Section One: Reading Comprehension

Magnetism

Magnets were known by the ancients, and much of our qualitative terminology concerning magnetic fields is colored by this fact. In particular, we often speak of magnetic fields in terms of bar magnets, since this is the way the fields were first studied. For example, we know that the poles of a bar magnet experience forces when placed in a magnetic field. If a bar magnet is suspended by a delicate fiber, as shown in Figure 3-1, a particular end of the magnet will always point approximately north on the earth, provided no other magnetic objects are nearby. This end of the magnet is called the *north pole of* of the magnet. The other end is the *south pole.* A device such as this is nothing more than a simple compass.

Further studies .with bar magnets show that the north poles of two magnets repel each other. The south pole of a magnet is always attracted by the north pole of another magnet. If one tries to break off the north pole from a simple bar magnet, the effort proves unsuccessful. The broken magnet becomes two new bar magnets, each having a north and a south pole. These are qualitative features with which we are all familiar.

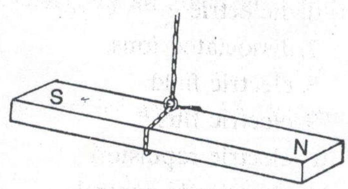


Figure 3-1. The North Pole of a Magnet Is Defined to Be the Pole That Points North When the Magnet Is Freely Suspended.

Magnetic fields are easily plotted by means of compass needles, small bar magnets. The direction in which the compass needle points is taken to be the direction of the magnetic field. We can therefore determine the direction of the magnetic field at a point by observing the orientation of a small compass needle placed at the point. This fact is used in Figure 3-2 to plot the magnetic field in the vicinity of bar magnet. The magnetic field lines are drawn in such a way that a compass needle placed on the line will align itself tangentially to the line. Typical magnetic fields are shown in Figure 3-3. Notice that the field lines emerge from north poles and enter south poles. Why is this always true? As we see from the Figure, the earth acts like a huge magnet with the magnet's north pole being near the position of the earth's south pole. *The* *earth's geographic north pole is near its magnetic south pole.*

An important step in the understanding of the nature of magnetic fields occurred in 1820 when Hans Christian Oersted discovered that currents in wires produce magnetic fields. This fact is easily demonstrated by the experiment illustrated schematically in Figure 3-4a. If no current flows in the wire, the compass needles line up parallel to each other, all pointing north. However, when a current flows in the wire, the needles line up as indicated. Experiments such as this show that the current-carrying wire has a magnetic field about it similar to that shown in Figure 3-4b. In this, as well as in later diagrams, the symbol indicates an arrow coming toward the reader, and x represents an arrow going away from the reader. The symbols are meant to suggest the tip and tail of the arrow.

A simple rule for remembering the direction of the magnetic field lines about a wire is the *right-hand rule.* This rule states that if one grasps the wire with the right hand in such a way that the thumb points in the direction of the current, the fingers will circle the wire in the same sense as do the field lines. This rule is illustrated in Figure 3-5. Notice that it is very similar to the right-hand rule for the direction assigned to torques and rotations.

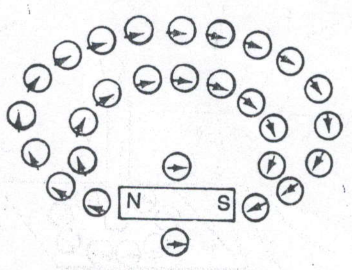
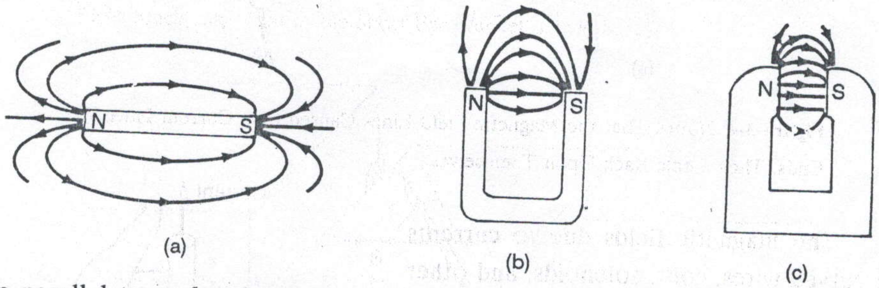


Figure 3-2. A Compass Needle Points in the Direction of the Magnetic Field.



