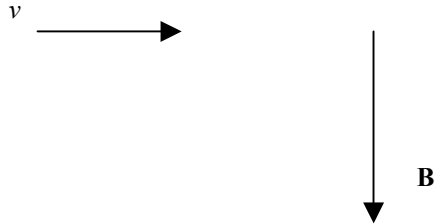# Magnetism Worksheet

1. A charged particle is traveling at a speed v in the direction indicated. A uniform magnetic field is present; its magnitude is B and its direction is shown. What is the magnitude and direction of the uniform electric field that would have to be present to ensure that the particle travels in a straight line?

$v \longrightarrow$

$B \downarrow$

2. A uniform magnetic field points in the negative z direction. A 2-m length of wire is located in the xy plane.

   a) Rank in order of magnitude (largest to smallest) the forces on the wire if the current is traveling in the (A) 0° direction; (B) 30° direction; (C) 45° direction; (D) 90° direction. (If two or more are equal, use "equals" signs.) [Directions are *relative to* the positive x-axis direction, so positive x is the "0°" direction.] *Note that the wire **remains** in the xy plane the whole time.*

   b) Will the direction of the force on the wire be the ***same*** for cases A-D, or will it vary when the direction of the current changes? Explain your answer.

3. A single long wire carrying a current is shown. The direction of the current is indicated. At point #1, the magnitude of the magnetic field produced by the current is equal to "B." Indicate the direction of the magnetic field at point #1, and the direction **and** the magnitude (in terms of "B") of the magnetic field at all other points shown (#2-6).
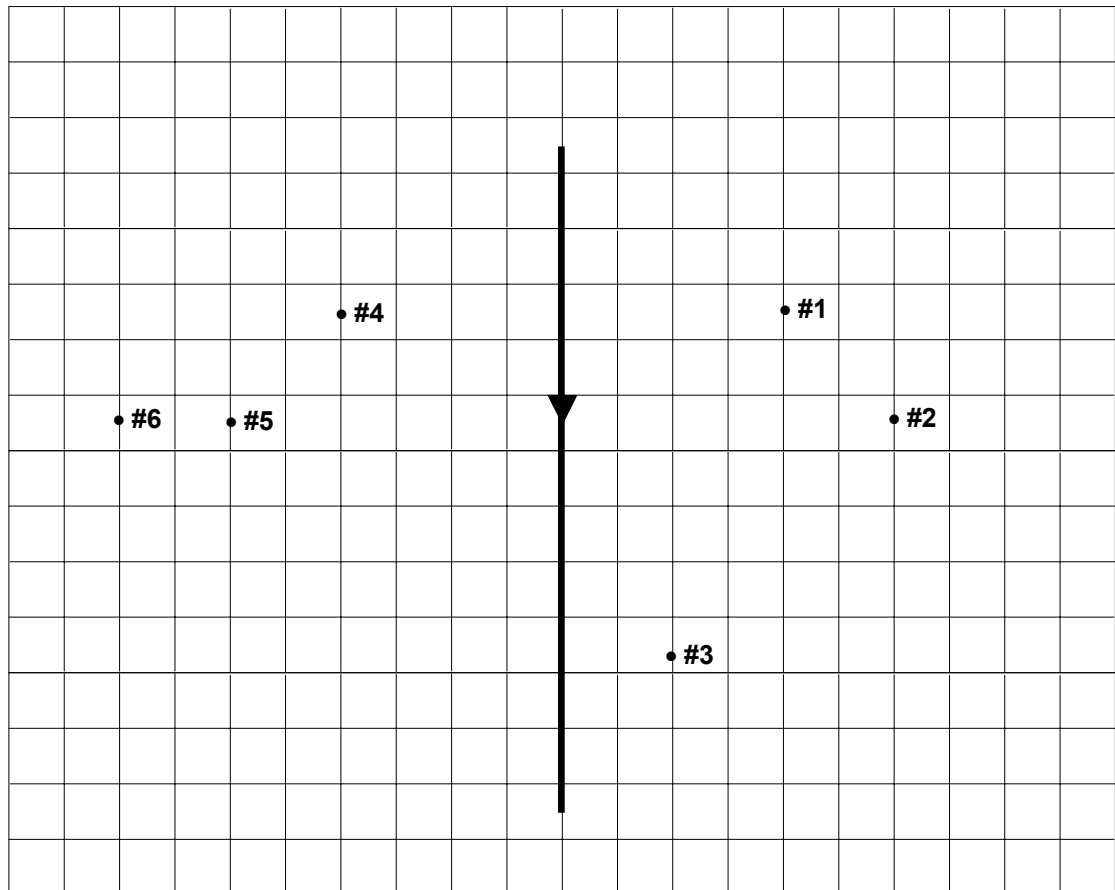
4.

a) The diagram shows a "top" view of the bar magnet, looking directly ("head-on") at the north pole. Indicate the directions of the magnetic field at the five points indicated (use the Magnaprobe). Is this a ***uniform*** magnetic field?

