LIFEPAC®

SCIENCE

STUDENT BOOK

8th Grade | Unit 6

Alpha Omega
PUBLICATIONS

SCIENCE 806

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Energy 2

Introduction

God said, "Let there be lights in the firmament of the heaven to divide the day from the night" (Genesis 1:14). This light is the original source of earth's energy. Today the growing and active population of the earth is searching for new ways to get energy for the machines of our civilization. Our demand for energy in all its forms has become so great that new sources need to be found for America and the world.

Energy, the capacity to do work, exists in many forms that have been discovered over the years. Static electricity was an interesting toy known to the Greeks in 600 B.C. To Benjamin Franklin it was a stimulant to his curiosity. The scientific study of electricity began with the study of lightning by Franklin. Our understanding of electricity, motors, and generators is based on the concept of magnetism, a naturally occurring property of our planet and of several minerals that make up the earth.

Scientists today are looking at old and new ways to provide energy for the people. In this LIFEPAC® the main topics for study are magnetism, electricity, and energy for the future.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. Describe the behavior of magnets.
2. Illustrate a magnetic force field.
3. List and apply the laws of electrostatics.
4. Apply Ohm's law to values in simple circuits.
5. List modern uses of electricity.
6. Associate inventions with their inventors.
7. Describe conventional energy sources.
8. Name some potential energy source of the future.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. MAGNETISM

In the twelfth century the **lodestone** was used as a compass in navigation, according to the records of the time. In China it was used even earlier. In the first century before Christ, the Roman, Lucretius, wrote about magnetism. Modern study of magnetism began with the work of William Gilbert.

SECTION OBJECTIVES

Review these objectives. When you have completed this section, you should be able to:

1. Describe the behavior of magnets.
2. Illustrate a magnetic force field.

VOCABULARY

Study these words to enhance your learning success in this section.

align (u līn´). To form into a line.

declination (dek lu nā´ shun). Deviation of a compass needle from geographic (true) north and south.

domain (dō mān´). A minute region within a magnet.

induce (in düs´) Cause or produce without direct contact.

lodestone (lōd´ stōn). A rock or mineral that is magnetic.

magnet (mag´ nit). Anything that attracts iron.

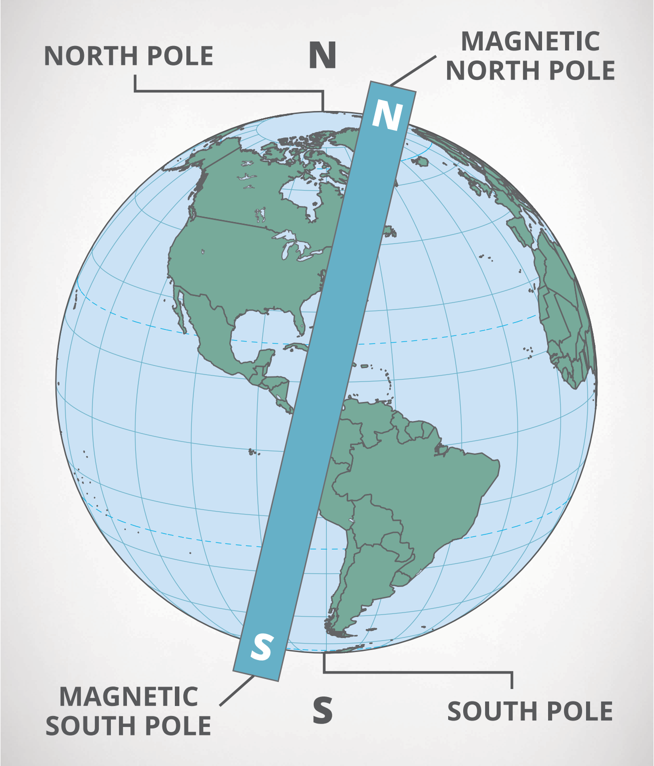
repel (ri pel´). Force apart by a natural force.

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.*

Pronunciation Key: h**a**t, **ā**ge, c**ã**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /ŦH/ for **th**en; /zh/ for mea**s**ure; /u/ represents /a/ in **a**bout, /e/ in tak**e**n, /i/ in penc**i**l, /o/ in lem**o**n, and /u/ in circ**u**s.

