Week 8 Lab.

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BCH 8/26/03

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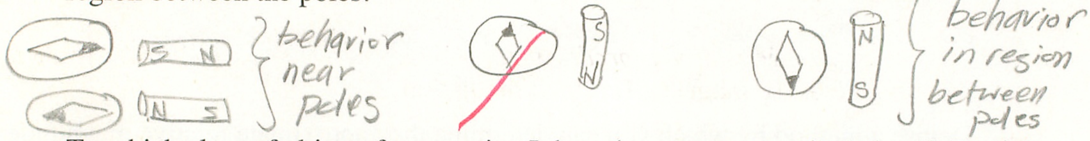
II. Magnetic fields

We have observed that magnets interact even when they are not in direct contact. In electrostatics we used the idea of an electric field to account for the interaction between charges that were separated from one another. For magnetic interactions, we similarly define a *magnetic field*.

A. Obtain a compass from a tutorial instructor.

1. Use the compass to explore the region around a bar magnet.

   Describe the behavior of the compass needle both near the poles of the magnet and in the region between the poles.



   To which class of objects from section I does the compass needle belong? Explain.

   class (b) objects which are not magnetized, but which are attracted by magnets.

2. Move the compass far away from all other objects. Shake the compass and describe the behavior of the compass needle.

   needle points in the N-S direction, with colored tip pointing to North

   Does the needle behave as if it is in a magnetic field?

   Yes

   We can account for the behavior of the compass needle by supposing that it interacts with the Earth and that the Earth belongs to one of the categories from section I.

   To which class of objects from section I do your observations suggest the Earth belongs? Explain how you can tell.

   Class (a). because campus is deflected by earth magnatic field.

3. We define the *north pole* of a magnet as the end that points toward the arctic region of the Earth when the magnet is free to rotate and is not interacting with other nearby objects.

   On the basis of this definition, is the geographic north pole of the Earth a magnetic north pole or a magnetic south pole?

   magnetic South

   Use your compass to identify the north pole of an unmarked bar magnet.

   did this.

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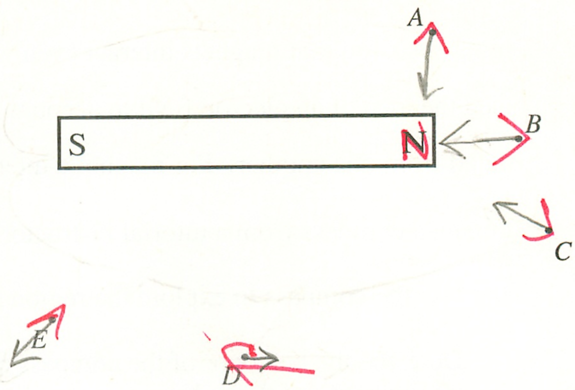
B. Place a bar magnet on an enlargement of the diagram at right.



1. Place the compass at each of the lettered points on the enlargement and draw an arrow to show the direction in which the north end of the compass points.

   Discuss with your partners how the interaction of the compass with the magnet depends on the distance from the bar magnet and the location around the bar magnet.

   as distance gets longer, interaction becomes weaker

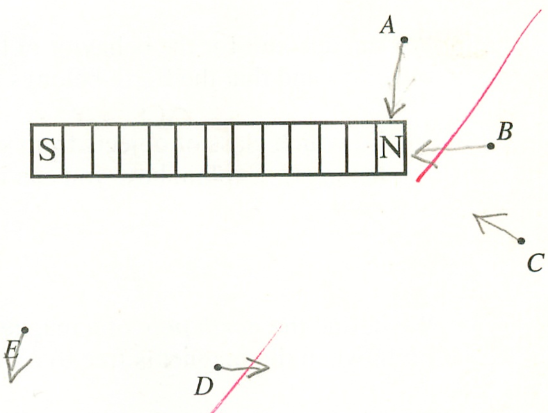
   Devise a method by which you can determine the approximate relative magnitudes of the magnetic field at each of the marked locations. Explain your reasoning.

   as needle become aligned with bar, field is weakest.

