Chapter Resources

Magnetism

Includes:

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- Transparency Activities
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Hands-On Activities
Mini LAB

Observing Magnetic Fields

Procedure

1. Place iron filings in a plastic petri dish. Cover the dish and seal it with clear tape.

2. Collect several magnets. Place the magnets on the table and hold the dish over each one. Draw a diagram in the Data and Observations section of what happens to the filings in each case.

3. Arrange two or more magnets under the dish. Observe the pattern of the filings.

Data and Observations

Analysis

1. What happens to the filings close to the poles? Far from the poles?

2. Compare the fields of the individual magnets. How can you tell which magnet is strongest? Weakest?
Assembling an Electromagnet

Procedure

1. Wrap a wire around a 16-penny steel nail ten times. Connect one end of the wire to a D-cell battery, as shown in Figure 9C in your text. Leave the other end loose until you use the electromagnet.

   **WARNING:** When current is flowing in the wire, it can become hot over time.

2. Connect the wire. Observe how many paper clips you can pick up with the magnet.

3. Disconnect the wire and rewrap the nail with 20 coils. Connect the wire and observe how many paper clips you can pick up. Disconnect the wire again.

Data and Observations

<table>
<thead>
<tr>
<th>Paper clips picked up with 10 coils</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper clips picked up with 20 coils</td>
<td></td>
</tr>
</tbody>
</table>

Analysis

1. How many paper clips did you pick up each time? Did more coils make the electromagnet stronger or weaker?

2. Graph the number of coils versus number of paper clips attracted. Predict how many paper clips would be picked up with five coils of wire. Check your prediction.
A valuable tool for hikers and campers is a compass. Almost 1,000 years ago, Chinese inventors found a way to magnetize pieces of iron. They used this method to manufacture compasses. You can use the same procedure to make a compass.

Real-World Question
How do you construct a compass?

Materials
- petri dish
- water
- sewing needle
- magnet
- tape
- marker
- paper
- plastic spoon
- *alternate materials

Goals
- Observe induced magnetism.
- Build a compass.

Safety Precautions

Procedure
1. Reproduce the circular protractor shown. Tape it under the bottom of your dish, so it can be seen but not get wet. Add water until the dish is half full.
2. Mark one end of the needle with a marker. Magnetize the needle by placing it on the magnet aligned north and south for 1 min.
3. Float the needle in the dish using a plastic spoon to lower the needle carefully onto the water. Turn the dish so the marked part of the needle is above the $0^\circ$ mark. This is your compass.

4. Bring the magnet near your compass. Observe how the needle reacts. Measure the angle the needle turns. Record your observations and measurement in the Data and Observations section.

**Data and Observations**

Observations:

Angle the needle turns:

**Conclude and Apply**

1. **Explain** why the marked end of the needle always pointed the same way in step 3, even though you rotated the dish.

2. **Describe** the behavior of the compass when the magnet was brought close.

3. **Observe** the marked end of your needle. Does it point to the north or south pole of the bar magnet? **Infer** whether the marked end of your needle is a north or a south pole. How do you know?

**Communicating Your Data**

Make a half-page insert that will go into a wilderness survival guide to describe the procedure for making a compass. Share your half-page insert with your classmates. For more help, refer to the Science Skill Handbook.
Lab Preview

Directions: Answer the following questions before you begin the Lab.

1. What safety precautions are necessary while doing this lab?

2. What supplies the electric current to run the motor?

Electric motors are used in many appliances. For example, a computer contains a cooling fan and motors to spin the hard drive. A CD player contains electronic motors to spin the CD. Some cars contain electric motors that move windows up and down, change the position of the seats, and blow warm or cold air into the car's interior. All these electric motors consist of an electromagnet and a permanent magnet. In this activity you will build a simple electric motor that will work for you.

Real-World Question

How can you change electric energy into motion?

