

HW10

Due Friday Dec. 3, 2010

1. A copper (Cu) wire 3 mm in diameter is carrying a current of 10 Amp. Assuming that one free electron per Cu atom, find the drift velocity of the free electrons. Cu has a density of 8.9 gm/cm^3 and an atomic mass of 63.5 gm.
2. An infinitely long straight wire coincides with the z-axis carries a constant current I . A circular loop of radius a lies in the xz plane moving in the +x direction with a constant speed v from the -x side to the +x side. Find the time dependence of the induced emf in the loop with $t = 0$ set at the time when the center of the loop passes through the z-axis.
3. A thin spherical shell of radius a rotates about the z-axis with a constant angular speed ω . The rotating shell is in a uniform \mathbf{B} field, which is in the xz plane at an angle α with respect to the axis of rotation. Find the induced electric field at each point on the sphere.
4. Consider a situation where the flux that passes through the first coil, also passes through the second coil. For example, we can achieve this by winding two coils on the same torus. Show that under these conditions the mutual induction $M_{12} = (L_1 L_2)^{1/2}$, where L_1 and L_2 are the self inductances of the two coils.
5. Consider an electromagnetic "eddy current" brake consisting of a metallic disc of conductivity σ and thickness d rotating about an axis through the disc center. A uniform \mathbf{B} field is applied perpendicular to the plane of the disc over a small area a^2 located at a distance ρ from the axis. Show the torque to the disc at the instant when its angular speed is ω is given roughly by $\sigma \omega B^2 \rho^2 a^2 d$.
6. Consider a long straight coaxial cable consisting of an inner solid conductor of radius a , and an outer conducting tube of inner radius b and outer radius c , where $a < b < c$.
 - (a) Find the \mathbf{B} field everywhere.
 - (b) Find the magnetic energy per unit length.