

PHYS 3414 - Electricity and Magnetism- Homework Set 9

Test Review

These will not be collected. I wrote these in a hurry. Centennial is killing me (or is it you). Solutions are posted. I worked them quickly, so I don't guarantee the details. Problem 2 contains a step that can not be completed during a test.

- 1** A sphere of radius a has a polarization that changes with radius according to the function $\vec{P} = \gamma r \hat{r}$ where γ is a constant. Compute \vec{E} , \vec{D} , and any bound charge.
- 2** A conducting sphere of radius a is held at voltage V_0 . The sphere is coated with a dielectric of thickness d where the dielectric constant changes linearly from ϵ_a to ϵ_b over its thickness. Find the capacitance of the sphere with respect to ground. This contains a step that is too difficult for a test question.
- 3** A loop of wire carries current I and has radius R . Set up the integral you would use to calculate the vector potential inside the loop but in the plane of the loop. Simplify until a one-dimensional integral results.
- 4** Compute the energy of a plasma of charge confined to a sphere of radius a where the charge density inside is $\gamma = \text{constant}$ and the charge density outside is zero.
- 5** A square permanent magnet of height 1mm and sides of length 1cm is in the $x-y$ plane. The magnetization is $\vec{M} = M_0 \hat{z}$, where $M_0 = 1 \times 10^6 \text{ A/m}$. Compute the field at a point 1cm from the magnet along the z -axis.
- 6** A square permanent magnet of height 1mm and sides of length 1cm is in the $x-y$ plane. The magnetization is $\vec{M} = M_0 \hat{z}$, where $M_0 = 1 \times 10^6 \text{ A/m}$. Approximate the field at a point 10cm from the magnet along the z axis.
- 7** A current sheet carries current 1A/m in the \hat{x} direction. Parallel to the sheet, a wire carries current 1A in the x -direction a distance d above the sheet. Compute the force per unit length on the wire.
- 8** A cylindrical capacitor with inner radius a and outer radius b is filled with a dielectric with susceptibility χ_e and conductivity σ . If a voltage V_0 is established across the conductors, compute the current per unit length between the conductors.
- 9** A cylindrical capacitor with inner radius a and outer radius b is filled with a dielectric with susceptibility χ_e and conductivity σ . If a voltage V_0 is established across the conductors, compute the energy stored per unit length.
- 10** A square of wire with sides ℓ and cross-section A lies flat in the $x-y$ plane in a uniform magnetic field that is changing as $\vec{B} = B_0 \hat{z} \cos(\omega t)$. The wire has resistivity ρ . Compute the current as a function of time. Indicate the direction of the current from $t = 0$ to $t = \pi/2\omega$.
- 11** A cylindrical rod of iron ($\mu_r = 200$, $r = a$) partially fills a long solenoid (N' , I , $r = b$). Compute the inductance per unit length.