Chapter Resources

Electricity

Includes:

Reproducible Student Pages

ASSESSMENT
✓ Chapter Tests
✓ Chapter Review

HANDS-ON ACTIVITIES
✓ Lab Worksheets for each Student Edition Activity
✓ Laboratory Activities
✓ Foldables—Reading and Study Skills activity sheet

MEETING INDIVIDUAL NEEDS
✓ Directed Reading for Content Mastery
✓ Directed Reading for Content Mastery in Spanish
✓ Reinforcement
✓ Enrichment
✓ Note-taking Worksheets

TRANSPARENCY ACTIVITIES
✓ Section Focus Transparency Activities
✓ Teaching Transparency Activity
✓ Assessment Transparency Activity

Teacher Support and Planning
✓ Content Outline for Teaching
✓ Spanish Resources
✓ Teacher Guide and Answers
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- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at: gpscience.com
- Interactive Chalkboard
- The Glencoe Science Web site at: gpscience.com
- An interactive version of this textbook along with assessment resources are available online at: mhln.com
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Hands-On Activities
Mini LAB

Investigating Charged Objects

Procedure
1. Fold over about 1 cm on the end of a roll of tape to make a handle. Tear off a strip of tape about 10 cm long.
2. Stick the strip on a clean, dry, smooth surface, such as a countertop. Make another identical strip and stick it directly on top of the first.
3. Pull both pieces off the counter together and pull them apart. Then bring the nonsticky sides of both tapes together. What happens?
4. Now stick the two strips of tape side by side on the smooth surface. Pull them off and bring the nonsticky sides near each other again.

Analysis
1. What happened when you first brought the pieces close together? Were they charged alike or opposite? What might have caused this?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. What did you observe when you brought the pieces together the second time? How were they charged? What did you do differently that might have changed the behavior?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Mini LAB

Investigating Battery Addition

Procedure
1. Make a circuit by using wire to link two bulbs and one D-cell battery in a loop. Observe the brightness of the bulbs.
2. Assemble a new circuit by linking two bulbs and two D-cell batteries in a loop. Observe the brightness of the bulbs.

Data and Observations

<table>
<thead>
<tr>
<th>Brightness</th>
</tr>
</thead>
<tbody>
<tr>
<td>One D-cell</td>
</tr>
</tbody>
</table>

Analysis
1. What is the voltage difference of each D cell? Add them together to find the total voltage difference for the circuit you tested in step 2.

2. Assuming that a brighter bulb indicates a greater current, what can you conclude about the relationship between the voltage difference and current?
Identifying Conductors and Insulators

Lab Preview
Directions: Answer these questions before you begin the Lab.

1. Name the parts of a flashlight.

2. Which part of a flashlight provides a voltage difference?

The resistance of an insulator is so large that only a small current flows when it is connected in a circuit. As a result, a lightbulb connected in a circuit with an insulator usually will not glow. In this lab, you will use the brightness of a lightbulb to identify conductors and insulators.

Real-World Question
What materials are conductors and what materials are insulators?

Materials
- battery
- bulb holder
- flashlight bulb
- insulated wire

Goals
- Identify conductors and insulators.
- Describe the common characteristics of conductors and insulators.

Safety Precautions

Procedure
1. Set up an incomplete circuit as shown in Figure 1.
2. Touch the free bare ends of the wires to various objects around the room. Test at least 12 items.
3. In the table below, record which materials make the lightbulbs glow and which don’t.

Data and Observations

<table>
<thead>
<tr>
<th>Material Tested with Lightbulb Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightbulb glows</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
</tbody>
</table>

Table 1
Conclude and Apply
1. Is there a pattern to your data?

2. Do all or most of the materials that light the lightbulb have something in common?

3. Do all or most of the materials that don’t light the lightbulb have something in common?

4. **Explain** why one material may allow the lightbulb to light and another prevent the lightbulb from lighting.

5. **Predict** what other materials will allow the lightbulb to light and what will prevent the lightbulb from lighting.

6. **Classify** all the materials you have tested as conductors or insulators.