Materials

- 22-gauge enameled wire (4 m)
- steel knitting needle
- steel rod
- nails (4)
- hammer
- ceramic magnets (2)
- 18-gauge insulated wire (60 cm)
- masking tape
- fine sandpaper
- approximately 15-cm square wooden board
- wooden blocks (2)
- 6-V battery
- *1.5-V batteries connected in a series (4)
- wire cutters
- scissors
- *Alternate materials

Goals

- Assemble a small electric motor.
- Observe how the motor works.

Safety Precautions

WARNING: Hold only the insulated part of a wire when it is attached to the battery. Use care when hammering nails. After cutting the wire, the ends will be sharp.

Procedure

1. Use sandpaper to strip the enamel from about 4 cm of each end of the 22-gauge wire.

2. Leaving the stripped ends free, make this wire into a tight coil of at least 30 turns. A D-cell battery or a film canister will help in forming the coil. Tape the coil so it doesn't unravel.

3. Insert the knitting needle through the coil. Center the coil on the needle. Pull the wire's two ends to one end of the needle.

4. Near the ends of the wire, wrap masking tape around the needle to act as insulation. Then tape one bare wire to each side of the needle at the spot where the masking tape is.
5. Tape a ceramic magnet to each block so that a north pole extends from one and a south pole from the other.

6. Make the motor. Tap the nails into the wood block as shown in the figure. Try to cross the nails at the same height as the magnets so the coil will be suspended between them.

7. Place the needle on the nails. Use bits of wood or folded paper to adjust the positions of the magnets until the coil is directly between the magnets. The magnets should be as close to the coil as possible without touching it.

8. Cut two 30-cm lengths of 18-gauge wire. Use sandpaper to strip the ends of both wires. Attach one wire to each terminal of the battery. Holding only the insulated part of each wire, place one wire against each of the bare wires taped to the needle to close the circuit. Observe what happens.

Conclude and Apply

1. Describe what happens when you close the circuit by connecting the wires. Were the results expected?

2. Describe what happens when you open the circuit.

3. Predict what would happen if you used twice as many coils of wire.

Communicating Your Data

Compare your conclusions with other students in your class. For more help, refer to the Science Skill Handbook.
Earth's Magnetism

Earth is surrounded by a magnetic field that is similar to the magnetic field around a bar magnet. Magnets have a north magnetic pole and a south magnetic pole. Earth's south magnetic pole is near the north geographic pole, and its north magnetic pole is near the south geographic pole. You usually do not notice Earth's magnetic field because it is weak. In your classroom, wires carrying electric current also produce magnetic fields that add to Earth's magnetic field and can change its direction. A compass can show the direction of the magnetic field. A compass needle is a small bar magnet that aligns itself along the magnetic field lines around the compass. You can use a compass to map the magnetic field in your classroom.

**Strategy**
You will use a compass.
You will map the magnetic field in your classroom.

**Materials**
- compass
- graph paper

**Procedure**
1. Draw a floor plan of the classroom on the graph paper. (The floor plan does not have to be to scale.) Indicate north, south, east, and west on the floor plan.
2. Mark the desk locations on the floor plan with a small circle and a number.
3. Take a compass reading at each numbered location. Note the compass needle's direction. See Figure 1. Draw it neatly on the floor plan. Record each angle in Table 1.

**Data and Observations**

**Table 1**

<table>
<thead>
<tr>
<th>Location</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Laboratory Activity 1 (continued)

Questions and Conclusions

1. In what direction did your compass needle point in most of the readings?

2. Where did the largest changes in the direction of the compass needle occur?

3. What might have caused the direction of the compass needle to change in your classroom?

4. Draw a diagram of Earth showing the relative positions of the geographic axis and the magnetic axis.

Strategy Check

_____ Can you use a compass?

_____ Can you make a magnetic map of your classroom?
Audiocassette tapes, videotapes, and computer diskettes are all forms of magnetically recorded information. An electromagnet records a series of magnetic codes on the tape or disk. When the tape or disk is read, an electromagnet converts these codes into electric currents that are used to produce words, sounds, and images.