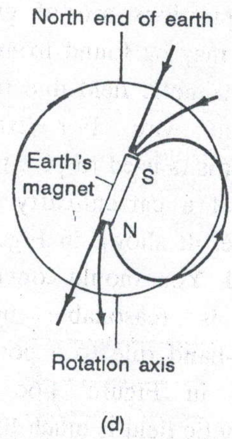


Figure 3-3. Using the Fact That a Compass Needle Should Line up Along the Field Lines, You Should Be Able to Show That the Lines Drawn Are Reasonable.

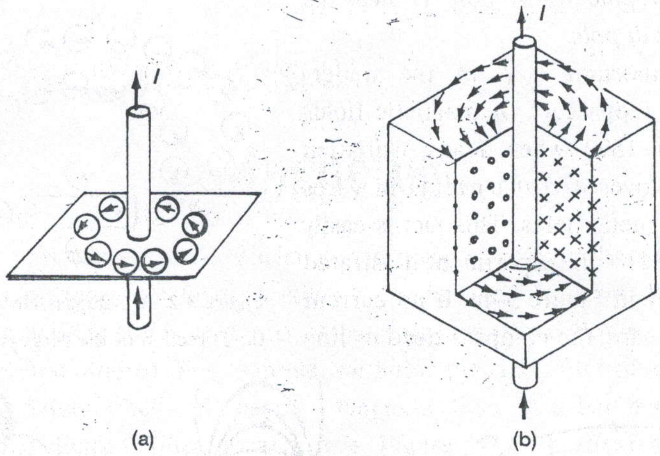


Figure 3-4. Notice That the Magnetic Field Lines Caused by a Current Have No Ends: They Circle Back Upon Themselves.

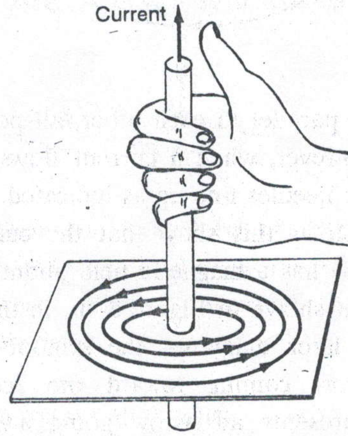


Figure 3-5. The Right-Hand Rule for Remembering the Direction of a Magnetic Field Caused by a Current in a Wire.

The magnetic fields due to currents in curved wires, coils, solenoids, and other configurations are of great importance. They may be found from a knowledge of the magnetic field due to a portion of a straight wire. For example, when a compass is used to plot the magnetic field around a current-carrying loop of wire, the result shown in Figure 3-6a and b is found. You should convince yourself that this is reasonable by applying the right-hand rule to a portion of the loop. Note in Figure 3-6c that the loop's magnetic field is much like that of a short, fat bar magnet. In that sense, the current loop can be considered to have a north and south pole. We shall see later that this is one aspect of a very important and far-reaching similarity between bar magnets and current loops. It is a simple matter to show that a wire carrying a current through a magnetic field experiences a force. For example, a schematic diagram of such an experiment is shown in Figure 3-7. There we see a wire carrying a current I through a magnetic field furnished by a magnet. The field is directed from right to left

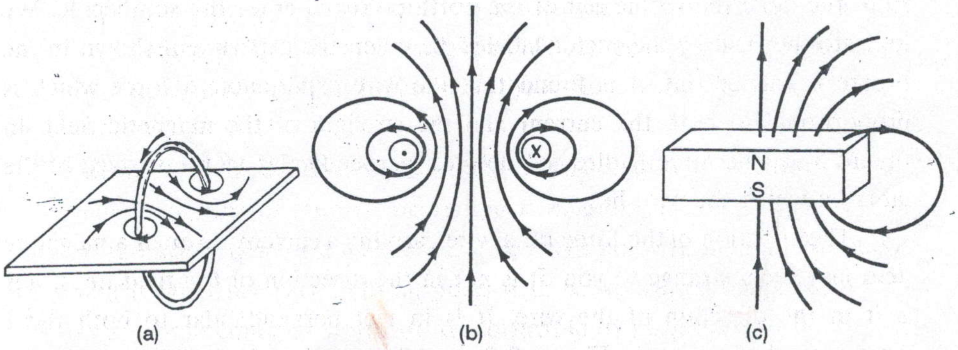


Figure 3-6. The Current-Carrying Loop Shown in (a) and (b) Has a Magnetic Field Much Like That of the Short Bar Magnet Shown in (c).

