magnetic field is circular. The path of the electrons can be made straight by applying a voltage difference to the parallel plates. Write on the figure which plate must be connected to the positive voltage to make the path of the electrons a straight line. **Explain why.**

c. The distance between the two parallel plates is 5 cm. What voltage should be applied to the plates to have electrons with speed 1×10^6 m/s emerging from the hole **o**?

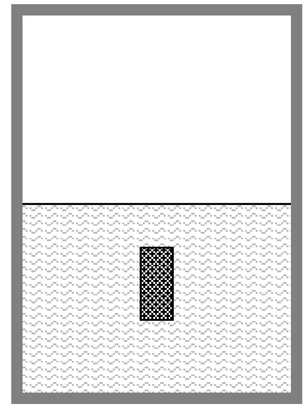
d. Assuming the voltage calculated in question **c** is applied to the parallel plates, explain in one sentence what happens to the electrons with velocity less that1×10^6 m/s. **Explain why**

Q5. A capacitors C and a coil are connected as shown on the figure.
The capacitors has capacitance $C = 94\ \mu F$.
The coil has 2000 turns. It is 10 cm long and its cross-section area is $A = 3\ cm^2$. The internal resistance of the coil is $4\ \Omega$.



a. Calculate the inductance of the coil.
b. Calculate the resonance frequency of the circuit.

The circuit is connected to a $10\ V_{rms}$ source. The frequency of the source is set to the resonance frequency of the circuit.
c. Calculate the impedance of the circuit.
d. Calculate is the peak magnetic field inside the coil.

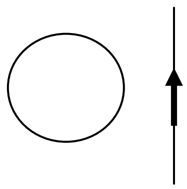


Q6. An aluminum calorimeter of mass 50 g has a volume of 2 x 10^{-3} m^3. The calorimeter contains 1 liter of water (m = 1 kg, V = 10^{-3} m^3). The rest of the volume of the calorimeter is filled with air at atmospheric pressure (1x10^5 N/m^2). Initially the calorimeter is in thermal equilibrium with the water at 20 ^{0}C.
A copper block of mass 200 g and temperature T = 150 ^{0}C is then dropped into the water.

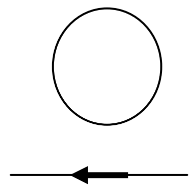
a. To answer the questions below you can neglect the heat absorbed by the air in the calorimeter. Explain in one sentence why you can neglect it.
b. First assume that no water is vaporised; find the equilibrium temperature of the calorimeter after the block has been introduced.
c. Assuming no water is vaporised and no air escaped from the calorimeter what is the pressure in the air above the water at thermal equilibrium (ignore the thermal expansion).
d. Assume now that 1 g of the water is vaporised when the block is introduced, what will be the equilibrium temperature of the calorimeter?
e. Given that 1 g of water contains 3.34 x10^{22} molecules what will be the pressure in the air above the water at thermal equilibrium (ignore the thermal expansion and the small change of volume of the water)

	Specific heat (J/kg.K)
Aluminium	900
Copper	390
Water	4186
Air (c_v)	742
Latent heat of vaporisation for water: 2260 KJ/Kg	

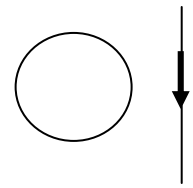
Q7. A varying current i is flowing in the straight wire as shown in the figures. Draw on the figures the direction of the induced current in the loop.



i increase

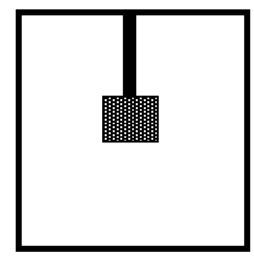


i increase



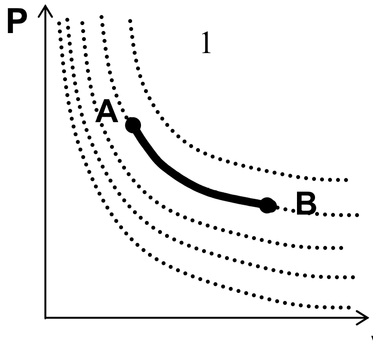
i decrease

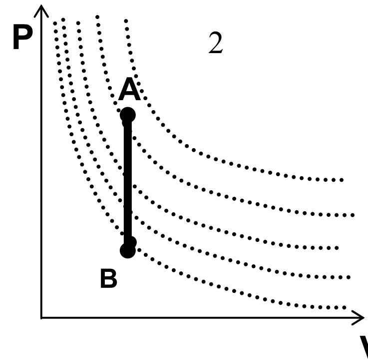
Q8. A ceramic cube of side a = 1 cm is at temperature 420 ^{0}C it is suspended inside an evacuated box by a glass rod of length 25 cm and cross-sectional area 2 cm^2. The temperature of the walls of the box is 25 ^{0}C.
Given that the thermal conductivity of glass is 0.84 J/smK and that the emissivity of ceramic is 0.7, calculate the heat lost by the cube in one second?

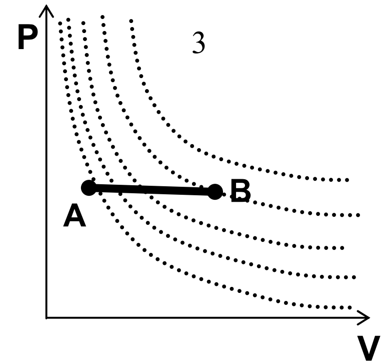


Q9. A thermodynamic system evolves from state A to state B following the paths indicated on the figures below. The dotted lines represent the isothermals.

a. Write under each figure the name of the process corresponding to the path shown.







1: ....

2: ....

3: ....

b. In which of the above processes (1, 2 or 3) is the work equal to zero? **................**

c. In which of the above processes (1, 2 or 3) is the internal energy conserved**? ....**

d. A gas can be taken form a sate A with volume v1 to a state with volume v2 using either an adiabatic process or an isothermal process. Which of the two processes represented in the figure is the adiabatic process, **AB** or **AC**?