**Strategy**
You will create a magnetically coded message on a strip of paper.
You will read a magnetic code on a strip of paper.

**Materials**
- 1 very small disk magnet, no more than 5 mm in diameter
  (can also be cut out of a flexible magnetic strip)
- masking tape
- paper or plastic cup, or film canister
- paper
- scissors
- pencil
- 4 disk magnets
- ruler

<table>
<thead>
<tr>
<th>4-Digit Letter Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 0000 E 1111 R 0010 U 1011</td>
</tr>
<tr>
<td>B 1000 I 0100 S 0011 P 1001</td>
</tr>
<tr>
<td>C 1100 O 0110 N 0001 H 0101</td>
</tr>
<tr>
<td>D 1110 T 0111 L 1010 F 1101</td>
</tr>
</tbody>
</table>

**Procedure**
1. Mark one side of the tiny magnet with tape. This side represents “1” and the other side represents “0.” Put it in the cup. This is your reader magnet.
2. Cut a piece of paper about 5 cm wide and 30 cm long.
3. Choose a letter from the list above to encode. Write the letter and your group’s number on the back of the paper strip.
4. Tape a magnet to the back of the paper strip near one end.
5. Turn the paper over and mark that end of the paper “start.” Put the reader magnet over the strip.

If the reader magnet shows the wrong number (your first number is 1 and it shows 0), untape the magnet from the back, flip it over, and retape it.
Laboratory Activity 2 (continued)

6. Repeat step 5 with each of the other three magnets until you have four magnets taped in a line to the back of the paper. These four magnets should spell out the 4-digit code you selected.

7. Exchange codes with at least three groups. For each, use the reader magnet to read their code. Check your answer against the letter written on the back of the strip. Record your results.

Data and Observations

Your group: ________ ________ ________ ________ letter: ________
1st exchange: ________ ________ ________ ________ letter: ________
2nd exchange: ________ ________ ________ ________ letter: ________
3rd exchange: ________ ________ ________ ________ letter: ________

Questions and Conclusions

1. Did you successfully read the other groups’ codes? Explain.

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

2. How could you make certain that all the groups could read the other groups’ codes?

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Strategy Check

_____ Can you create a magnetically coded message on a strip of paper?

_____ Can you read a magnetic code on a strip of paper?
Magnetism

**Magnetic Force**

**Magnetic Field**

* a compass can detect this on Earth

* acts through a magnetic field

* attracts or repels objects

* extends through space and point from a north or a south pole
Meeting Individual Needs
Directions: Use the following terms to complete the concept map below.

- electromagnet
- iron bar
- electric current
- magnetic field

1. A(n) is surrounded by a(n) that interacts with a(n) to make a(n).

Directions: Circle the term that correctly completes each sentence below.

5. When an electric current is created, (waves/electrons) flow in a wire.

6. Earth’s magnetic (field/domain) extends into space and is called the magnetosphere.

7. A/An (aurora/compass needle) will align itself along Earth’s magnetic field lines, pointing toward the north or south pole.
Section 1  •  What is magnetism?

Directions: The lines in the illustration show magnetic forces acting between two pairs of bar magnets. Correctly label the unlabeled poles of the magnets: \( N \) for north and \( S \) for south. Then answer the questions that follow.

3. What generalization can you make about the reaction between like poles?

4. What generalization can you make about the reaction between unlike poles?

Directions: Circle the term that correctly completes each sentence.

5. The magnetic field is strongest near (the poles/the center) of a bar magnet.
6. Materials that can become magnetized include steel and (copper/iron).
7. The needle of a compass lines up with Earth’s magnetic field and points to (Earth’s poles/Earth’s equator).
8. Magnetic field lines that curve toward each other show (repulsion/attraction).
9. Some animals have tiny pieces of (magnetite/magnetosphere) in their brains to help them find their way.
10. A magnet contains a large number of magnetic (domains/poles) that are lined up and pointing in the same direction.
Section 2: Electricity and Magnetism

Directions: Arrange the steps below that describe a ringing doorbell in the correct order starting with 1 and ending with 7. Write the corresponding letter for each step in the space beside each number.