2. We *define* the direction of the magnetic field at a point as the direction in which the north end of a compass needle points when the compass is placed at that point.

   Make the arrows on your enlargement into magnetic field *vectors* (*i.e.*, draw them so that they include information about both the magnitude and direction of the field).

C. Obtain some small magnets and stack them north-to-south until you have a bar about the same length as your bar magnet. Place them on an enlargement of the diagram at right.



1. On the enlargement, sketch the magnetic field *vectors* at the locations *A–E*.

   How does the magnetic field of the stack of magnets compare to the magnetic field of the bar magnet?

   They seem equall in strength

2. Break the stack in half and investigate the breaking points. Describe how many north and how many south poles result.

   each time you break it, we get a new North and new south poles.

   What does your observation suggest about how a bar magnet would behave when broken in half?

   we get 2 new magnets / each is about half as strong as original.

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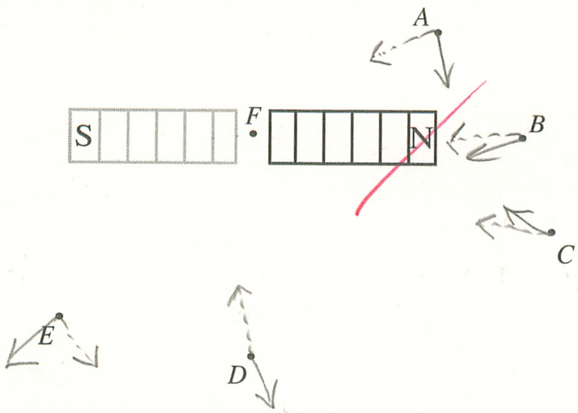
3. On your enlargement draw the magnetic field vectors at the six locations *A–F* when just the right half of the stack of magnets is present.

   Using a different color pen, draw the magnetic field vectors when just the left half of the stack of magnets is present.



Compare the field vectors for the two half-stacks of magnets to the field vectors for the whole stack.

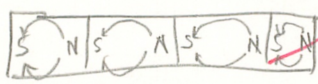
Is your observation consistent with the idea that magnetic fields obey the principle of superposition? Explain.

yes. because if we do vector additions of the 2 fields, we will set the field for the whole bar.

From your observations, what can you infer about the direction of the magnetic field inside a bar magnet? Explain.

it is as if bar is made of Large # of small magnets each has N-S poles. field goes from N to south.

Sketch magnetic field vectors for a few points inside the magnet.



Does the magnetic field of a bar magnet always point away from the north pole and toward the south pole of the magnet? Explain.

Yes. because every time you break it, a new magnet with same N-S direction appens.

What can you infer about the strength of the magnetic field inside the magnet as compared to outside the magnet?

Same

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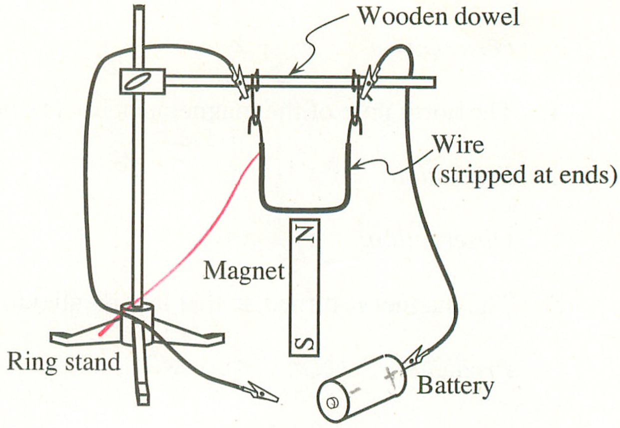
I. The magnetic force on a current-carrying wire in a magnetic field

Obtain the following equipment:

