Problems

Chapter 8

1. Consider a proton moving in a uniform magnetic field of 4.00mT. At a certain time it moves in a direction 30.0° away from the magnetic field direction. At that time, the force on the proton is 8.00×10^{-17}N in magnitude.
   (a) Find the speed of the proton at the given time.
   (b) Find the kinetic energy of the proton (in electron-volts) at the given time.
2. An electron accelerates from zero velocity to a velocity $\vec{\mathbf{v}}$ by travelling through a potential difference of 2.0kV. After that, it is observed to move at constant velocity through a region where both an electric and a magnetic field are present. This second electric field is uniform and it is produced by two large plates with a potential difference of 50V and a separation of 2.0mm. If the electric field is perpendicular to the velocity, find the magnetic field.
3. An electron is moving in a region where both an electric field $\vec{\mathbf{E}}$ and a magnetic field $\vec{\mathbf{B}}$ are present. The instantaneous velocity of the electron is

   $$\vec{\mathbf{v}} = 5.0\hat{\mathbf{j}} + 2.0\hat{\mathbf{k}} \text{ m/s}$$

   and its instantaneous acceleration is

   $$\vec{\mathbf{a}} = (4.0 \times 10^{12})\hat{\mathbf{i}} \text{ m/s}^2.$$

   If the magnetic field is

   $$\vec{\mathbf{B}} = 2.0\hat{\mathbf{i}} \text{ T}$$

   find the electric field $\vec{\mathbf{E}}$.
4. An electron moves along a circular path of radius 20cm due to a uniform magnetic field. It has a kinetic energy of 5.0 keV.
   (a) Find the speed of the electron.
   (b) Find the magnitude of the magnetic field.
   (c) Find the frequency of the orbiting motion.
   (d) Find the time period of the orbit.
5. In one experiment, a proton and an unknown particle are accelerated to the same speed and then introduced into the same uniform magnetic field. The resulting orbit radius of the unknown particle is measured to be twice that of the proton. In another experiment, the same two particles are accelerated again. But this time they are given the same kinetic energy. Once again, they are introduced into the same magnetic field. This time the resulting orbit radii of the two particles are measured to be the same. It is independently known that the unknown particle is one of three possibilities – a deuteron (deuterium nucleus), an alpha particle (helium nucleus) or a proton. Determine which one it is.

6. A power line runs along the north-south direction and two adjacent poles holding it up are 100m apart. The Earth's magnetic field in the vicinity has a magnitude of 60.0μT and is pointed downwards $70°$ from the horizontal north. Assuming the line to be horizontal, find the direction and magnitude of the magnetic force on it between poles at an instant when the current is flowing towards north and has a magnitude of 2000A.

7. A 10.0cm long wire is placed along the x axis and it has a current of 5.00A flowing in the positive x direction. The wire is immersed in a uniform magnetic field given by the following.

$$\vec{\mathbf{B}} = 0.200\hat{\mathbf{j}} + 0.800\hat{\mathbf{k}} \text{ T}.$$

   Find the magnetic force on the wire.

8. A 20 turn circular coil of wire is placed in the xy plane as shown below. The radius of the coil is 4.0m. The current in each turn is $i = 0.10$A in the direction shown. A uniform magnetic field $\vec{\mathbf{B}}$ acts on this coil and it is given by the following.

$$\vec{\mathbf{B}} = 0.40\hat{\mathbf{i}} + 0.50\hat{\mathbf{k}} \text{ T}.$$

   Find the torque on the coil.