__non__-uniform
magnetic field
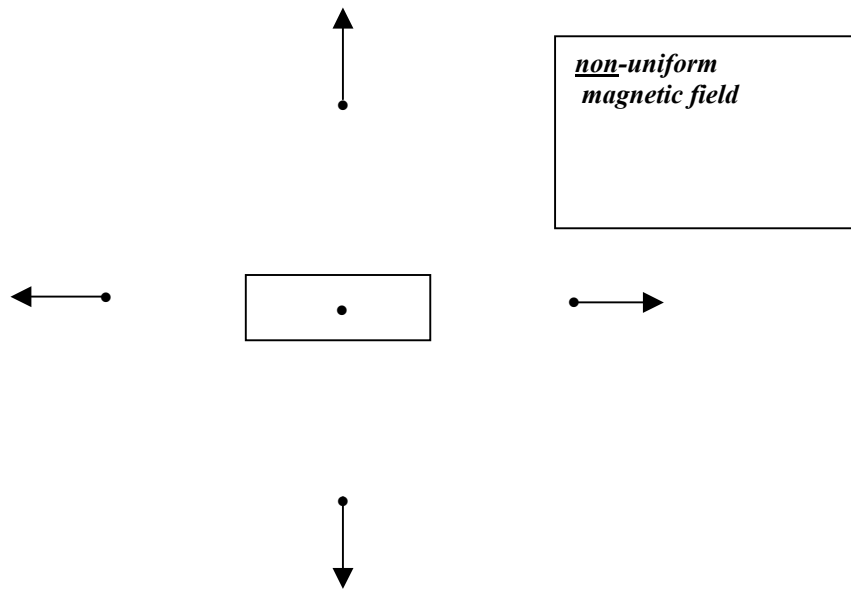
b) Suppose we place the current loop shown below directly over the north pole of the magnet (i.e., lay it flat on the diagram above, centered on the point at the middle of the rectangle). Indicate the direction of the force on each of the four sides of the current loop (due to the magnetic field of the magnet).

force __into__
page on all
sides of loop
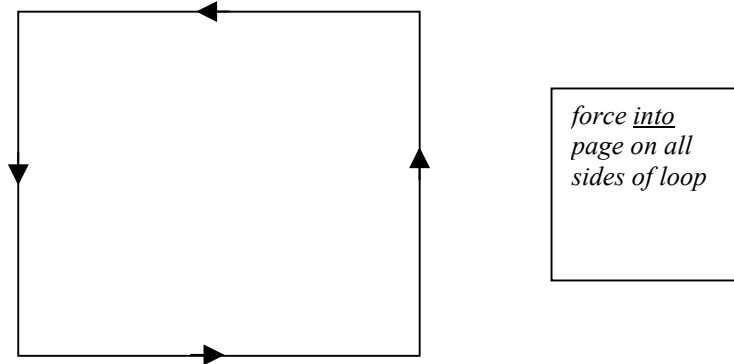
c) What will happen to the loop? That is, will it move, rotate, both, or neither? Explain your answer. ***loop will be __attracted toward__ magnet (because forces on all sides of loop are __toward__ magnet)***

d) Is the *south pole* or the *north pole* of the current loop closer to the north pole of the magnet? Is that consistent with your answer to (c)? ***By right-hand rule, the magnetic field points __up__ out of page for this current loop; therefore, top side is north and bottom side is __south__; south is __closer__ to magnet (and so is attracted to north pole as in [c])***

e) Recalling the similarities between bar magnets and current loops, try to explain why magnets attract and repel each other. (Use the other side of this page.) ***South pole of magnet is like bottom side of current loop on this page; it will be attracted toward north pole of another magnet because forces on microscopic currents pull it __toward__ north pole (as is case here); near a __south__ pole, forces would be in __opposite__ direction.***

3. Explain why two rectangular bar magnets will attract or repel each other, depending on how the poles are oriented with respect to each other. Sketch two diagrams, one showing attraction and the other showing repulsion. Label north and south poles of each magnet, and indicate the *direction of flow* of the net current "inside" each bar magnet (that is, the electric current that originates from the movement of electrons inside the atoms of the magnetic material).

7. Each box shows a segment of wire carrying a current; a uniform magnetic field is present near the wire segment. The magnitude and direction of the current are shown, and the length of the wire is indicated. The magnitude and direction of the magnetic field are shown. The "SAMPLES" show that for the currents and fields indicated, the resulting force is "F" in case (A) and "3F" in case (B), both pointed in to the paper. Find the magnitude and direction of the force acting on the wire in each box. If it is zero, write "zero."

4. Explain how an electric motor works. Draw a sketch and write down any relevant equations.

5. Explain how an electric generator works. Draw a sketch and write down any relevant equations.