PERMANENT MAGNETS

If you have ever used a **magnet** to pick up nails, pins, or other iron particles, you have noticed that some materials could not be picked up. Magnets pick up iron, nickel, and cobalt and some alloys of these materials. **Lodestone**, an iron ore, is a natural form of permanent magnet. In this section you will study the behavior of various types of magnetic materials.



| The earth acts like a giant bar magnet.

Magnetic materials. In seventeenth-century England, the personal physician of Queen Elizabeth I wrote about magnetism. He was a respected and well-known scientist named William Gilbert. Gilbert explained in his book, *De Magnete*, that the magnetic needle of the compass lines up in a north-south manner because the earth is a giant lodestone. He took a ball of lodestone which he called a *terella (little earth)* and placed needles on its surface. They lined up so that the needles all pointed along the same lines and toward the *poles*. Gilbert wrote his book in Latin because that was the language all educated people used then. This book began the scientific study of magnetism.

Today we call lodestone *magnetite*. Magnetite is a mineral that is found all over the world. Its usual occurrence is as small crystals in igneous rocks. Sometimes large masses are found. Magnetite is an iron oxide. Black particles in sand are commonly magnetite.

| A lodestone is nature's magnetic rock. It acts as a magnet

William Gilbert discovered that the earth behaves like a giant magnetic iron bar. Today we know that the earth's magnetic forces are not located at the exact north and south poles but are tilted. The difference between true north and magnetic north is called the magnetic **declination**. Sailors call it variation of the compass.

Nickel and cobalt are lesser known natural magnets. These metals can be mixed with iron and some other metals to produce magnets.

Try this investigation.

These supplies are needed:

- world globe showing latitude and longitude
- flexible ruler

Follow these directions and answer the questions. Put a check in the box when each step is completed.

☐ 1. Locate on the globe 76.2° north latitude and 101° west longitude. This location is the magnetic north pole.

☐ 2. Locate on the globe 66° south latitude and 139.1° east longitude. This location is a magnetic south pole.

☐ 3. Find the scale of miles on the globe. Write in the data table the distance represented by one inch on the globe.

☐ 4. Measure the inches from the magnetic north pole to the geographic North Pole. Record this distance in inches.

☐ 5. Measure the inches from the magnetic south pole to the geographic South Pole. Record this distance in inches.

	Measurements
Miles represented by one inch on globe	
Inches from true north to magnetic north	
Inches from true south to magnetic south	

1.1 How far is magnetic north from true, or geographic, north?

____

1.2 How far is magnetic south from true, or geographic, south?

____

Magnetic Declination Experiment

Other objects in the universe have magnetic fields. Scientists are studying magnetism of other planets and even the stars. Some magnetic fields extend far into space. A relationship exists between magnetic storms on the sun and poor radio reception on earth.

Magnetic forces. Magnetic forces are the attractions felt by materials close to the magnet. The idea of a *field* is the same as the *sphere of influence* Gilbert described. The field is the space around the magnet in which the magnetic strength can be measured.

The atoms within a magnet line up so that they point in one direction. In nonmagnetic material, atoms point in all directions. In naturally magnetic metals the atoms are lined up. Sometimes a natural magnet can be used to make other materials magnetic. If a magnet is cut in half, each part will have an N pole and an S pole. A metal bar may be demagnetized by hammering or dropping it. This treatment will throw the atoms into disorder. The atoms will no longer be in orderly rows.

Induced magnetism. Magnetism is **induced** in an iron bar when the bar is stroked with a magnet. The stroking lines up the atoms in the iron bar and makes it magnetic. The tiny N and S poles become aligned through the bar. This kind of magnet will gradually weaken as the atoms lose their **alignment**.

Try this investigation.

These supplies are needed:

- bar magnet
- glass
- needle
- water

Follow these directions and answer the questions. Put a check in the box when each step is completed.

☐ 1. Beginning at the point of the needle, stroke the needle gently with the N pole of the bar magnet. Repeat twelve times. Always stroke in the same direction.