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**Communicating Your Data**
Compare your conclusions with those of other students in your class. **For more help, refer to the Science Skill Handbook.**

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6  Electricity
**Lab Preview**

**Directions:** Answer these questions before you begin the Lab.

1. Why is a switch on a desk lamp wired in series with the bulb?

2. Explain why you may hear a circuit breaker open after a toaster, a blender, and a microwave were turned on.

**Imagine what a bedroom might be like if it were wired in series. For an alarm clock to keep time and wake you in the morning, your lights and anything else that uses electricity would have to be on. Fortunately, most outlets in homes are wired in parallel circuits on separate branches of the main circuit.**

**Real-World Question**

How do the behaviors of series and parallel circuits compare?

**Form a Hypothesis**

Predict what will happen to the other bulbs when one bulb is unscrewed from a series circuit and from a parallel circuit. Explain your prediction. Also, form a hypothesis to explain in which circuit the lights shine the brightest.

**Possible Materials**

- 6-V dry-cell battery
- small lights with sockets (3)
- aluminum foil
- transparent tape
- scissors
- paper
- paper clips

**Goals**

- **Design** and construct series and parallel circuits.
- **Compare** and contrast the behaviors of series and parallel circuits.

**Safety Precautions**

Some parts of circuits can become hot. Do not leave the battery connected or the circuit closed for more than a few seconds at a time. Never connect the positive and negative terminals of the dry-cell battery directly without including at least one bulb in the circuit.

**Test Your Hypothesis**

**Make a Plan**

1. As a group, agree upon and write the hypothesis statement.
2. Work together determining and writing the steps you will take to test your hypothesis. Include a list of the materials you will need.
3. How will your circuits be arranged? On a piece of paper, draw a large parallel circuit of three lights and the dry-cell battery as shown in your text. On the other side, draw another circuit with the three bulbs arranged in series.
4. Make conducting wires by taping a 30-cm piece of transparent tape to a sheet of aluminum foil and folding the foil over twice to cover the tape. Cut these to any length that works in your design.
Follow Your Plan
1. Make sure your teacher approves your plan before you start.
2. Carry out the experiment. **WARNING:** Leave the circuit on for only a few seconds at a time to avoid overheating.
3. As you do the experiment, record your predictions and your observations.

Analyze Your Data
1. **Predict** what will happen in the series circuit when a bulb is unscrewed at one end. What will happen in the parallel circuit?

2. **Compare** the brightness of the lights in the different circuits. Explain.

3. **Predict** what happens to the brightness of the bulbs in the series circuit if you complete it with two bulbs instead of three bulbs. Test it. How does this demonstrate Ohm’s law?

Conclude and Apply
1. Did the results support your hypothesis? Explain by using your observations.

2. Where in the parallel circuit would you place a switch to control all three lights? Where would you place a switch to control only one light? Test it.

Communicating Your Data
**Prepare** a poster to highlight the differences between a parallel and a series circuit. Include possible practical applications of both types of circuits. **For more help, refer to the Science Skill Handbook.**
A car battery consists of a series of wet cells. Each wet cell contains two plates called electrodes, made of different metals or metallic compounds, and a solution called an electrolyte. Chemical reactions occur between the electrodes and the electrolyte. These reactions create a voltage difference between the two electrodes. Voltage difference is measured in a unit called the volt (V). If the two electrodes of a wet cell are connected by a conductor, electrons will flow through the conductor from one electrode, called the negative (−) electrode, to the other, called the positive (+) electrode. Within the cell, electrons will flow from the positive electrode to the negative electrode. The flow of electrons is caused by a chemical reaction.

Wet cells vary in their voltage difference. The voltage difference of a wet cell depends on the materials that make up the electrodes.

**Strategy**

You will construct a wet cell.
You will measure the voltage difference of a wet cell with a voltmeter.
You will observe how the voltage difference of a cell depends on the electrode materials.

**Materials**

- 2 alligator clips
- 250-mL beaker
- long iron nail
- 100-mL graduated cylinder
- 2 wires
- short wire tie
- 2 glass rods
- tin strip
- zinc strip
- hydrochloric acid (HCl)
- voltmeter

**Procedure**

1. Place two glass rods across the top of the beaker.
2. Use an alligator clip to hang the zinc strip from one of the glass rods. The strip should hang near one side of the beaker.
3. Attach one wire to the alligator clip.