1. a. The moving hammer strikes the bell.
2. b. Current flows through the completed circuit, turning on an electromagnet.
3. c. A spring pushes the iron plate and hammer back into place.
4. d. You press the doorbell button, which completes a circuit.
5. e. The cycle begins again.
6. f. The movement of the hammer opens the circuit again, making the electromagnet lose its magnetic field.
7. g. The electromagnet attracts an iron plate attached to a hammer.

Directions: Complete the following sentences.

8. A motor is any device that

9. A generator is any device that

10. A transformer is a device that
### Key Terms: Magnetism

**Directions:** Match the following terms with the correct descriptions below.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>aurora</td>
<td>1. a group of atoms with their magnetic poles pointed the same direction</td>
</tr>
<tr>
<td>compass</td>
<td>2. imaginary lines of force around a magnet</td>
</tr>
<tr>
<td>electric generator</td>
<td>3. a force created through a magnetic field</td>
</tr>
<tr>
<td>electric motor</td>
<td>4. a magnetic needle that is free to turn</td>
</tr>
<tr>
<td>electromagnet</td>
<td>5. a current-carrying wire wrapped around an iron core</td>
</tr>
<tr>
<td>magnetosphere</td>
<td>6. a device that uses the interaction between electricity and magnetism to produce motion</td>
</tr>
<tr>
<td>magnetic domain</td>
<td>7. colored lights in the sky created by the interaction of Earth's magnetic field and charged particles in the solar wind</td>
</tr>
<tr>
<td>magnetic field</td>
<td>8. the magnetic field around Earth that extends into space</td>
</tr>
<tr>
<td>magnetism</td>
<td>9. a device that uses induction to produce electric power</td>
</tr>
<tr>
<td>transformer</td>
<td>10. an electrical device that changes the voltage of alternating current</td>
</tr>
<tr>
<td>alternating current</td>
<td>11. in the United States, it changes from positive to negative 60 times each second</td>
</tr>
</tbody>
</table>
Instrucciones: Usa los siguientes términos para completar el mapa conceptual.

electroimán barra de hierro corriente eléctrica campo magnético

1. Un(a) está rodeada por un(a) que interactúa con un(a) para formar un(a)

Instrucciones: Haz un círculo alrededor del término que complete correctamente cada oración.

5. Cuando se crea una corriente eléctrica, los(olas) (ondas/electrones) fluyen por el alambre.

6. El (campo/dominio) magnético de la Tierra se extiende en el espacio y se llama magnetosfera.

7. La (aurora/aguja de una brújula) se alinea con las líneas magnéticas de la Tierra, apuntando hacia el polo norte o el polo sur.
Sección 1 - ¿Qué es el magnetismo?

Instrucciones: Las líneas en la ilustración muestran fuerzas magnéticas actuando entre dos pares de imanes. Rotula correctamente los polos de los imanes que no están rotulados como N si es norte o S si es sur. Contesta luego las preguntas.

1. ___
2. ___

3. ¿Qué generalización puedes hacer acerca de la reacción entre polos iguales?

4. ¿Qué generalización puedes hacer acerca de la reacción entre polos opuestos?

Instrucciones: Encierra en un círculo el término que completa correctamente cada oración.

5. El campo magnético es más fuerte cerca de (los extremos/el centro) de un imán de barra.
6. Los materiales que pueden magnetizarse incluyen el acero y el (cobre/hierro).
7. La aguja de una brújula se alinea con el campo magnético de la Tierra y señala hacia (los polos terrestres/el ecuador).
8. Las líneas de los campos magnéticos que se curvan unas hacia otras muestran (repulsión/atracción).
9. Algunos animales tienen trozos diminutos de (magnetita/magnetosfera) en el cerebro que les ayuda a guiarse.
10. Un imán contiene un gran número de (dominios/polos) magnéticos que se alinean y señalan en la misma dirección.