☐ 2. Coat the needle with butter or vegetable oil and gently place the needle on the water. The needle will float if it is placed on the water without breaking the surface.

1.3 Which pole does the eye of the needle seek? ______________________

1.4 Where did the needle get its magnetism? __________________________

____

Compass Experiment

Write the letter of the correct choice.

1.5 The lodestone was used for navigation as early as __________ .
a. 100 B.C. b. 500 c. 1200 d. 1500

1.6 The scientific language of the sixteenth century was __________ .
a. Greek b. French c. English d. Latin

Write true or false.

1.7 ____________ Lodestone was invented in the twelfth century.

1.8 ____________ The earth's magnetic poles coincide with its geographic poles.

1.9 ____________ Magnetite is valuable because it is a rare mineral.

1.10 ____________ The sun has a magnetic field.

Complete these sentences.

1.11 Lucretius, who wrote about magnetism in the first century, B.C., was a citizen of _________________________________ .

1.12 The personal physician of Queen Elizabeth I, who wrote *De Magnete,* was _________________________________ .

1.13 The name of the mineral that was formerly called lodestone is ___________________________ .

1.14 As distance from a magnet increases, the magnetic field (increases, decreases) ___________________________ .

1.15 The difference between geographic (true) north and magnetic north is called ___________________________ .

1.16 The region, or sphere, of influence around a magnet is called the magnetic _______________ .

1.17 If an iron bar is stroked with a magnet, magnetism is said to be _________________ in the bar.

Answer these questions.

1.18 What makes magnetic material magnetic? ____

____

1.19 What is the effect on the atoms of an iron bar when the bar is stroked with a magnet?

____

____

1.20 What is the effect on a magnet of hammering it or dropping it?

____

____

1.21 What elements in addition to iron, are magnetic?

a. ______________________ and b. ______________________

MAGNETIC FIELDS

For the purpose of study, a magnet is thought of as being composed of small segments called **domains**.

The region around a magnet that exerts a force on a small bit of iron is a *magnetic field*. The field is centered on a magnetic pole, and can be illustrated by the pattern of magnetic lines of force. The strength of a magnetic field obeys the inverse square law: Magnetic strength decreases as distance from the pole increases.

Poles. The poles of a magnet are called *north* and *south*. If a bar magnet is hung by a string around its middle, the north, or N, pole of the magnet will point to magnetic north. The south, or S, pole of the magnet will point to magnetic south. Like poles of bar magnets **repel** each other, and unlike poles attract.

Lines of force. The lines of force of a magnet can be made visible by sprinkling iron filings around the magnet. The magnetic lines of force show as lines of iron filings in the magnetic field. Concentrated filings indicate a strong field.

Magnetic lines of force travel through paper, glass, plastic, wood, and many other materials. They do not travel through iron and steel. A magnetic compass is not reliable in a steel-framed structure because the metallic walls cause the needle to deflect.

View 806 Magnetism, from the Grade 8 SCIENCE EXPERIMENTS Video

Try this investigation.

These supplies are needed:

- two bar magnets
- iron filings
- one horseshoe magnet
- sheet of glass or plastic

Follow these directions and complete the activities. Put a check in the box when each step is completed.

- ☐ 1. Place a bar magnet on a table.
- ☐ 2. Put a sheet of glass or plastic over the magnet.
- ☐ 3. Sprinkle the iron filings over the sheet evenly.
- ☐ 4. Sketch the magnet in the following space and show the lines made by the iron filings.
- ☐ 5. Return the filings to their container.

Bar Magnet

- ☐ 6. Place a horseshoe magnet on the table.
- ☐ 7. Put a sheet of glass or plastic over the magnet.
- ☐ 8. Sprinkle the iron filings over the sheet.
- ☐ 9. Sketch the magnet in the following space and show the lines made by the iron filings.
- ☐ 10. Return the filings to their container.

Horseshoe Magnet

Magnetism Experiment

- ☐ 11. Place two bar magnets N pole to N pole with an inch between them.
- ☐ 12. Put a piece of glass or plastic over the magnets.
- ☐ 13. Sprinkle the iron filings over the glass or plastic.
- ☐ 14. Sketch the magnets in the following space and show the lines made by the iron filings.
- ☐ 15. Return the filings to their container.

