Homework 7 – Chapter 29

Ch. 29, Q: 3, 6, 9, 11
Ch. 29, P: 5, 7, 14, 30, 37, 42

Questions

3) If a charged particle is moving in a straight line through some region of space the magnetic field is not necessarily zero. There could be a magnetic field could be in the same direction (or opposite direction) as the velocity of the particle.

6) Similarities include between electric and magnetic field include: both cause forces for which the force is proportional to the charge. Differences include: the force is parallel or anti-parallel to the electric fields, the force is perpendicular to the magnetic fields. Electric fields can do work but magnetic fields cannot.

9) a) The magnetic field must be into the page by the right hand rule (remember that the electron is negatively charged). b) If the magnetic field were reversed the deflection would be in the opposite direction.

11) If the plane of the loop is perpendicular to the magnetic field, the force on the loop is uniform so there is no torque.

Problems

5) Since we know the mass and acceleration we can find the force and relate it to the magnetic field.

$$F_B = q\vec{v}\times\vec{B}$$

$$\left(1.673\times10^{-27}\,kg\right)\left(2.00\times10^{13}\,\frac{m}{s^2}\right)=\left(1.602\times10^{-19}\,C\right)\left(1.00\times10^{7}\,\frac{m}{s}\right)B$$

$$B = 2.09\times10^{-2}\,T$$

The magnetic field must be in the –ŷ, because of the right hand rule.

7)

$$F_B = |q|vB\sin\theta$$

$$8.20\times10^{-13}\,N = \left(1.602\times10^{-19}\,C\right)\left(4.00\times10^{6}\,m/s\right)\left(1.70T\right)\sin\theta$$

$$\theta = \arcsin(0.754) = 49^\circ or 181^\circ$$

14) In order for the tension in the flexible wires to be zero, the force from the magnetic field would have to equal the gravitational force, or rather the force per length.

$$\frac{F_B}{L} = \frac{ILB}{L} = \frac{mg}{L}$$

$$I = \frac{m}{L}\frac{g}{B} = \left(0.04\frac{kg}{m}\right)\left(\frac{9.80m/s^2}{3.60T}\right) = 0.109A$$

Since the magnetic force needs to be opposite the gravitational force, the current should be to the right.

30) First, we need to calculate the velocity of the ion. We can do this by equation the kinetic energy to the change in potential energy.

$$qV = \frac{m}{2}v^2$$

$$v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{2(1.602\times10^{-19}C)(833V)}{(3.2\times10^{-26}kg)}} = 91.3\times10^3 m/s$$

Now we need to equate the magnetic force to the centripetal force.

$$qvB\sin\theta = m\frac{v^2}{r}$$

$$r = \frac{mv}{qB} = \frac{(3.2\times10^{-26}kg)(91.3\times10^3 m/s)}{(1.602\times10^{-19}C)(0.920T)} = 0.0198m$$

37) First we need to find the velocity from the kinetic energy.

$$E = \frac{m}{2}v^2$$

$$v = \sqrt{\frac{2E}{m}} = \sqrt{2\frac{10\times10^6 eV}{1.673\times10^{-27}kg}\left(\frac{1.602\times10^{-19}J}{eV}\right)} = 43.7\times10^6 m/s$$

We find the magnetic field in a manner similar to the last problem.

$$qvB\sin\theta = m\frac{v^2}{r}$$

$$B = \frac{mv}{qr} = \frac{(1.673\times10^{-27}kg)(43.7\times10^6 m/s)}{(1.602\times10^{-19}C)(5.8\times10^{10}m)} = 7.88\times10^{-12}T$$

42) When both electric and magnetic fields are both acting on the particle the forces must be equal and we can use this to find the velocity of the particles.

$$|q|vB\sin\theta = F_B = F_E = |q|E$$

$$v = \frac{E}{B\sin 90^\circ} = \frac{2500V/m}{0.0350T} = 7.14\times10^4 m/s$$

$$r = \frac{mv}{qB} = \frac{(2.18\times10^{-26}kg)(7.14\times10^4 m/s)}{(1.602\times10^{-19}C)(0.035T)} = 0.278m$$