20 Magnetismo
Instrucciones: Reorganiza los siete pasos que describen el proceso de un timbre que suena, de manera que estén en el orden correcto. Escribe la letra de cada paso en el espacio a la izquierda de cada número.

1. a. El martillo en movimiento golpea una campana.
2. b. La corriente fluye por todo el circuito, activando a un electroimán.
3. c. Un resorte empuja la placa de hierro y el martillo de vuelta a su sitio.
4. d. Presionas el botón del timbre, el cual completa un circuito.
5. e. El ciclo comienza de nuevo.
6. f. El movimiento del martillo abre de nuevo el circuito, haciendo que el electroimán pierda su campo magnético.
7. g. El electroimán atrae la placa de hierro que está adherida a un martillo.

Instrucciones: Complète las oraciones.

8. Un motor es un aparato que

9. Un generador es un aparato que

10. Un transformador es un aparato que
Instrucciones: Aparea cada término con su descripción correcta.

<table>
<thead>
<tr>
<th>término</th>
<th>descripción</th>
</tr>
</thead>
<tbody>
<tr>
<td>aurora</td>
<td>1. grupo de átomos con sus polos magnéticos señalando en la misma dirección</td>
</tr>
<tr>
<td>brújula</td>
<td>2. líneas imaginarias alrededor de un imán</td>
</tr>
<tr>
<td>electroimán</td>
<td>3. fuerza creada en un campo magnético</td>
</tr>
<tr>
<td>campo magnético</td>
<td>4. aguja magnética que se mueve libremente</td>
</tr>
<tr>
<td>magnetismo</td>
<td>5. alambre que lleva corriente enrollado alrededor de un núcleo de hierro</td>
</tr>
<tr>
<td>transformador</td>
<td>6. aparato que usa la interacción entre la electricidad y el magnetismo para producir movimiento</td>
</tr>
<tr>
<td>corriente alterna</td>
<td>7. luces coloreadas en el cielo que son creadas por la interacción entre el campo magnético terrestre y partículas cargadas provenientes del viento solar</td>
</tr>
<tr>
<td>magnetosfera</td>
<td>8. campo magnético alrededor de la Tierra que se extiende hacia el espacio</td>
</tr>
<tr>
<td>motor eléctrico</td>
<td>9. aparato que usa la inducción para producir potencia eléctrica</td>
</tr>
<tr>
<td>generador eléctrico</td>
<td>10. aparato eléctrico que cambia el voltaje de la corriente alterna</td>
</tr>
<tr>
<td>dominio magnético</td>
<td>11. en Estados Unidos, cambia de positivo a negativo y de nuevo a positivo 60 veces por segundo</td>
</tr>
</tbody>
</table>
What is magnetism?

Directions: Match the terms in Column II with the descriptions in Column I by writing the letter of the correct term in the blank at the left.

**Column I**

1. a stone that attracts iron
2. It affects only objects that have magnetic domains.
3. a group of atoms with aligned magnetic poles
4. Earth’s magnetic field
5. It weakens as you get farther from the magnetic poles.

**Column II**

a. magnetic domain
b. magnetic field
c. magnetic force
d. magnetite
e. magnetosphere

Directions: Study the pattern of iron filings around each set of magnets below, then answer the questions.

6. How would you label pole 1?

7. How would you label pole 2? Why?

8. How would you label poles 5 and 6? Why?

9. How could you use iron filings to tell which of two bar magnets is stronger?
Electricity and Magnetism

Directions: Use the figures below to answer questions 1 through 5.

1. In figure A, when electrons move in the coiled wire what is produced?

2. In figure A, if you changed the direction of electron flow by switching the connections to the battery, what would happen?

