NDU

Faculty of Natural and Applied Sciences

Department of Sciences

PHS 212 - Electricity & Magnetism

Final Exam - Spring 2005

Duration: 120 minutes (2h)

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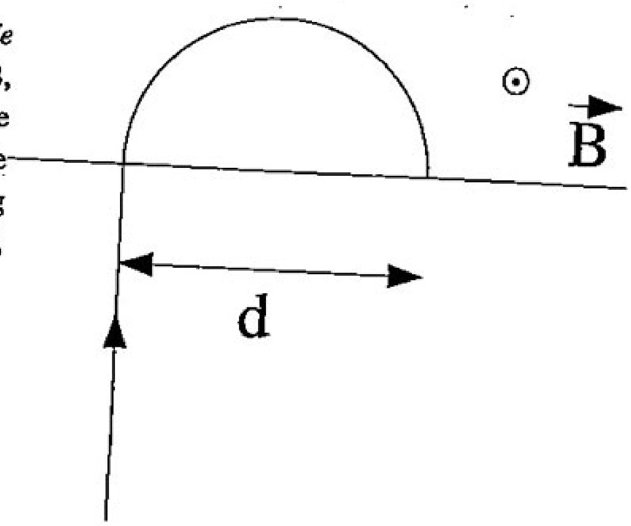
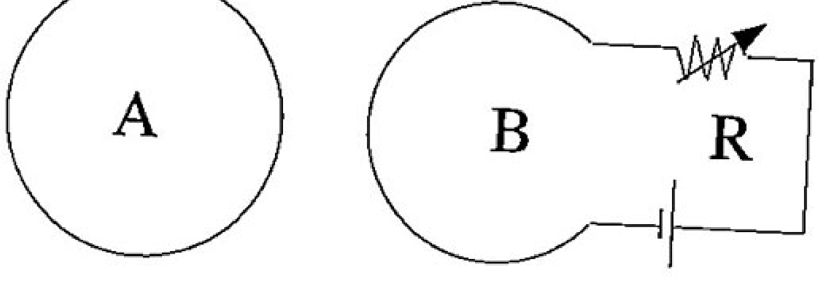
1. In a mass spectrometer, an ion of charge $+Ze$ and mass M enters a region of uniform field B, and travels in a semi-circle until it hits a the wall a distance d from where it entered (see the figure). If the ion achieved its energy by being accelerated through a voltage difference V, show that $M = \dfrac{B^2 d^2 Ze}{8V}$.



2. A non-conducting sphere of radius a has a volume charge density $\rho = \rho_0 e^{\frac{-r^3}{a^3}}$. a) What is the total charge on this sphere. b) What is the electric field at any point inside the sphere. c) What is the electric field at any point outside the sphere. Express your answers for a) and b) in terms of the total charge.

3. Two non-coaxial coils rest on the page, their normals along z (see figure). For coil B, a battery drives current counterclockwise. Let the variable resistance R increase. Describe a) the change in the magnetic field through coil A due the change in R, b) the direction of the magnetic field induced in the coil A, c) the direction of circulation of the emf induced in coil A, d) the direction of circulation of the current induced in coil A, and the direction of the magnetic force acting on the loop. f) How do your answers change if R is decreased?



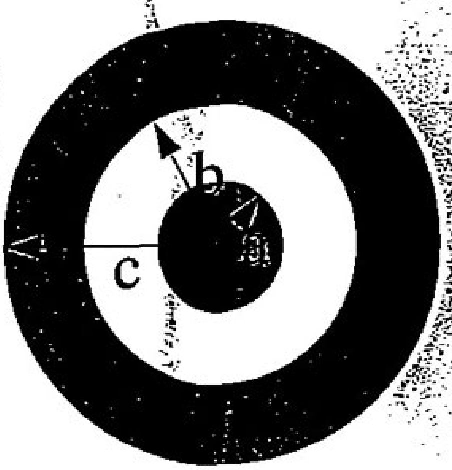
$qE = m\frac{v^2}{R}$

$\frac{1}{2} m V_1^2 = 24\, \Delta V$

$\frac{1}{2} m V_1^2 + qV$

4. Consider a ring of radius a in the xy-plane centered at the origin. Its upper half has charge per unit length $+\lambda$, and its lower half has charge per unit length $-\lambda$. From symmetry considerations, determine the direction of the electric field at the center. b) Find the magnitude of the electric field at this point.

5. Consider a co-axial cable with inner current $2I$ into the page and uniformly distributed over $r < a$, and outer current I out the page and uniformly distributed over $b < r < c$. Find the magnetic field (magnitude and direction) for a) $r < a$, b) $a < r < b$, c) $b < r < c$, and d) $r > c$.



6. You are given three initially uncharged conducting spheres of radii 5 cm, 15 cm and 30 cm. They are placed at large distances from each other. The 15-cm sphere is then-charged to a potential of 1000 V. Once isolated it is connected by a thin wire to the 5-cm sphere.

(a) Find the potentials and charges of the 15-cm and 5-cm spheres once equilibrium is reached.

(b) The thin wire is now disconnected. The 15-cm sphere is then connected to the still uncharged 35-cm sphere. Find the potentials and charges of the two spheres once equilibrium is reached.

(c) The thin wire is disconnected. We now proceed to connect the 5-cm sphere to the 35-cm sphere with a thin wire. Find the potentials and charges of the two spheres once equilibrium is reached.