N Pole to N Pole

- ☐ 16. Turn one of the bar magnets around so they are N pole to S pole with an inch between them.
- ☐ 17. Sprinkle the iron filings over the glass or plastic.
- ☐ 18. Sketch the magnets in the following space and show the lines made by the iron filings.

N Pole to S Pole

- ☐ 19. Put all the materials away.

Sample images for the sketches can be found on the back pages of this unit.

Magnetism Experiment

1.22 State the rule of magnetism that is illustrated by the lines of the iron filings in Step 14.

____

1.23 State the rule of magnetism that is illustrated by the lines of the iron filings in Step 18.

____

1.24 Why was the glass or plastic used to separate the filings from the magnets in the experiment? ____

____

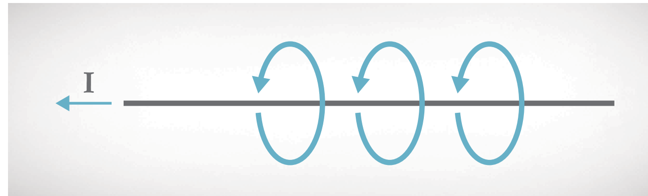
1.25 Did the glass or plastic stop the passage of the magnetic lines of force? ______________

1.26 Do the iron filings bridge the open end of the horseshoe magnet?

____

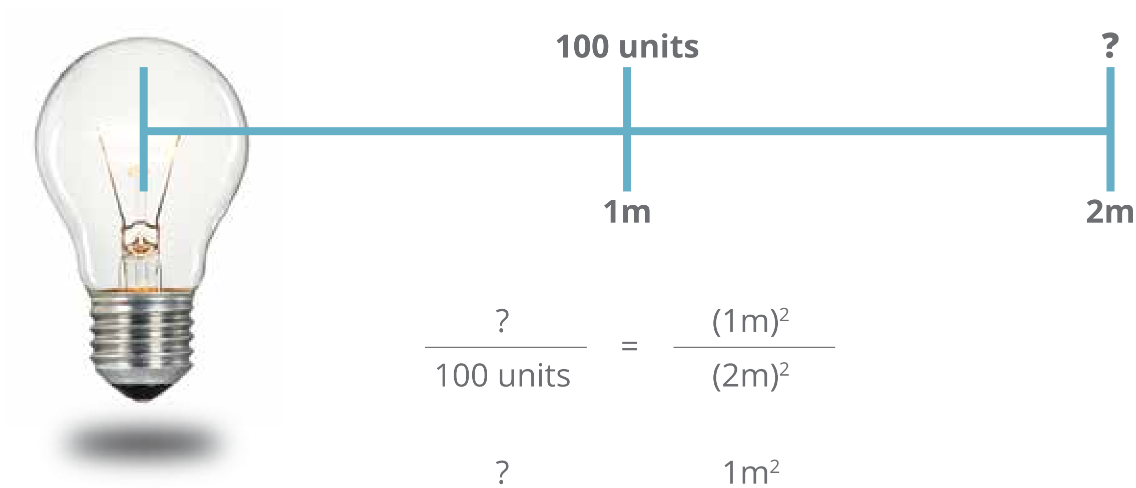
Magnetism Experiment

In 1820 Hans Christian Oersted discovered that a compass needle came to rest at right angles to a wire carrying an electric current. This orientation means that lines of force around a current-carrying wire are a series of circles with the wire running through the centers of the circles. This discovery led rapidly to others involving the relationship between electricity and magnetism.



Inverse square law. The inverse square law says that the magnetic force decreases as the square of the distance from the pole. Magnetism is like light, which is intense at the source and diminishes as the distance increases.

