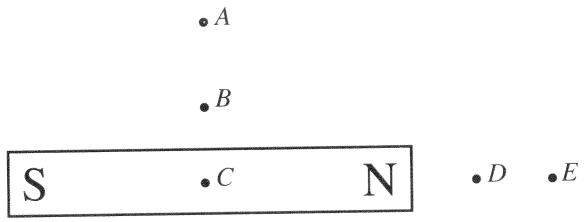
1. Answer the questions below on the basis of your experience with charges and magnets.

   a. Based on your experience with *electric field lines:*

   - how should the *direction* of the magnetic field at every point be related to the *magnetic field lines?*

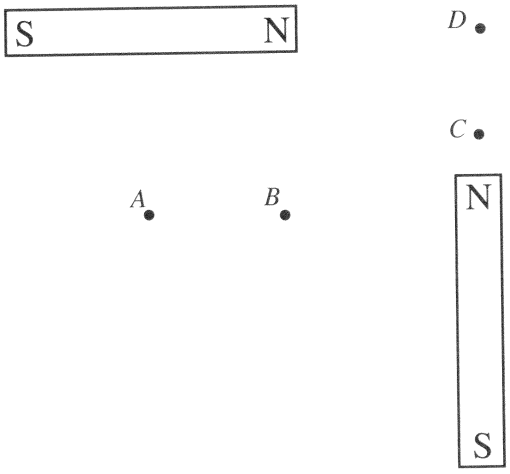
   - how should the *strength* of the magnetic field at every point be reflected in the *magnetic field lines?*

   b. Carefully draw the *magnetic field lines* for the bar magnet shown below. Be sure to draw the field lines so that they include information about the *strength* and *direction* of the field both inside and outside the magnet.



   c. Based on the magnetic field lines you have drawn, rank the magnitude of the magnetic field at points *A–E*.

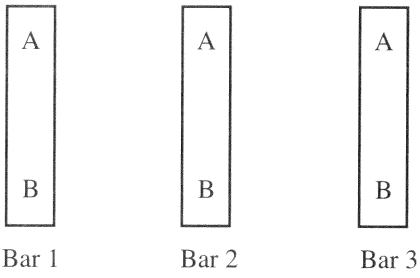
2. Two identical magnets are placed as shown. Using different colored pens sketch the approximate magnetic field vectors at the four labeled points for:



   - just the horizontal top magnet,
   - just the vertical bottom magnet, and
   - when both are present.

   Explain how you determined the field vectors for the case when both magnets are present.

3. Three metal bars, labeled 1, 2, and 3, are marked A and B on either end as shown.



Bar 1 Bar 2 Bar 3

The following observations are made by a student:

- end 1B repels end 3A
- end 1A attracts end 2B
- end 2B attracts end 3B

a. To which of your three classes from section I of the tutorial *Magnets and magnetic fields* could bar 1 belong? Explain your reasoning and the characteristics that define each of your classes.

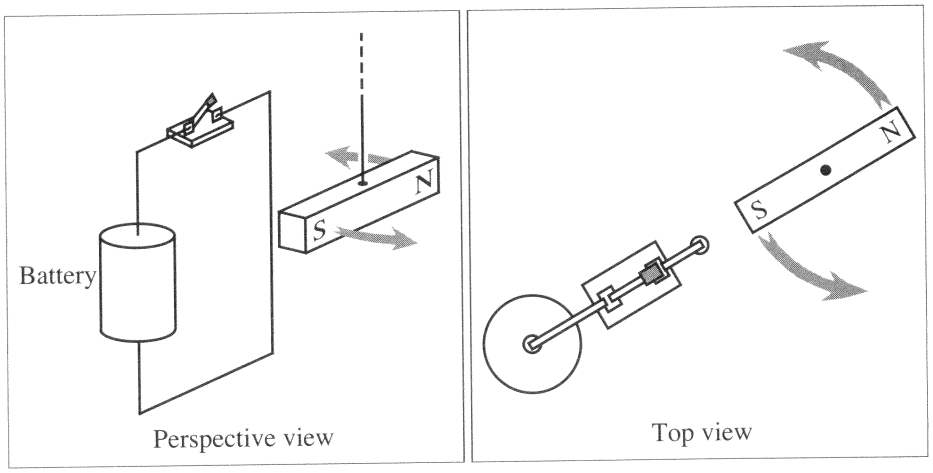
b. To which of your three classes could bar 2 belong? Explain your reasoning.

c. Would end 2A *attract, repel,* or *neither attract nor repel* end 3A if the two ends were brought near one another? If it is not possible to tell for certain, what are the possibilities? Explain.