3. In figure A, if an iron bar were inserted into the wire coil, what would happen to the iron bar?

4. Suppose you wrapped an iron bar with wire and connected the ends of the wire to a battery. What is this device called? What would happen to this device if you disconnected the battery?

5. In figure B, if you repeatedly moved a bar magnet in and out of the wire coil, what would be produced? What is this process called?

Directions: Answer the following questions on the lines provided.

6. What is the function of an electric motor in terms of electric power and motion?

7. Briefly explain how an electric motor works.

8. What is the function of an electric generator in terms of electric power and motion?

9. Briefly explain how an electric generator works.
Magnetic Fields in 2-D and 3-D

The magnetic field surrounding a magnet is actually three-dimensional. You will prepare a permanent two-dimensional model of a magnetic field. This model is similar in appearance to what you have seen in your textbook. Then, you will prepare two models of magnetic fields in three dimensions.

Part A—Preparing a Permanent Two-Dimensional Model of a Magnetic Field

Materials
- iron filings
- sheet of white paper
- bar magnet
- can of spray shellac

Safety Precautions

WARNING: Keep the shellac away from heat and flames. Use in a well-ventilated room. Wear goggles.

Procedure

Sift the iron filings to remove the fine particles. Use only the larger particles for this activity. Place the magnet under the paper and lightly sprinkle the iron filings over the top of the paper. Tap the paper gently and the filings should move into place, lining up along the magnetic field lines. In a well-ventilated area, carefully spray the pattern of iron filings with a light coating of shellac. Allow the shellac to dry completely. The shellac coating should preserve the pattern long enough for you to make comparisons with the three-dimensional models.

Part B—Preparing a Temporary Three-Dimensional Model of a Magnetic Field

Materials
- white corn syrup
- or glycerine
- large jar
- iron filings (sifted)
- stirring rod or spoon
- large test tube
- tape or wire (optional)

Safety Precautions

WARNING: Do not taste, eat, or drink anything used in this experiment.

Procedure

Fill the jar with glycerine or corn syrup. Add some iron filings and stir gently to distribute the filings throughout the glycerine. Place the bar magnet in the test tube and stand the test tube straight up in the jar. If needed, use tape or a piece of wire to hold the tube straight. After a short period of time the filings will align with the force lines of the magnet. You will then be able to see that the magnetic field completely surrounds the magnet.

Part C—Preparing a Permanent Three-Dimensional Model of a Magnetic Field

Materials
- package of clear gelatin
- iron filings (sifted)
- water
- stirring rod or spoon
- hot plate
- large test tube
- bar magnet
- tape or wire (optional)
- large jars

Safety Precautions

WARNING: Do not taste, eat, or drink anything used in this experiment.

Procedure

Prepare the gelatin as described on the package. CAUTION: Wear goggles throughout the experiment. Pour the prepared gelatin into the jar. CAUTION: The solution will be hot. After the gelatin starts to thicken, add some iron filings and stir gently to distribute the filings throughout the gelatin. Put the magnet in the test tube and support the test tube so that it stands upright in the jar. Place the jar in the refrigerator for several hours. The iron filings will align with the force lines in the magnetic field and the three-dimensional pattern will be preserved in the gelatin.

Observations

Draw a picture of your models on a separate sheet of paper.
The New Wave in Electric Currents

A turbine has blades that can spin a shaft. The shaft is connected to an electric generator that produces electric current when the shaft spins. Various sources of energy are used to make a turbine spin. However, some of these energy sources, such as fossil fuels, are being used up and can pollute the environment. The search is on for alternative sources of energy to spin turbine blades.

One source of energy can be found in the continuous motion of ocean waves and tides. The back-and-forth and up-and-down motions of these water waves carry energy that can be used to turn turbines and generate electricity.

A few countries, such as Australia, the United States, France, and Britain, have built experimental stations that use ocean waves to generate electricity. One problem is that near the shore ocean waves move back and forth. However to generate electricity, this back and forth motion must be made to spin a turbine shaft in one direction.