Example: Find the illumination at two meters from a light source if the illumination is 100 units at one meter from the source.



$$\frac{?}{100\text{ units}} = \frac{(1\text{m})^2}{(2\text{m})^2}$$

$$\frac{?}{100\text{ units}} = \frac{1\text{m}^2}{4\text{m}^2}$$

$$\frac{?}{100\text{ units}} = \frac{1}{4}$$

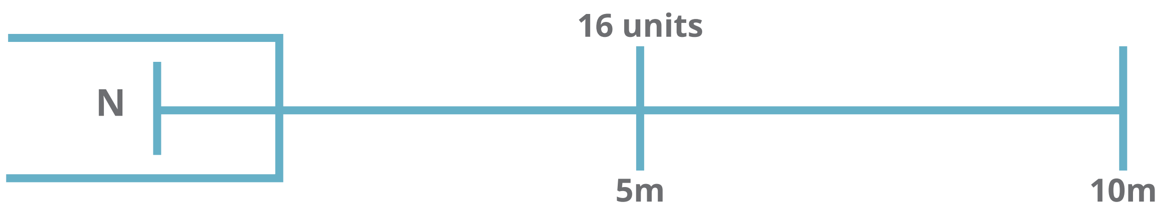
$$? = 25$$

Illumination at 2m from source is 25 units.

| Illumination at 2 m from source is 25 units.

The same relationship exists with the invisible lines of force of a magnet. If the distance from the magnet is doubled the strength of the field is quartered.

Example: Find the magnetic field strength at ten meters from an N-pole if the field strength is 16 units at five meters from the pole.



$$\frac{?}{16 \text{ units}} = \frac{(5\text{m})^2}{(10\text{m})^2}$$

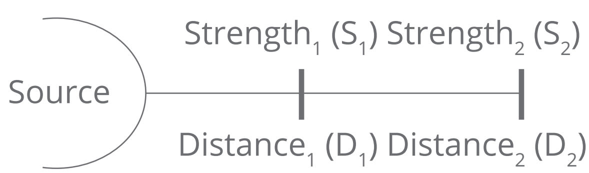
$$\frac{?}{16} = \frac{25\text{m}^2}{100\text{m}^2}$$

$$\frac{?}{16} = \frac{1}{4}$$

$$? = 4$$

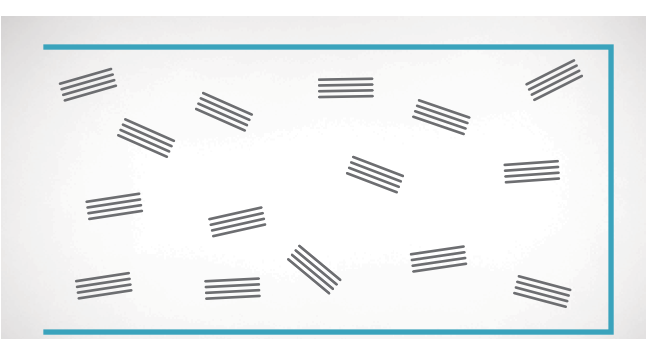
Magnetic field strength at 10m from the pole is 4 units.

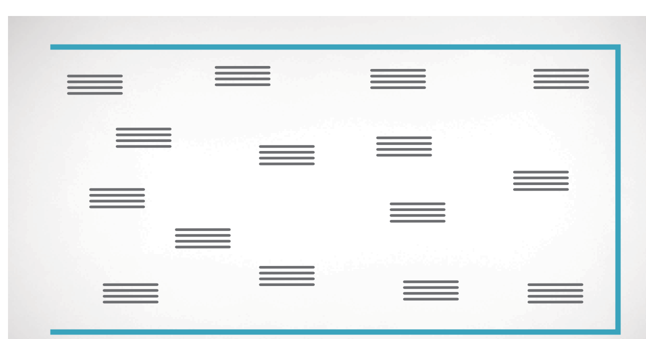
The general formula for the strength of a force or strength of light as you change the distance is shown below.



$$\frac{S_1}{S_2} = \frac{(D_2)^2}{(D_1)^2}$$

Domain theory. The domain theory was proposed as a convenient way to explain the alignment of atoms within a magnet. Within each tiny region of a magnet, a group of atoms are aligned in a single direction and produce a magnetic field. Domains in an unmagnetized substance are not aligned but instead are in a random pattern. If a magnet is dropped or struck, some of the domains are knocked out of alignment and the magnet is weakened. If the magnet is dropped or hit repeatedly, it will be demagnetized.


