1	2	3	4	5	6	7	8	Total

Phys 2102 Final Examination **Fall 2009** **Duration 3 hours**

ID :	**Name:**

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

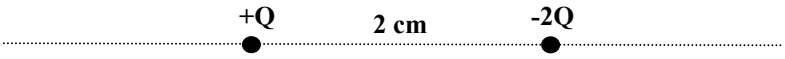
Q1 [7 marks]. A positive charge Q and a negative charge -2Q are placed 2 cm from each other as shown in the figure.

a. Find the position of the point A (other than infinity) where the net electric field is equal to zero.

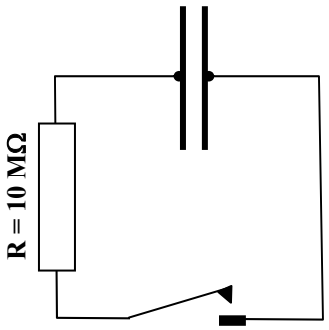
b. Draw the point A on the figure

c. Find the position of the point B (other than infinity) where the net electrostatic potential is zero.

d. Draw on the figure the point B



Q2 [7 marks]. Two parallel pates of area 200 cm^2 are separated by a distance of 1 mm. The plates are connected in series with a 10 MΩ resistor and a switch as shown in the figure.



Initially the switch is open and there is a charge of 0.5 μC on the plates.

a. What is the electrostatic energy stored in the capacitor?

b. Some oil (dielectric constant 4.0) is introduced between the plates. What is the potential difference between the plates after the oil is introduced.

c. After the oil is introduced the switch is closed. What is the charge on the plates 7 ms after the switch has been closed?

Iron	
Resistivity at 20 ^{0}C	Temperature coefficient
9.71 x10^{-8} Ω m	0.00651 ^{o}C^{-1}

Q3 [6 marks]. The heating element of an eclectic oven is made of a piece of iron of length 5 m and cross section 0.1 mm^2.

a. What is the resistance of the heating element at 20 ^{0}C ?

b. The power of the oven is 2500 W when connected to a 220 V_{rms} source. What is the temperature of the heating element when the oven is connected to the source?

Q4. [10 marks; 2 marks each].

a. An electron guns produces a beam that carries a current of 1.6 mA. How many electrons per second are emitted by the gun?

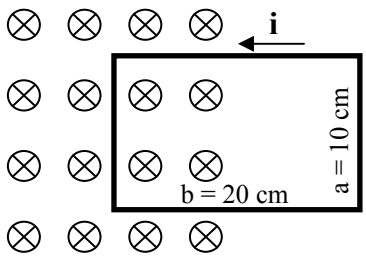
b. A battery with internal resistance 4 Ω is used to deliver a current of 2 A in a resistor of resistance 10 Ω. What is the terminal voltage (open circuit) of the battery?

c. An AC function generator supplies a peak to peak voltage V_{pp} = 20 V to a resistor R = 100 Ω. What is the average power dissipated in the resistor?

d. Two parallel plates are placed 2 cm from each other. The plates are connected to a 600 V battery. A proton enters between the plates what is the electrostatic force on the proton?

e. The length of the side of an aluminum cube at 30 ^{o}C is 25 cm. What is the volume of the cube at liquid nitrogen temperature (77 K).[coefficient of linear expansion for aluminum is $25x10^{-6}\ ^{0}C^{-1}$]

Q5 [8 marks]. A wire of resistance 2 Ω is in the shape of a rectangular loop of sides a = 10 cm and b = 20 cm.
A current of 400 mA is flowing in the wire in the direction indicated by the arrow in the figure.
Half of the loop is in a uniform magnetic field of 2 T directed perpendicular to the plane of the loop as shown in the figure.



a. What is the net magnetic force on the loop?
b. Draw on the figure the direction of the net force.
c. The magnetic field is reduced from 2 T to 0.5 T in 10 ms. What is the net current in the loop as the field is reduced.

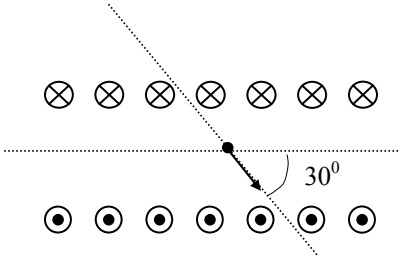
Q6 [9 marks]. A solenoid with 2,000 windings is 20 cm long and has a cross-section area of 25 cm^2.

a. What is the self inductance of the solenoid?

b. A current of 2 A is flowing in the solenoid in the direction indicated in the figure. What is the magnetic energy stored in the solenoid?

c. What is the magnitude of the magnetic field inside the solenoid?

d. Draw on the figure the direction of the magnetic field inside the solenoid.



An electron with velocity $v = 2x10^3$ m/s at an angle of 30 degrees with the axis of the solenoid enters in the solenoid.

e. What is the magnetic force on the electron?

f. Indicate on the figure the direction of the force

g. What is the radius of the helical path of the electron inside the solenoid?

h. What is the component of the speed of the electron along the axis of the helical path?

	melting point (^{0}C)	heat of fusion kJ/kg	boiling point (^{0}C)	Heat of vaporization (kJ/kg)
Water	**0**	**333**	**100**	**2255**

substance	ice	water	steam
specific heat c_p (J/kg)	**2086**	**4180**	**1963**

Q7 [7 marks].

a. How much heat is required to change a 0.1 kg block of ice at temperature -5 ^{o}C into steam at a temperature 110 ^{o}C?

b. The heat is provided by a 2 Ω resistor connected to 10 V (DC) source. Assuming no heat losses, how long will it take to change the block of ice from -5 ^{o}C into steam at 110 ^{o}C?

c. All the steam goes into a container of volume V = 0.01m^3. When the temperature is110 ^{o}C the pressure inside the container is 1.77x10^6 Pa. How many water molecules were there in the ice block?

d. What is the average kinetic energy of a water molecule in the container?

Q8 [6 marks]. An steel rod of length 150 cm and diameter 5 cm is connected between the inside of a high temperature chamber and an aluminum plate of diameter 10 cm situated on the outside of the chamber as shown in the figure. The temperature outside the chamber is 30 ^{0}C.
When the system is in its steady state all the heat flowing by conduction through the rod is radiated by the aluminum plate. In the steady state the temperature of the plate is 90 ^{0}C.
a. Given that the emmisivity of the aluminum plate is 0.8, what is the amount of heat per second that comes out of the chamber?
b. Given that the thermal conductivity of steel is 40 J/ms^{o}C what is the temperature inside the chamber?