One experimental turbine uses the changes in air pressure produced by waves flowing into and out of an enclosed space. The turbine blades have been designed so they turn in the same direction whether the air pressure pushes the blades as the wave comes in or goes out. The following diagrams show how this turbine works.

1. Why are ocean waves a promising source of energy?

2. Why are new energy sources needed?

3. State one problem with using wave energy to generate electricity.

4. How has the problem in question 3 been solved by the turbine discussed here?
Section 1  What is magnetism?

A. Thousands of years ago people discovered ________________.
   1. Iron acted like magnetite when ________________ with it.
   2. Pieces would point ________________ when allowed to turn.

B. Magnets have a north and south pole; north and south poles ________________ each other,
while two norths or two souths ________________ each other.
   1. ________________—the area around a magnet through which the magnetic force
      is exerted
      a. Magnetic field lines begin at a ________________ pole and end at a ________________ pole.
      b. The magnetic field is strongest close to the ________________.
   2. Moving ______________________ produce a magnetic field.
      a. A group of atoms with their fields pointing in the same direction is called
         a ________________________.
      b. A magnet contains a ________________ number of magnetic domains.

C. Earth’s magnetic field, the ________________, extends into space and originates in
Earth’s molten iron outer core.
   1. Some ________________, such as homing pigeons, have magnetite in their brains that
      helps them navigate.
   2. Earth’s magnetic field ________________ over time.
      a. It has even ________________.
      b. Ancient ________________ reveal magnetic field ________________ from long ago.
   3. A ________________, a magnetic needle free to turn, can be used to detect Earth’s
      magnetic field.
Section 2  Electricity and Magnetism

A. An ____________________________ is a current-carrying wire wrapped around an iron core.
   1. The _________________________ of an electromagnet is turned on or off when the electric current is turned on or off.
   2. ________________ and high-speed trains use electromagnets to operate.

B. Current-carrying _____________ produce a magnetic field that acts the same way as a magnet's magnetic field.
   1. Two current-carrying wires can attract or repel each other as if they were two ________________.
   2. The magnetic field around a wire causes it to be ____________ or ________________ by a magnet, depending on the direction the current is flowing in the wire.
   3. An __________________________ (device that converts electrical energy into kinetic energy) runs by using the magnetic field formed by a ______________________________ formed into a loop.

C. Charged particles from the Sun follow Earth's magnetic field to the poles where they create the ________________.

D. A ___________________________ uses a magnetic field to turn motion into electricity.
   1. An ___________________________ (AC) changes from positive to negative due to a looped wire changing direction of motion.
   2. A generator can produce both ___________________________ (DC), which flows in one direction, and AC current; large power plants produce ____________________________.
   3. ________________ such as gas, coal, and water provide power plants with kinetic energy to generate electricity.
   4. ________________ is a measure of how much energy electric charges in a current are carrying.

E. A __________________________ changes the voltage of an alternating current.
   1. Using two ________________ of wire wrapped around an ________________ core produces an ________________ voltage and an ________________ voltage.
2. The ratio of coils on the input side of a transformer to coils on the output side is _____________ the ratio of the input voltage to the output voltage.

F. _____________ — a material that has no resistance to the flow of electrons.

1. A _____________ is repelled by a superconductor.

2. MRI imagers use the fact that the nucleus of a _____________ atom behaves like a magnet.

3. Energy in the form of _____________ is applied to the body during an MRI.
Assessment
# Magnetism Review

## Part A. Vocabulary Review

**Directions:** Write the correct term in the space beside each definition.

<table>
<thead>
<tr>
<th>magnetosphere</th>
<th>generator</th>
<th>aurora</th>
<th>magnetic field</th>
<th>transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnetic domain</td>
<td>alternating</td>
<td>motor</td>
<td>electromagnet</td>
<td></td>
</tr>
</tbody>
</table>

