Portland State University
General Physics Workshop
Problem Set 4

Magnetic Fields

Equations and Relations:

Force on a moving charged particle:
$F = qvB\sin(\theta)$

Force on wire carrying a current I:
$F = IlB\sin(\theta)$

Torque on current loop: $\tau = NIAB\sin(\theta)$

1. A +2-μC charge is at rest in a magnetic field of 2 T pointing along the +x-axis. What is the force acting on this charge in the magnetic field?

2. A proton moving with a velocity of 4.0 multiply 10^7 m/s along the +y-axis enters a magnetic field of 0.20 T directed along the -x-axis. What is the magnitude and direction of the force acting on the proton?

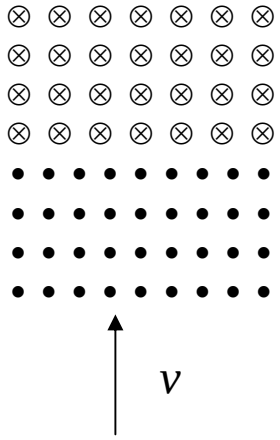
3. A wire of a certain length, carrying a current of 2.0 A, is placed perpendicular to a magnetic field of strength 0.20 T. If the wire experiences a force of 0.40 N what is the length of the wire?

4. A Nickel Ion (^{58}Ni, 28 protons, 30 neutrons) has a mass of 96.2 x 10^{-27}Kg and a charge of +e. It is accelerated from rest through a potential difference of 2000V and deflected in a magnetic field of 0.3 T.
   a.) Find the radius of the orbit of the Ion.
   b.) How long does it take the Ion to complete one orbit.
   c.) Calculate the radius for a ^{60}Ni Ion of the same charge (the mass ratio is 58/60). How much does the radius change?

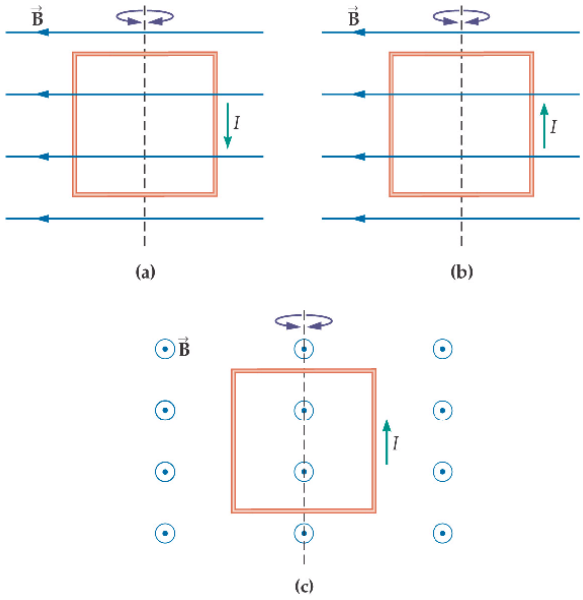
- *A moving charge experiences a force in an electric as well as in a magnetic field. How can you determine if the charge is deflected by the magnetic field.*
- *Draw a magnetic field map of the earth.*
- *What are the similarities and differences of electric and magnetic field lines?*
- *You have two steel bars; one magnetized and the other unmagnetized. How can you determine which steel bar is magnetized. (You don't have any other tools) How do you determine the polarity of the magnetized steel bar?*
- *If you place a steel bar in the north-south direction and hammer on it, it becomes slightly magnetized. Why?*

- *An electron passes through a region of space without being deflected. Can you conclude that there is no field in this region.*

- *Trace the path of positive and negative charge would take as it enters the magnetic field shown in the figure. How does the trajectory depend on the mass of the charge?*



5.



a.) For each (all four!) side of the loop in Figure (a), (b) and (c) indicate the direction of force acting on the wire. (Use a circle with a dot for a force out of the paper, a circle with cross for a force into the paper, and arrows for a force up/down/right/left, if there is no force write "0N")

b.) For a magnetic field of B=1 T and current I=10 A, find the magnitude of the magnetic force exerted on each side of the loop in Figure (b) (each side of the loop is 0.5 m).

c.) For a magnetic field of B=1 T and current I=10 A find the magnitude of the torque exerted on the loop in Figure (a) about the vertical axis of rotation, (each side of the loop is 0.5 m).

Additional Questions:

1. A charge moves along the +x axis and experiences no magnetic force, although there is a magnetic field. What can you conclude about the direction of the magnetic field?

2. A moving charge experiences the maximum possible magnetic force when moving in a magnetic field. What can you conclude about the angle θ that the charge's velocity makes with respect to the magnetic field?

3. If a magnet is held near the screen of a TV or computer monitor, the picture is distorted. What causes the picture to be distorted? With a color TV or monitor, the distortion remains even after the magnet is removed, (i.e. don't try this at home). Why?