

1. A hollow spherical shell carries charge density $\rho = k/r^2$, in the region $a \leq r \leq b$.

(a) Find the electric field \vec{E} in the three regions: (I) $r < a$, (II) $a \leq r \leq b$, (III) $r > b$. (8%)

(b) Plot $|\vec{E}|$ as a function of r . (3%)

(c) Find the potential at center ($r = 0$). (6%)

2. A sphere of radius R carries a polarization $\vec{P} = k\vec{r}$, where k is a constant and \vec{r} is the vector from the center.

(a) Calculate the surface bound charge density σ_b and volume bound charge density ρ_b . (7%)

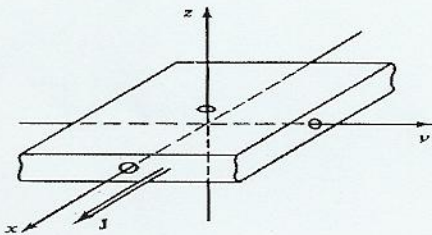
(b) Find the electric field inside and outside the sphere. (8%)

3. A circular loop of wire, with radius R , lies in the xy plane, centered at the origin, and carries a current I running counterclockwise as viewed from the positive z axis.

(a) What is its magnetic dipole moment? (3%)

(b) What is its (approximate) magnetic field at points far from the origin? (5%)

4. A thick slab extending from $z = -a$ to $z = a$ carries a uniform volume current $\vec{J} = J\hat{i}$ (see figure in below). Find the magnetic field both inside and outside the slab. (10%)



5. A square loop of wire, of side a , lies midway between two long wires, $3a$ apart, and in the same plane. Actually, the long wires are sides of a large rectangular loop, but the short ends are so far away that they can be neglected. A clockwise current I in the square loop is gradually increasing: $dI/dt = k$ (a constant). (a) Find the emf induced in the big loop. (b) Which way will the induced current flow? (15%)

國立中正大學九十五學年度碩士班招生考試試題
系所別：物理學系

科目：電磁學

第 1 節

第 2 頁，共 2 頁

6. Imagine a very long solenoid with radius R , n turns per unit length, and current I . Coaxial with the solenoid are two long cylindrical shells of length l --- one, inside the solenoid at radius a , carries a charge $+Q$, uniformly distributed over its surface; the other, outside the solenoid at radius b , carries charge $-Q$. l is supposed to be much greater than b . When the current in the solenoid is gradually reduced, the cylinders begin to rotate. (a) Explain this phenomena by the conservation of angular momentum. (b) Where does the angular momentum come from? (20%)

7. Show that the mode TE_{00} can not occur in a rectangular wave guide. (15%)