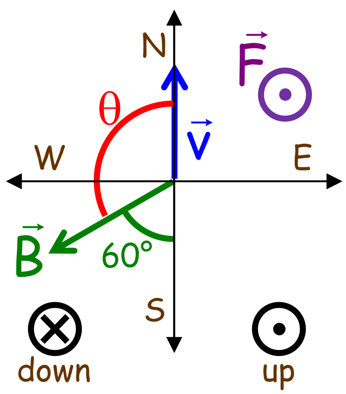
1. A proton is moving due north in a uniform magnetic field that is pointing 60° west of south. $F = qvB\sin\theta$ and $q = 1.6 \times 10^{-19} C$
   a. Draw the magnetic field vector on the coordinate system below, and label all the directions on the coordinate system.
   b. Draw the velocity vector on the same coordinate system.
   c. What is the angle between v and B?
   d. Draw the Force vector on the same coordinate system, and write down a description of the direction.
   e. Find the magnitude of the Force vector if B = 1.6 T and v = 3 x 10^6 m/s



c) $\theta = 180^\circ - 60^\circ = 120^\circ$

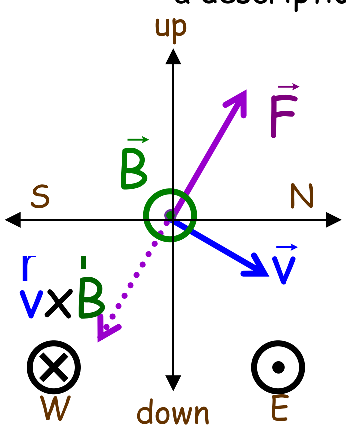
d) The force is out of the page … up from the ground

e) $F = qvB\sin\theta$

$$F = (1.6 \times 10^{-19} C)(3 \times 10^6 m/s)(1.6T)\sin(120^\circ)$$

$$F = 6.65 \times 10^{-13}\ N$$

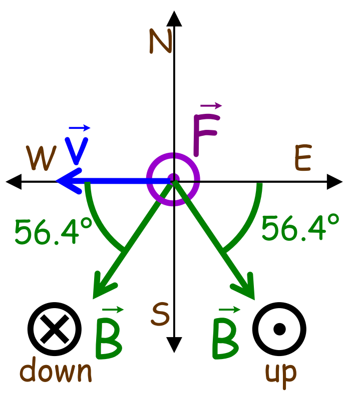
2. An electron is moving northward, 30° down from the horizontal in a uniform magnetic field that is pointing due west.
   a. Draw the velocity vector on the coordinate system below, and label all the directions on the coordinate system.
   b. Draw the magnetic field vector on the same coordinate system.
   c. What is the angle between v and B?
   d. Draw the Force vector on the same coordinate system, and write down a description of the direction.



c) B and v are $\perp$ so $\theta = 90^\circ$

d) The force is toward the north, 60° above the horizontal

3. A proton is moving west with a speed of 2.0×10^5 m/s in a 1.2 T uniform magnetic field. It experiences an upward magnetic force of 3.2×10^{-14} N.
   a. Sketch the velocity on a coordinate system so that the force is aimed in (or out) of the page.
   b. Calculate the angle between the velocity and the magnetic field.
   c. Sketch the magnetic field on the graph (you should have two possible directions for B, sketch them both.



b) find θ

$$F = qvB\sin\theta \Rightarrow \sin\theta = \frac{F}{qvB}$$

$$\sin\theta = \frac{(3.2 \times 10^{-14} N)}{(1.6 \times 10^{-19} C)(2.0 \times 10^5 m/s)(1.2T)} = 0.833$$

$$\theta = 56.4^\circ$$

c) The magnetic field is 56.4° from v, with the perpendicular component south to give F up for a p^+. The parallel component can be to the east or west as shown.

4. After being accelerated through a potential difference of 6.5kV, a doubly charged Oxygen atom O_2^{-2} ($m_O = 2.65 \times 10^{-26}$ kg) moves in a circle of radius 22 cm.
   a. Sketch the direction the negative ion curves when it enters the magnetic field shown directed into the page.
   b. Find the magnitude of the magnetic field,

$$\tfrac{1}{2}mv^2 = q\Delta V \text{ and } \frac{mv^2}{r} = qvB$$

$$v = \sqrt{\frac{2q\Delta V}{m}} \text{ and } \frac{mv}{r} = qB$$

$$B = \frac{mv}{qr} = \sqrt{\frac{2m\Delta V}{qr^2}}$$

$$B = \sqrt{\frac{2(2.65 \times 10^{-26} kg)(6.5 \times 10^3 V)}{2(1.6 \times 10^{-19} C)(0.22m)^2}}$$

$$B = 0.15 \text{ T}$$