1. A magnet is hung by a string and then placed near a wire as shown. When the switch is closed, the magnet rotates such that the ends of the magnet move as indicated by the arrows.

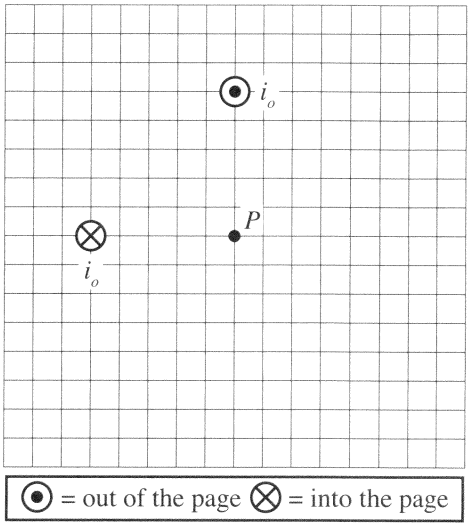
   At the instant the switch is closed determine:

   - the direction of the current through the wire segment nearest the magnet. Explain.



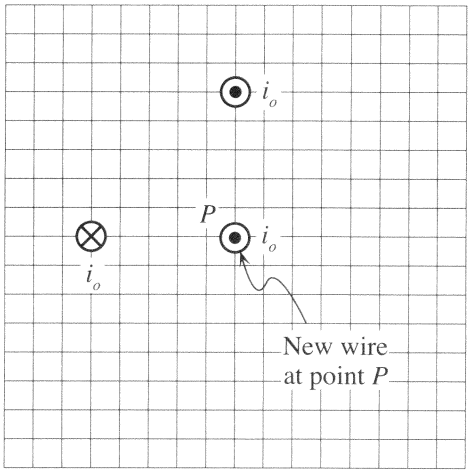
   - the direction of the net force exerted by the magnet on the wire segment at the instant that the magnet is in the position shown. Explain.

2. Shown at right is a cross-sectional view of two long straight wires that are parallel to one another. One wire carries a current i_o out of the page, the other carries an equal current i_o into the page.



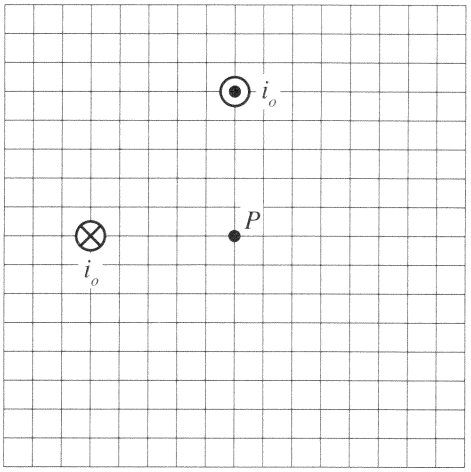
   a. Draw a vector on the diagram to show the direction of the magnetic field, if any, at point P. Explain your reasoning.

   b. Suppose that a third wire, carrying another current i_o out of the page, passes through point P.



      Draw a vector on the diagram to indicate the magnetic force, if any, exerted on the current in the new wire at P. If the magnitude of the force is zero, indicate that explicitly. Explain your reasoning.

   c. Suppose instead that the third wire (carrying the same current i_o out of the page) is placed such that the magnetic field at point P has zero magnitude. Determine the location of the third wire. (*Hint:* You will need to know how the magnetic field depends on the distance from the wire. This relationship can be found in your text.)



      Clearly indicate on the diagram at right the correct location of the new wire. Explain how you determined your answer.