Phsx 2220 - Homework #6

29-1. An alpha particle travels at a velocity **v** of magnitude 550 m/s through a uniform magnetic field **B** of magnitude 0.045 T. (An alpha particle has a charge of $+3.2 \times 10^{-19}$ C and a mass of 6.6×10^{-27} kg.) The angle between **v** and **B** is 52°. What are the magnitudes of (a) the force $\mathbf{F}_B$ acting on the particle due to the field and (b) the acceleration of the particle due to $\mathbf{F}_B$? (c) Does the speed of the particle increase, decrease, or remain equal to 550 m/s?

29-2. A proton travels through uniform magnetic and electric fields. The magnetic field **B** = -2.5 **i** mT. At one instant the velocity of the proton is **v** = 2000 **j** m/s. At that instant, what is the magnitude of the net force acting on the proton if the electric field is (a) 4.0 **k** V/m, (b) -4.0 **k** V/m, and (c) 4.0 **i** V/m? (**i**, **j**, and **k** are unit vectors.)

29-3. An electron is accelerated through a potential difference of 1.0 kV and directed into a region between two parallel plates separated by 20 mm with a potential difference of 100 V between them. The electron is moving perpendicular to the electric field when it enters the region between the plates. What magnetic field is necessarily perpendicular to both the electron path and the electric field so that the electron travels in a straight line?

29-4. A strip of copper 150 μm thick is placed in a uniform magnetic field **B** of magnitude 0.65 T, with **B** perpendicular to the strip. A current i = 23 A is then sent through the strip such that a Hall potential difference V appears across the width. Calculate V. (The number of charge carriers per unit volume for copper is 8.47×10^{28} electrons/m^3.)

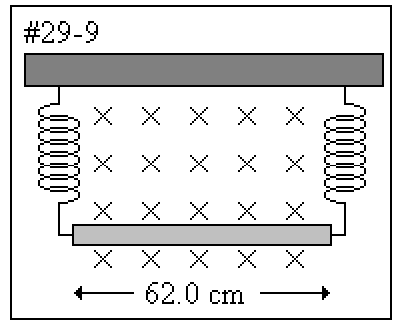
29-5. An electron is accelerated from rest by a potential difference of 350 V. It then enters a uniform magnetic field of magnitude 200 mT with its velocity perpendicular to the field. Calculate (a) the speed of the electron and (b) the radius of its path in the magnetic field.

29-6. Physicist S. A. Goudsmit devised a method for measuring accurately the masses of heavy ions by timing their periods of revolution in a known magnetic field. A singly charged ion of iodine makes 7.00 rev in a field of 45.0 mT in 1.29 ms. Calculate its mass, in unified atomic mass units. Actually, the mass measurements are carried out to much greater accuracy than these approximate data suggest.

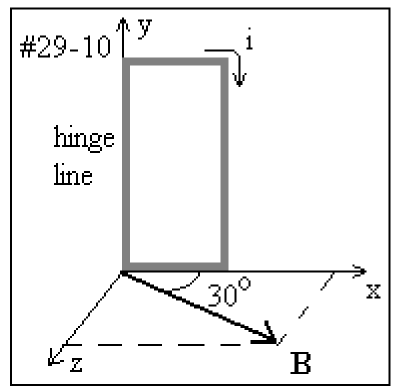
29-7. An alpha particle ($q = +2e$, $m = 4.00$ u) travels in a circular path of radius 4.50 cm in a magnetic field with $B = 1.20$ T. Calculate (a) its speed, (b) its period of revolution, (c) its kinetic energy in electron-volts, and (d) the potential difference through which it would have to be accelerated to achieve this energy.

29-8. A physicist is designing a cyclotron to accelerate protons to one-tenth the speed of light. The magnet used will produce a field of 1.4 T. Calculate (a) the radius of the cyclotron and (b) the corresponding oscillator frequency. Relativity considerations are not significant.

29-9. A wire of 62.0 cm length and 13.0 g mass is suspended by a pair of flexible leads in a magnetic field of 0.440 T, as shown at right. What are the magnitude and direction of the current required to remove the tension in the supporting leads?



29-10. The figure at right shows a rectangular, 20-turn coil of wire, 10 cm by 5.0 cm. It carries a current of 0.10 A and is hinged along one long side. it is mounted in the xy plane, at an angle of 30^o to the direction of a uniform magnetic field of 0.50 T. Find the magnitude and direction of the torque acting on the coil about the hinge line.



29-11. A circular coil of 160 turns has a radius of 1.90 cm. (a) Calculate the current that results in a magnetic dipole moment of $2.30\ A{\cdot}m^2$. (b) Find the maximum torque that the coil, carrying this current, can experience in a uniform 35.0 mT magnetic field.

29-12. The magnetic dipole moment of Earth is 8.00×10^{22} J/T. Assume that this is produced by charges flowing in Earth’s molten outer core. If the radius of their circular path is 3500 km, calculate the current they produce.