**Figure 1**

- Alligator clips
- Glass rods
- Zinc strip
- Beaker
- 2 Wires

**Figure 2**

- Wet cell
- Wire tie
- Iron nail
- Voltmeter

4. Attach the other end of the wire to the negative (−) terminal of the voltmeter.
5. Attach the iron nail to the second glass rod with the small wire tie. Attach the second alligator clip to the top of the nail. See Figure 1.
6. Connect the second alligator clip to the positive (+) terminal of the voltmeter with the other wire as shown in Figure 2.
6. Carefully add 75 mL of hydrochloric acid to the beaker. **CAUTION:** Hydrochloric acid causes burns. Rinse any spills immediately with water. Make sure that the zinc strip and the nail are partially submerged in the acid.

7. Observe the wet cell. Record any changes in Table 1. Record the reading of the voltmeter in the data table.

8. Disconnect the wires. Carefully empty the acid from the beaker where your teacher indicates. Rinse the beaker, zinc strip, and iron nail and dry them with paper towels.

9. Repeat steps 1 through 8 using the zinc strip and the tin strip. In step 4, attach the tin strip to the glass rod with the alligator clip. After adding the HCI to the cell, record your observations and the reading of the voltmeter in Table 1.

### Data and Observations

**Table 1**

<table>
<thead>
<tr>
<th>Electrodes</th>
<th>Observations</th>
<th>Voltage difference (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>zinc, iron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>zinc, tin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questions and Conclusions

1. How do you know that a chemical reaction has occurred in the wet cell after you added the acid?

2. Which pair of electrodes produced the greater voltage difference?

3. If one of the alligator clips is removed from the electrode, would a current exist? Explain.

4. Explain the difference between an electric current and voltage.

### Strategy Check

____ Can you construct a wet cell?

____ Can you measure the voltage difference of a wet cell?
Simple Circuits

Can you imagine a world without electricity? It is hard to believe that electrical energy became commercially available in the early 1880s.

The appliances plugged into the wall outlets of a room are part of an electric circuit. The most simple type of electric circuit contains three elements:
- a source of electrical energy, such as a dry cell;
- a conductor such as copper wire, which conducts an electric current; and
- a device, such as a lamp, which converts electrical energy into other forms of energy.

Complex circuits may contain many elements. How the elements are arranged in a circuit determines the amount of current in each part of a circuit.

Strategy

You will construct a series circuit and a parallel circuit.
You will observe the characteristics of the elements in circuits.
You will compare and contrast the characteristics of elements in series and parallel circuits.

Materials

- aluminum foil
- 9-V dry cell battery
- scissors
- 20-cm × 20-cm cardboard sheet
- 9-V mini-battery clip
- stapler and staples
- 2 LEDs (light-emitting diodes)
- 500-Ω resistor
- transparent tape
- metric ruler

Procedure

Part A—Constructing and Observing a Series Circuit

1. Place the cardboard sheet on a flat surface.
2. Cut 2 1-cm × 10-cm strips of aluminum foil with the scissors.
3. Attach the battery clip to the 9-V mini-battery. Securely attach the battery and the two aluminum foil strips to the board with tape as shown in Figure 1.
4. Staple the exposed end of the red lead wire from the battery clip to the top foil strip. Staple the exposed end of the black lead wire from the clip to the bottom foil strip as shown in Figure 2. Be sure that the staples are pressing the exposed ends of the wires securely against the foil strips.

Figure 1

[Diagram of a series circuit]

Figure 2

[Diagram of a parallel circuit]
Laboratory Activity 2 (continued)

5. Cut a 1.0-cm-wide gap in the top foil strip with the scissors. Tape down the ends as shown in Figure 3.

6. Place the 500-Ω resistor across the gap. Securely staple the two wires of the resistor to the cut aluminum strip as shown in Figure 3.

7. Push the long lead wire of the LED into the top aluminum strip. Push the short lead wire from the LED into the bottom strip as shown in Figure 4.

8. Observe the LED, noticing its brightness. Record your observation in the Data and Observations section.

9. Cut a 1-cm-wide gap in the lower foil strip with the scissors. Tape down the ends. Observe the LED. Record your observations in the Data and Observations section.

10. Insert the second LED across the gap in the bottom foil strip. Connect the long lead wire of this LED to the right segment of the strip as shown in Figure 5.

