

PHYS 3414 - Electricity and Magnetism- Test 2 - Part 1

All problems are worth 25 points. The majority of points on each problem will be awarded for doing the physics correctly; if you have correctly done the physics, but cannot carry out the mathematics, you will still receive most of the points. I write the test after we won the soccer game.

1 A flat square loop of wire with side length ℓ is in the x - y plane centered at the origin. The loop carries a current I in the clockwise direction when viewed from the positive z axis. Compute the vector potential at a point a distance $R > \ell$ along the x axis.

2 A spherical capacitor is formed of two conductors of radius a and b where $a < b$. The capacitor is centered at the origin. Half the capacitor ($z < 0$) is filled with a dielectric with relative permittivity ϵ_1 and half the capacitor ($z > 0$) with dielectric with relative permittivity ϵ_2 .

a Compute the capacitance.

b Compute the total charge stored on the inner conductor if a potential V_0 is established across the two conductors. Report the division of this charge between the top half, Q_+ where $z > 0$; and Q_- where $z < 0$.

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3 A circular magnet with radius $a = 1\text{cm}$ and thickness $d = 1\text{mm}$ and magnetization $1 \times 10^5\text{A/m}$ lies in the $x - y$ plane centered at the origin.

a Calculate the magnetic field at the center of the magnet.

b Calculate the torque a magnetic field $\vec{B} = B_0\hat{x}$ would exert on the magnet if $B_0 = 0.2\text{T}$.

4 The radius of a wire decreases from a to b over a distance of ℓ . A voltage V_0 is established across the ends of the wire. The wire has resistivity ρ .

a Compute the resistance.

b Compute the electric field as a function of distance along the wire in terms of V_0 and geometric constants.