**NDU**
Faculty of Natural and Applied Sciences
Department of Sciences

PHS 212–Electricity and Magnetism
Final Exam– Spring 2000
Duration: 2 hours

Instructor: Dr. Roger Hajjar

Calculators and two cheat sheets are allowed.
Solve all problems.

1. A plane slab of thickness d has a uniform volume charge density ρ. Find the magnitude of the electric field at all points in space both (a) inside and (b) outside the slab, in terms of x, the distance measured from the median plane of the slab.

2. How long does it take electrons to get from a car battery to the starting motor? Assume that the current is 115A and the electrons travel through copper wire with cross–sectional area 31.2 mm² and length 85.5 cm. Assume that every Cu atom contributes 1 electron to the free electron gas in the wire.

3. A metal sphere of radius R_1 is surrounded by a concentric dielectric shell of inner and outer radii R_1 and R_2. If the dielectric constant of the shell is κ, show that the capacitance of the metal sphere is

$$C = \frac{4\pi \kappa \varepsilon_0 R_1}{1 - (\kappa - 1)\frac{R_1}{R_2}}$$

4. You have a 50–W, 110 V light bulb, which you want to plug into a 440–V, 60–Hz source. To keep the bulb from burning out, you plan to connect it in series with a capacitor. What value of C should you use?
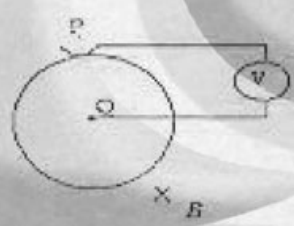
5. In the figure, the voltmeter is connected to the disk by means of the sliding contacts at the periphery and the axis of the disk. The disk has radius b and rotates at an angular velocity ω in the sense shown. A uniform magnetic field B is parallel to the disk axis. Show that there is an emf between the sliding contacts and that the voltmeter reading is $V = \frac{1}{2}\omega b^2 B$. Which of the two terminals P and Q is positive?

$\rho_{Cu} = 8.96 \times 10^3$ kg/m³
molar mass $m_{Cu} = 63.5$ g.

7. Find the capacitance of a metallic sphere of radius 10 cm uniformly coated with a 5 cm thickness of polypropylene of dielectric constant 2.3.

8. In a given Hall experiment involving Zinc, a 10.38 A current flows through a 25 μm thick foil and 2.55 cm wide. A positive Hall voltage of 0.71×10^{-5} V is measured when the magnetic field is 500 mT. Find the density and drift speed of charge carriers in Zinc.

9. Two charged conducting spheres of unknown radii are placed a large distance from each other. Their total charge is 5μC. They are initially at a potential of +400 V and -400 V. They are then connected by a thin metallic wire. The final potential of the spheres is 100 V. Find their radii.

$$\mu_0 = 4\pi \times 10^{-7}\frac{T.m}{A} \; ; \epsilon_0 = 8.85 \times 10^{-12}\frac{C^2}{N.m^2} \; ; e = 1.62 \times 10^{-19}C$$

$q_1 + q_2 = 5\mu C$

$V_1 = 400V = k\dfrac{q_1}{R_1}$

$V_2 = -400V = \dfrac{kq_2}{R_2}$

$V_f = V_1' = V_2' = 100V$

$100V = \dfrac{kq_1'}{R_1} = \dfrac{kq_2'}{R_2}$

$q_1 + q_2 = 5$

$\dfrac{400R_1}{k} - \dfrac{400R_2}{k} = 5$

$q_1' + q_2' = 5\mu C$

$\dfrac{R_1 q_2'}{R_2}$

$\dfrac{100R_1}{kR_{e0}} + \dfrac{100R_2}{k} = 5$

$\boxed{R_1 - R_2 = 0.0125}$

$\boxed{R_1 + R_2 = 0.05K}$

$\dfrac{100R_2}{K}$

$2R_1 = 0.0625K$

$R_1 = 0.03125 K$

$C = \dfrac{Q}{V}$

$R_2 =$

$\dfrac{4\pi\epsilon_0 b(-a+b) + ab(4\pi\epsilon_0 k_e)}{ab(4\pi\epsilon_0 k_e)(4\pi\epsilon_0 b)}$

$\dfrac{ab(4\pi\epsilon_0 k_e)(4\pi\epsilon_0 b)}{4\pi\epsilon_0(-ba + b + abk)}$

$\dfrac{ab(4\pi\epsilon_0 k_e)}{-abt}$

$\dfrac{}{b(-a+1+ak_e)}$