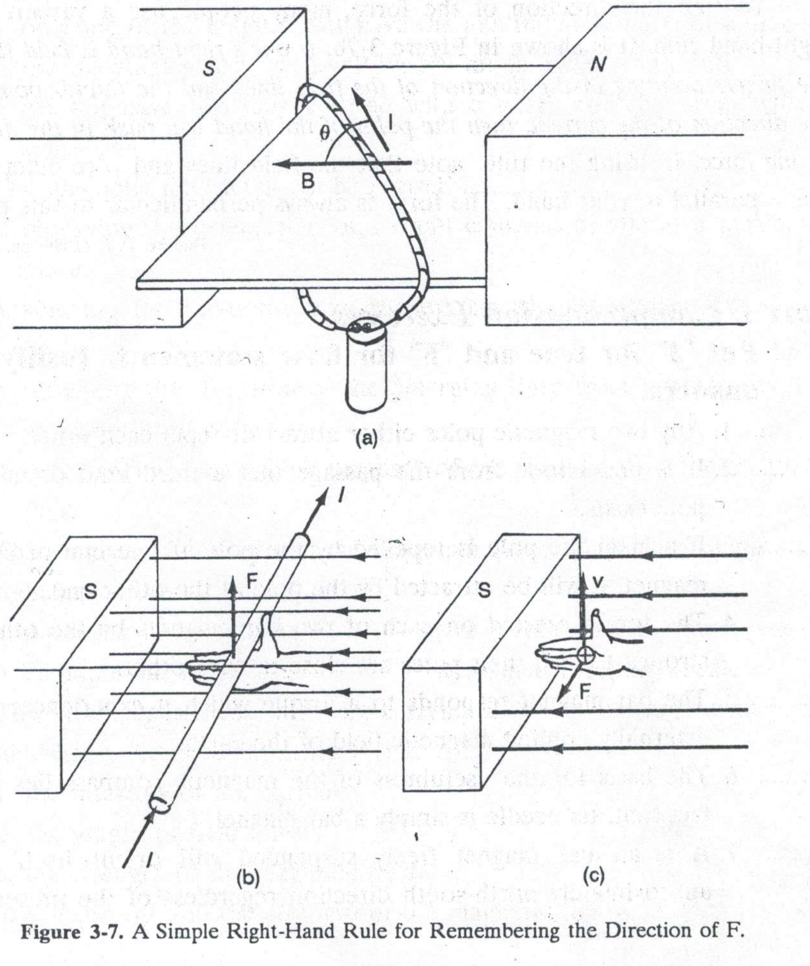


Figure 3-7. A Simple Right-Hand Rule for Remembering the Direction of F.

since the field lines come out of the north pole and enter the south pole. We indicate the field by the vector labeled **B**. When the experiment shown in the Figure is carried out, it is found that the wire experiences a force which is proportional to both the current and the strength of the magnetic field. In Figure 3-7a, the force is directed upward, perpendicular to the surface of the table on which the wire lies.

The direction of the force on a wire carrying a current through a magnetic field may seem strange to you. It is not in the direction of the field lines, nor is it in the direction of the wire. It is in fact perpendicular to both these directions. As we see in Figure 3-7a and b, the field lines (represented by B)and the current I define a plane–the plane of the tabletop in Figure 3-7a. The force on the wire is always perpendicular to the plane defined by **B** and **I**.

To find the direction of the force, many people use a variant of the right-hand rule. It is shown in Figure 3-7b. *If one's right hand is held flat with the fingers pointing in the direction of the field lines and the thumb pointing in the direction of the current, then the palm of the hand will push in the direction of the force.* In using the rule, note that the field lines and wire determine a plane parallel to your hand. The force is always perpendicular to this plane.

Bueche, F. J. (1986: pp. 441-444).

Part I. Comprehension Exercises

A. Put "T" for true and "F" for false statements. Justify your answers.

.... 1. Any two magnetic poles either attract or repel each other.

.... 2. It is understood from the passage that a third kind of magnetic pole exists.