- magnet
- wooden dowel
- ring stand and clamp
- battery
- two paper clips
- two alligator-clip leads
- 30 cm piece of connecting wire
- magnetic compass
- enlargement showing magnet and wire

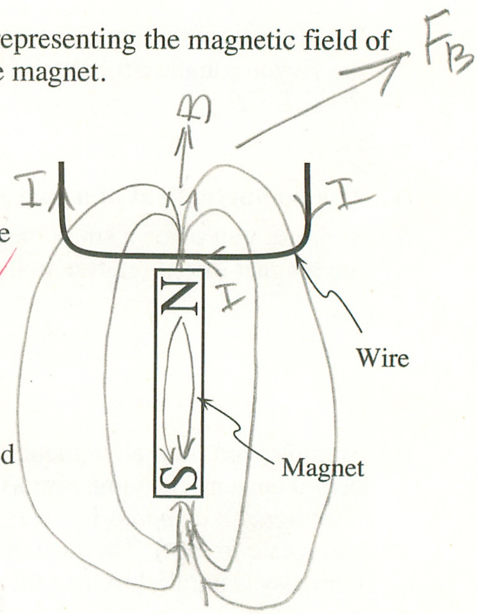


Hang the connecting wire from the paper clips as shown so that it swings freely. Do not connect the wires to the battery until told to do so.

A. On an enlargement of the figure below, sketch field lines representing the magnetic field of the bar magnet. Show the field both inside and outside the magnet.

On the diagram, indicate the direction of the current through the wire when the circuit is complete.

Predict the direction of the force exerted on the wire by the magnet when the circuit is complete. Explain.



Using Right hand Rule with I as shown

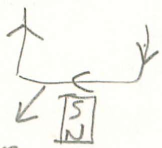
Check your prediction. (Do not leave the battery connected for more than a few seconds. The battery and wires will become hot if the circuit is complete for too long.)

checked

B. Make predictions for the following five situations based on what you observed in part A. Check your answers only after you have made all five predictions.

1. The magnet is turned so that the south pole is near the wire while the battery is connected.

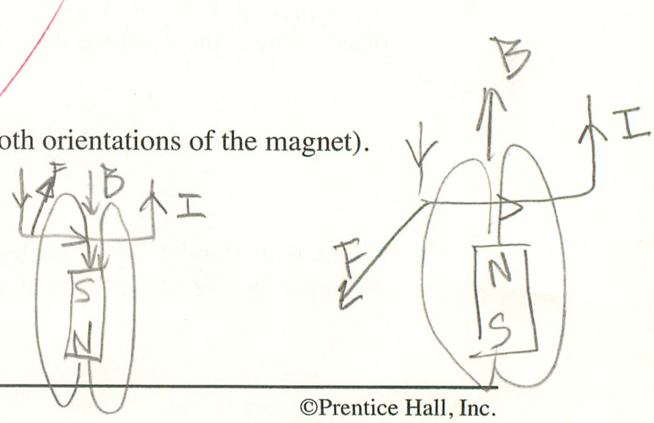
   Prediction:

   Observation: agree.

2. The leads to the battery are reversed (consider both orientations of the magnet).

   Prediction: Force out of page.

   Observation: agree

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3. The north pole of the magnet is held near the wire but the battery is not connected.

   Prediction: No Force on wire

   Observation: agree

4. The north pole of the magnet is held: (a) closer to the wire and (b) farther from the wire.

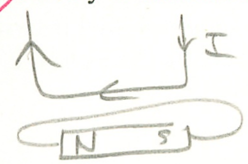
   Prediction: greater Force $F = q\bar{v} \times \bar{B}$ since $\bar{B}$ is stronger.