Unmagnetized Domains


Magnetized Domains

Magnetic forces are *induced* in some substances by causing the domains to become aligned. Some materials, such as iron, are easily magnetized and just as easily demagnetized. An alloy of aluminum, nickel, and cobalt, *alnico*, is difficult to magnetize, but makes permanent magnets of high quality.

Complete these sentences.

1.27 Ends of a bar magnet are called ______________________________ .

1.28 Iron filings sprinkled near a magnet arrange themselves into a pattern that describes the magnetic ____ .

1.29 Small regions within a magnet are called __________________________________ .

Write true or false.

1.30 ____________ Magnetic lines of force are unaffected by paper, glass, or plastic.

1.31 ____________ Like magnetic poles attract, unlike poles repel.

1.32 ____________ Magnetic force decreases as distance from the magnet increases.

Define these terms.

1.33 domain ____

____

1.34 alnico ____

____

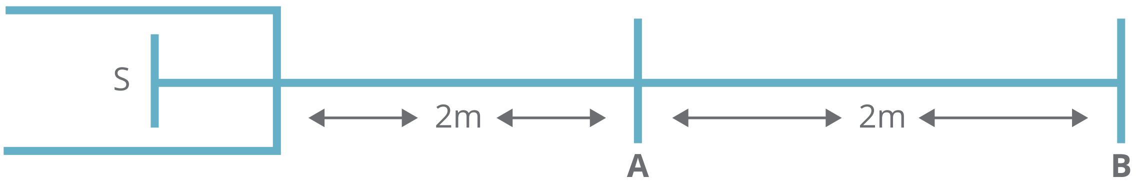
1.35 inverse square law ____

____

1.36 magnetic pole ____

____

Write the letter of the correct choice. This illustration applies to activities 1.37 and 1.38.



1.37 If the strength of the magnetic field at A is 16 units, the strength of the magnetic field at B is ________ .

a. 4 units b. 8 units c. 16 units d. 32 units

1.38 If the strength at B is 3, the strength t A is ________ .

a. 1/3 b. 3 c. 6 d. 12

Complete these activities.

1.39 Describe the results of placing two magnets in the position shown in the illustration, if the magnets are free to move.

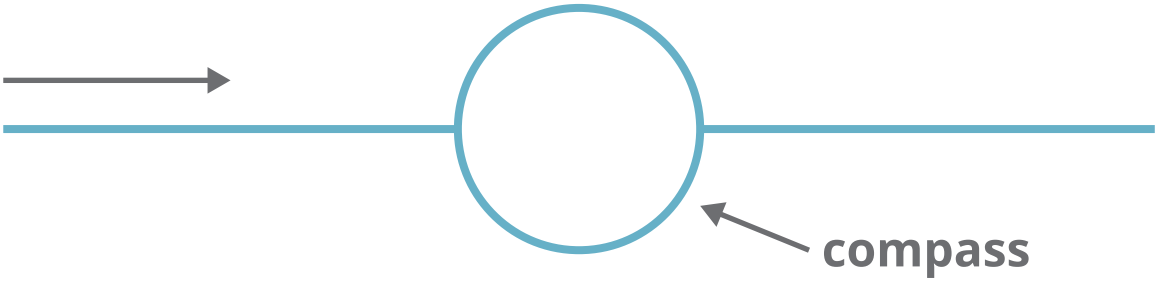
____

____

____

1.40 The relationship between magnetism and an electric current was discovered by ________________________ .

1.41 The illustration shows the direction of current in a wire. Draw on the illustration the orientation of a compass placed on the wire.



