

Name : \_\_\_\_\_

**Physics 272. Makeup Midterm II**  
**Show your work!!**

Problem 1: 25 points

The space between the conductors of a long coaxial cable used to transmit television signals has an inner radius  $r_1 = 0.15$  mm and outer radius  $r_2 = 2.1$  mm. Assume that each carries a charge of  $q = 0.2\mu$  C.

- (a) What is the electric field between the inner cylinder and outer cylinder in terms of their radii  $r_1, r_2$  and charge  $q$ ?**
- (b) What is the potential difference between the inner cylinder and outer cylinder in terms of their radii  $r_1, r_2$  and charge  $q$ ?**
- (c) Calculate the capacitance/length of the two conductors (give a numerical answer with units)**

Problem 2: 25 points

Consider the circuit shown below. The batteries in the circuit and the ammeter have negligible internal resistance.

a) Using Kirchoff's laws write down three equations that describe this circuit.

b) Find the current  $I_2$

Problem 3: 25 points

An electron has initial velocity  $(12.0 \text{ km/s})\hat{\mathbf{j}} + (15 \text{ km/s})\hat{\mathbf{k}}$  and constant acceleration  $2.00 \times 10^{12} \text{ m/s}^2\hat{\mathbf{i}}$  in a region in which both uniform magnetic and electric fields are present. The magnetic field is  $\vec{\mathbf{B}} = 0.080 \hat{\mathbf{i}} \mu\text{T}$ . (Note  $e = 1.6 \times 10^{-19} \text{ C}$ ,  $m_e = 9.11 \times 10^{-31} \text{ kg}$ ).

- a) Find the electric field (in component form).
- b) Find the electron's velocity as function of time (in component form).

Problem 4: 25 points

(a) The centers of two identical conducting spheres of radius 3.0 mm are separated by 20 mm. There is charge  $q$  on one sphere and charge  $-q$  on the other sphere. The initial capacitance of the system is  $C_0 = 10\mu\text{ F}$ . Additional charge is now transferred so that the charge on each sphere is doubled. *What is the new capacitance?*

(b) The drift velocity of conduction electrons in a copper wire is 14 cm/hour. If the electrons drift at such a low speed, why do electrical effects seem to occur immediately after a switch is thrown, such as when you turn on the room lights?

(c) Explain the *physical* basis of the operation of a mass spectrometer.

(d) The wire loop carries a clockwise current. There is a uniform magnetic field  $B$  directed to the right. What is the direction of the torque on the current loop?

(e) Three resistors  $R_1$  and  $R_2$  are connected in parallel, assume  $R_1 = R_2 = R$  and  $R_3 = 2R$ . What is the equivalent resistance in terms of  $R$ ?