   Observation: agree

5. The magnet is turned so that it is parallel to the wire while the battery is connected.

   Prediction: No force

   Observation: agree

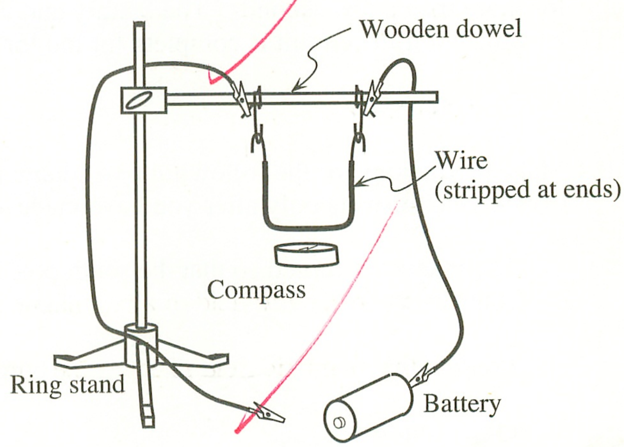


Resolve any discrepancies between your predictions and your observations. (*Hint:* Consider the *vector* equation for the magnetic force on a current-carrying wire in a magnetic field: $\vec{F} = i\vec{L} \times \vec{B}$.)

II. The magnetic field of a current-carrying wire

A. Suppose you place a small magnet in a magnetic field and allow it to rotate freely. How will the magnet orient relative to the external magnetic field lines? Illustrate your answer below.

B. Suppose you hold a magnetic compass near a current-carrying wire as shown. (A *magnetic compass* is a magnet that can rotate freely.) The face of the compass is parallel to the tabletop.



1. *Predict* the orientation of the compass needle when the circuit is complete. Sketch a diagram that shows the wire, the direction of the current through it, the direction of the magnetic field directly below the wire, and the predicted orientation of the compass needle.

2. Check your answer. If the deflection of the needle is not what you predicted, resolve the discrepancy. (*Hint:* Is there more than one magnetic field affecting the compass?)

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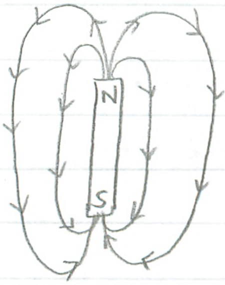
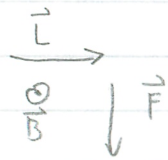
Week 8

11. A)

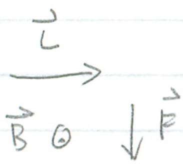


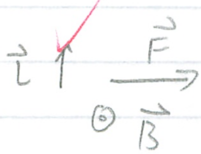
B) 1.



2. true

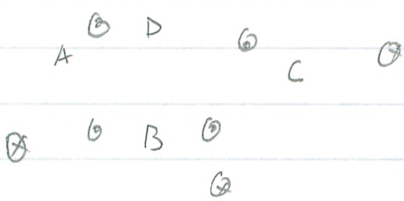
c)





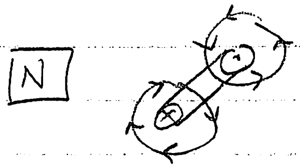
D)

III) A)

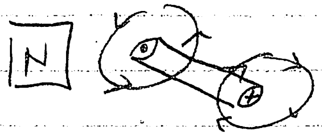


1. twisted wires outside from a solenoid
2. n $ s side. Field lines

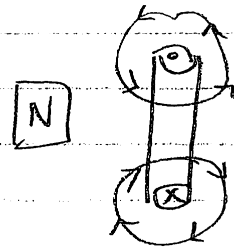
yes

B) 1. 

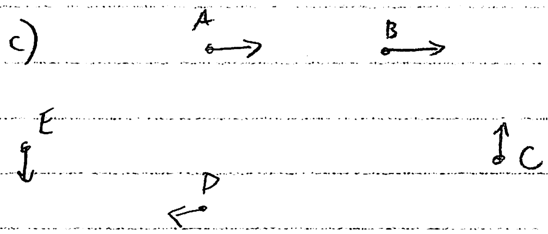
attracted to magnet
counterclockwise

2. 

attracts
clockwise

yes 

3. yes

c) 

3. Its the same
right end, left end

4. doubles
doubles