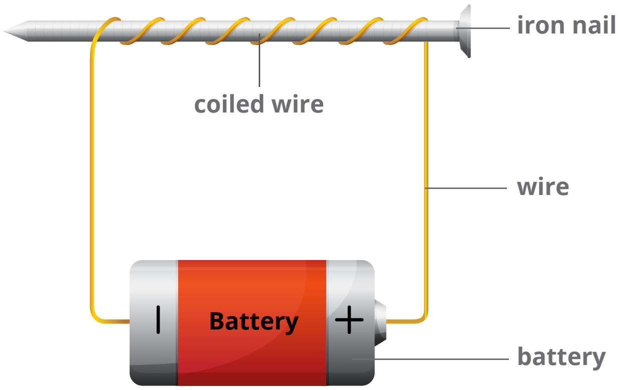
INDUCED MAGNETISM

Magnetism can be induced in an iron bar by stroking the bar with a magnet. This method produces a magnet that is weak and temporary. However, a magnet can be made that is very strong. An iron bar called the *core* is wrapped in a coil wire and the two ends of the wire are connected to a battery. This wire-wrapped core is an electromagnet. The iron bar will be magnetized as long as the wire carries an electric current. When the battery is disconnected, the magnetism vanishes.

Field strength. The strength of an electromagnet depends on the strength of the current, the number of turns of wire around the core, and the material in the core. The strength of the magnet can be changed by changing any one of these. The more turns in the core, the stronger the field; the stronger the current, the stronger the field.

Electromagnets are used to lift and move large loads of iron. Control is easy. The operator has only to turn the switch on or off. One use of electromagnets is the loading of freight cars with scrap iron.

Supermagnets. Scientists and engineers who study supercold believe that all motion in atoms and molecules would stop at the temperature of -460° Fahrenheit or -273° Celsius. So far this very low temperature has not been reached. The experiments have produced some interesting results, however.



| Electromagnet

Many materials that are not good conductors of electricity at normal temperature are excellent conductors at extremely cold temperatures. In some conductors the current even continues after the energy source is shut off.

Since *superconductors* do not resist the flow of electricity, they produce very strong magnetic fields. Some of these very strong magnets are used in atomic research. Research is being continued toward developing supermagnets and superconductors.

Write true or false.

1.42 ____________ The strength of an electromagnet is easy to control.

1.43 ____________ Magnetism can be maintained in a bar by hammering.

Complete these statements.

1.44 The extremely low temperature at which molecular motion ceases is __________ Celsius.

1.45 An electrical conductor that has very low resistance to current at low temperatures is called a(n) ____ .

1.46 A magnet formed from an iron core wrapped in current-carrying wire is a(n) ____ .

1.47 As temperature decreases, the strength of an electromagnet (increases, decreases) ___________________ .

Complete these activities.

1.48 Describe how electricity is used to produce a magnet.

____

____

1.49 List the three factors that determine the strength of an electromagnet.

a. ____

b. ____

c. ____

1.50 In terms of your answer to Activity 1.49, explain the effect of supercold on an electromagnet.

____

____

____

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Match these items (each answer, 2 points).

1.01 ________ William Gilbert

1.02 ________ magnetite

1.03 ________ electromagnet

1.04 ________ inverse square

1.05 ________ lines of force

1.06 ________ alnico

1.07 ________ demagnetize

1.08 ________ domain

1.09 ________ Oersted

1.010 ________ supermagnet

a. temporary magnetism

b. man-made permanent magnet

c. iron oxide

d. lines representing the strength and direction of magnetic force

e. *De Magnete*

f. very cold

g. strength decreases as the square of the distance

h. current-carrying wire has a magnetic field

i. small region within a magnet

j. drop or hammer

k. king of Sweden

Complete these activities (each answer, 5 points).

1.011 Draw the lines of force around a single bar magnet.

1.012 Draw the lines of force around two bar magnets, N pole to S pole.

Complete these activities (each answer, 2 points).

List three factors that determine the strength of an electromagnet.

1.013 ____________________

1.014 ____________________

1.015 ____________________

Give two ways in which a permanent magnet can be weakened.

1.016 ____________________

1.017 ____________________

Answer these questions (each answer, 3 points).

1.018 What was William Gilbert's big discovery? ____________________

____

1.019 How is an electromagnet made? ____________________

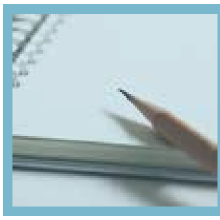
____

1.020 Why is a magnetic compass not useful for navigating a submarine?

____

____

39/49 **SCORE** ________ **TEACHER** ________ ________
initials date



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