1. group of atoms with aligned magnetic poles
2. device that converts electric energy into kinetic energy
3. current-carrying wire wrapped around an iron core
4. light emitted in a display sometimes called “northern lights”
5. uses magnetism to produce electric power
6. changes the voltage of an alternating current
7. area around a magnet where magnetic force acts
8. current that changes direction
9. Earth’s magnetic field

## Part B. Concept Review

**Directions:** Complete each sentence by underlining the best of the three choices in parentheses.

1. If the south pole of a strong magnet is brought near an iron nail, the domains in the nail will (line up with south poles pointing toward the magnet, be oriented randomly, line up with north poles pointing toward the magnet).
2. In a bar magnet, the lines of force are strongest (at the poles, on the sides, at the center).
3. Electricity flowing through a coil of wire produces (an alternating current, a magnetic field, a compass).
4. The interaction between Earth’s magnetic field and charged particles in solar wind produces (magnetic domains, the aurora, the magnetosphere).
5. You can increase the strength of an electromagnet by using (more coils of wire, a wooden core, an alternating current).
6. A doorbell works because it contains (an electric motor, a transformer, an electromagnet).
Chapter Review (continued)

7. In an electric generator, motion produces (magnetism, power, electricity).

8. A transformer can be used to change (direct current to alternating current, high voltage to low voltage, magnetism to electricity).

9. When a loop of wire is spun in a magnetic field, the current changes direction (two times, one time, no times) in a full spin of the loop.

Directions: Answer the following questions on the lines provided.

10. If a bar magnet is suspended at the center on a string and allowed to swing freely, in what direction will its south pole point?

11. What causes the colors of the aurora?

12. How is alternating current different from direct current?

13. The input side of a transformer has 10 coils of wire and an input voltage of 120 V. If the output side has 100 coils of wire, how will the output voltage be affected?

14. What are two ways to cause a current in a coil of wire?

15. If you lay a sheet of plastic over a bar magnet and shake iron filings onto the plastic sheet, how will the iron filings look? Why?

16. Where is the edge of a magnetic field?

17. What are magnetic domains? Are they in everything?

18. Has Earth’s magnetic field ever changed or moved?
Transparency Activities
These fish are rainbow trout. Recently, scientists discovered that rainbow trout have tiny amounts of magnetic material in cells in their noses. The researchers don’t know exactly how the trout use the magnetic material, but they think it might help the trout navigate.

Will he stick to the refrigerator?

1. Do you think the magnetic material in the trout’s nose makes a strong magnet? Why or why not?
2. What kind of material does a magnet stick to?
3. Where do you encounter magnets in your everyday life?
Heavy Duty

In a salvage yard it is necessary to move large amounts of scrap material. One way to do this is with a powerful magnet such as the magnet shown in the picture.

1. What does all the scrap material that the magnet can pick up have in common?
2. Would the magnet also be able to pick up old car seats or windshield glass? Explain.
3. How do you think the crane operator releases the scrap material from the large magnet?
Teaching Transparency

Activity

Principle of an Electric Generator

Electron flow
Teaching Transparency Activity (continued)

1. What is produced if a wire is made to move through a magnetic field?

2. In a generator, what kind of energy is changed into electric energy?

3. As in the transparency, if the wire is moved through a magnetic field, what happens to the electrons in the wire?

4. Does a generator use a magnetic field to turn electricity into motion or motion into electricity?

5. Name the two types of current produced by a generator.
Directions: Carefully review the graph and answer the following questions.

1. According to the graph, what year had the greatest number of sunspots?
   - A 1948
   - B 1958
   - C 1965
   - D 1980

2. Which year experienced the fewest sunspots?
   - F 1954
   - G 1964
   - H 1976
   - J 1983

3. What is the approximate length of time between points of low sunspot activity?
   - A 1 year
   - B 5 years
   - C 11 years
   - D 20 years