PHYSICS 211

FINAL EXAM

(TIME: TWO HOURS)

FINAL EXAM PAPERS WILL BE SHOWN ON THURSDAY, FEBRUARY 12,ROOM 121 PHYSICS DEPARTMENT, FROM 11:00 AM TILL 2:00 PM

February 10, 1998

NAME:_____

ID # :_____

SECTION:_____

12%

1. A spherical, **NON-CONDUCTING** shell has an inner radius r = a and an outer radius r = b. The shell contains a uniform charge density of $-|\rho|$ C/m^3.

   3%

   a) Find the force (magnitude and direction) on a test charge q_0 located at r = a/2.

   3%

   b) Find the electric field (magnitude and direction) for a < r < b.

3%

c) What is the electric field (magnitude and direction) for $r > b$?

3%

d) What is the potential for $r > b$?

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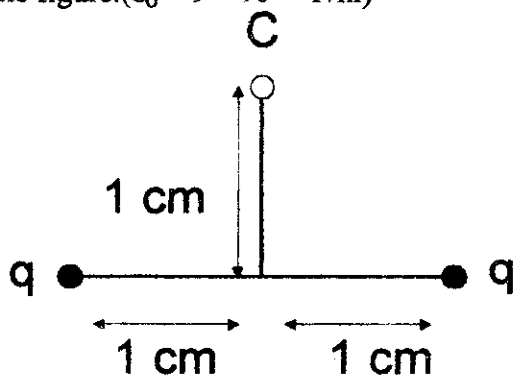
2. Two charges (q = - 3.0 μC each) are fixed in space and separated by a distance d = 2.0 cm as shown in the figure.($\varepsilon_o = 9 * 10^{-12}$ F/m)



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a) Calculate the electric potential at point C.

4%

b) How much work should be done to bring a third charge (Q = + 2.0 μC) slowly from infinity to the point C in the figure.

4%

c) Determine the potential energy U of the system of three charges with the third charge in place at C.

12%

3. Two conducting spheres, one of radius 6.0 cm and the second one of radius 12.0 cm, have initially each a charge of 30 nC. Both spheres are very far apart from each other. The spheres are subsequently connected by a fine, conducting wire. Find:
($\varepsilon_o = 9 * 10^{-12}$ F/m)

6%

a) the final charge on each sphere

6%

b) the potential of each sphere

15%

4. The plates of an isolated parallel plate capacitor attract each other with a force given by

$$F = q^2 / (2\varepsilon_o A)$$

where A is the area of the plates and q is the charge on the plates.

5%

a) Derive the above equation by calculating the work necessary to increase the plate separation from x to x + dx.

$W = \frac{q^2}{2C} = \frac{q^2 d}{2\varepsilon_o A}$

$W = F \times d$

$F = \frac{W}{d} = \frac{q^2}{2\varepsilon_o A}$

5%

b) The area of the plates of the parallel plate capacitor is 100 cm^2, the plate separation is 1 mm, and the capacitor is connected to a battery of 1000 V. Calculate the force with which the plates attract each other? ($\varepsilon_o = 9 * 10^{-12}$ F/m)

5%

c) What will be this force with which the plates attract each other, if the capacitor is disconnected from the battery and is then immersed in olive oil? The dielectric constant k of olive oil is 5.0.

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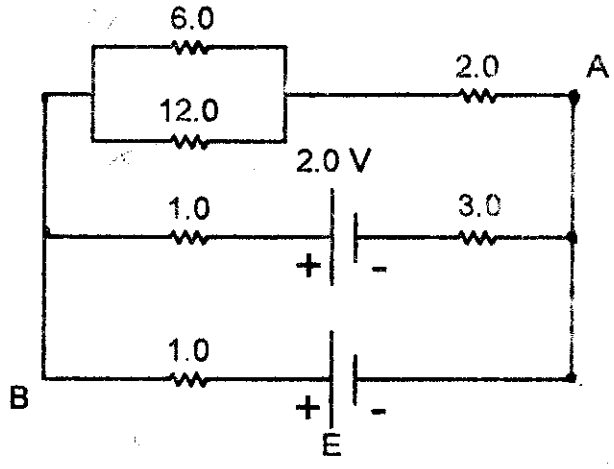
5 Given the circuit shown in the figure with all the resistors expressed in ohms The current in the 6.0 Ω resistor is 2.0 A.



4%

a) Find the magnitude and the directions of the currents in all branches.

4%

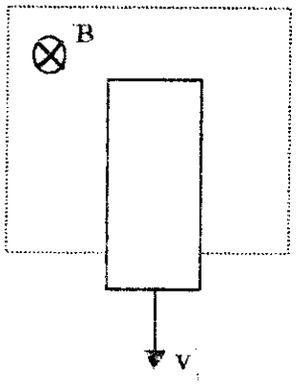
b) Find the emf of the battery E.

4%

c) Find the potential difference V_{AB} between the points A and B.

12%

6. A rectangular closed, conducting loop of wire is 50 cm long and 6 cm wide, and has a mass m = 5.0 g. The loop is initially at rest in a region in which a horizontal magnetic field B = 2.0 T exists.
The loop is then released to fall under its own weight, acquiring a terminal speed of v = 0.30 m/s.



4%

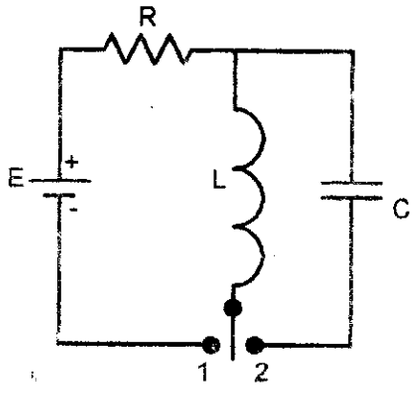
a) Find the direction of the induced current.

8%

b) Find the resistance of the loop.

15%

7. In the circuit shown in the figure, R = 0.2 Ω, L = 40 mH, C = 20 μF, and E = 1.0 V. The capacitor is initially uncharged. The switch is first thrown to position 1 and then 0.2 s later thrown to position 2.



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a) Find the period of the resulting oscillation.

5%

b) Find the energy stored in the LC circuit.

5%

c) Find the maximum potential difference on the capacitor.

10%

8. The four basic equations of electromagnetism (Maxwell's equations) are:

I: $$\oint \vec{E}.d\vec{s} = -\frac{d\Phi_B}{dt}$$

II: $$\oint \vec{B}.d\vec{s} = \mu_0 I + \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}$$

III: $$\oint \vec{E}.d\vec{A} = \frac{q}{\varepsilon_0}$$

IV: $$\oint \vec{B}.d\vec{A} = 0$$

Assume that the existence of magnetic monopoles is firmly established by experiment. Let q_m be the expression for the strength of the presumed magnetic monopole, analogous to the basic electric charge e.

5%

a) Which of the above four equations will have to be modified? What would be the new equations?

5%

b) What are the SI (MKS) units for q_m?