.... 3. If a magnetic pole is repelled by the pole at one end of another magnet, it will be attracted by the pole at the other end.

.... 4. The forces exerted on each of two bar magnets by the other are strongest when their poles are close to each other.

.... 5. The bar magnet responds to a torque which it experiences in the externally applied magnetic field of the earth.

.... 6. The basis for the usefulness of the magnetic compass lies in the fact that, its needle is simply a bar magnet.

.... 7. A small bar magnet freely suspended will orient itself in an approximately north-south direction regardless of the presence of other nearby magnets.

B. Choose a, b, c or d which best completes each item.

1. The main idea of the first paragraph is that _ _ d _ _

a) the north pole of a magnet and the earth point in the same direction.

b) a magnet has two different poles with concentrated magnetism.

c) a simple compass works on the principle of magnetism.

d) the idea of magnetic field was known to man for centuries.

2. If a bar magnet is broken into two pieces, c.

a) the resultant pieces will attract each other

b) only one of the magnets will have the qualitative features of a magnet.

c) the resultant pieces, each will have a north and a south pole.

d) we will have two magnets one with a north and the other with a south pole.

3. The magnetic field lines can be plotted by _ _ c.

a) observing the orientation of a small compass needle at a particular place.

b) studying the relationship of the earth's geographical and magnetic poles.

c) observing the direction of the emerging lines from north poles and entering south poles.

d) determining the possible tangents of the field lines to the magnetic field

4) The magnetic fields of current loops can be explained by applying the right-hand rule to _ _ c _ _ _

a) a portion of straight wire

b) a simple bar magnet

c) a current-carrying wire

d) a small compass needle.

5) The force experienced in a wire carrying a current through a magnetic field has a direct relationship with _ d _ _ _

a) the intensity of the current

b) the length of field lines

c) the strength of the magnetic field

d) the current and the strength of the magnetic field

6. If a current flows in a wire - - d - - . and

a) the resultant magnetic field lines will begin at the south pole/end at the north pole.

b) the compass needles in the vicinity will all point to the same direction

c) the application of the right_hand rule will show the field lines.

d) the resultant magnetic field lines will be rotating around the wire.

Part II : Language practice

A. Choose a, b, c or d which best completes each item

1. Magnetic flux density is another - - d - - - for magnetic induction

a. fame b. name c. reputation d. designation

2. The - - - d of the magnetomotive force acting in a magnetic circuit to the magnetic flux is called reluctance

a. relation b. rate c. relative d. ratio

3. A magnet c - to have its magnetism concentrated at two points termed the poles.

a. looks b. shows c. appears d. figures

4. The product of the magnetic pole - b . . . and the length of the magnet is called magnetic moment.

a. Vigor b. intensity c. sinew d. strength

5- The ratio of the magnetic moment of an atom or nucleus to its - c - - - - momentum is referred to as gyromagnetic

a. crooked b. sharp c. angular d. forked,

6. The metals iron, cobalt, nickel, and certain alloys which are - d - - more magnetic than any other known substances are said to be ferromagnetic.

a. hugely b. gigantically c. colossally d. vastly.

fame = réputation rate = taux Vigor = Vitalité sinew = tendon crooked = courbé forked = [illegible]

B. Fill in the blanks with the appropriate form of the words given.

1. Attract

a. whether clothes are   or not seems to depend partly on fashion, partly on social considerations, and partly on personal taste.

b. Probably some of you possess a piece of iron which can   small metal objects (like pins and needles) towards itself.

c. When a thing falls to the ground, it is because of the earth's

d. Her room was decorated so   that even older people were delighted with it.

2. illustrate

a. The mechanism of a blood cell provides an excellent - - - of point in question.

b. He has . . . . his classification by giving typical case histories.

c. The scientist provided - - - examples to clear the abstract and general points

3. Demonstrate

a. The truth of a scientific theory is - - - by the evidence which supports the theory.

b. A science teacher gives a - - - - of an experiment when he shows his students how to do it by performing it in front of them

c. The best way of teaching practical skills is to present them - - -

d. Scientists usually can be easily recognized by their - - - behavior.

4. Consider

a. Plans to expand the industry must be - - - - in relation to the trained workers available.

b. These are important - - - - and I am glad you brought them to my attention.