11. Observe both LEDs. Note if the brightness of LED 1 has changed from step 8. Record your observations in the Data and Observations section.

12. Predict what will happen to LED 2 if LED 1 is removed. Record your prediction.

13. Remove the first LED and observe the second LED. Record your observations.

14. Carefully remove LED 2, the staple from the black lead wire of the battery clip, and the two segments of the bottom foil strip from the cardboard sheet. (Disconnect LED 1 from the bottom foil strip first.) Leave all other circuit elements attached to the cardboard sheet for Part B of the experiment.

Part B—Constructing and Observing a Parallel Circuit

1. Cut a 1-cm × 10-cm strip of aluminum foil. Tape it to the board in place of the strip you removed in Step 14 of Part A. Staple the black lead wire of the battery clip to the lower foil strip.

2. Attach the first LED as you did in Step 7 of Part A. The long lead wire should still be attached to the top foil strip. Push the short lead wire through the bottom foil strip. Attach the second LED as shown in Figure 6 in the same manner.

3. Observe both LEDs. Note their brightness. Record your observations in the Data and Observations section.
4. Predict what will happen if LED 1 is removed. Record your prediction.
5. Remove LED 1. Record your observations.
6. Replace LED 2 and observe both LEDs. Note any change in brightness of the LEDs. Record your observations.
7. Predict what will happen if LED 2 is removed. Record your prediction.
8. Remove LED 2 and observe LED 1. Record your observations.

Data and Observations
Because the brightness of an LED in a circuit is directly related to the current in the circuit, the brightness of the LED is a measure of the current in that part of the circuit containing the LED.

Part A—Constructing and Observing a Series Circuit
Step 8. Observation of the LED when inserted into the foil strips:

Step 9. Observation of the LED when lower foil strip is cut:

Step 10. Observation of LEDs 1 and 2 when LED 2 is inserted across gap in bottom foil strip:

Step 11. Prediction if LED 1 is removed:

Step 12. Observation when LED 1 is removed:

Part B—Constructing and Observing a Series Circuit
Step 3. Observation of LEDs 1 and 2:

Step 4. Prediction if LED 1 is removed:

Step 5. Observation when LED 1 is removed:

Step 6. Observation when LED 2 is replaced:
Laboratory Activity 2 (continued)

Step 7. Prediction if LED 2 is removed:

Step 8. Observation when LED 2 is removed:

Questions and Conclusions
1. What do you think is the function of the 500-Ω resistor?

2. What happened to the current in the series circuit when an LED was removed?

3. What happened to the current in the series circuit when another LED was added?

4. What happened to the current in the parallel circuit when an LED was removed?

5. What happened to the current in the first LED in your parallel circuit when the second LED was added?

6. Explain what your answer to question 4 indicates about the total amount of current in the resistor.

7. How do you know if the lamps plugged into wall outlets in your house are part of a series circuit or a parallel circuit?

Strategy Check

____ Can you construct a series circuit?

____ Did your observations reflect your predictions?
Directions: Use this page to label your Foldable at the beginning of the chapter.

Know
Want
Learned
Meeting Individual Needs
Overview

Electricity

Directions: Complete the sentences by circling the correct words.

Electricity is 1. (static, parallel) when electric 2. (charges, circuits) accumulate on an object by gaining or losing 3. (branches, electrons) that move more easily in a(n) 4. (conductor, insulator) than they do in a(n) 5. (conductor, insulator).

Electricity in the form of a 6. (current, series) flows from object to object from 7. (low, high) voltage to 8. (low, high) voltage. This voltage 9. (parallel, difference) can be produced by a 10. (battery, generator) or by a 11. (battery, generator) at a power plant. Electrical 12. (charges, circuits) can be 13. (series, branches) with one 14. (loop, current) to flow through or they can be 15. (static, parallel) with two or more 16. (series, branches) for the electricity.

Directions: Use the following diagrams to answer the questions below

17. This is a ______________ circuit.  18. This is a ______________ circuit.

19. In which circuit will the brightness of the bulbs be diminished as more bulbs are added? ____________________________

20. In which circuit will both lights go out if one light is turned off? ____________________________

21. Which circuit is used to provide electricity to houses? ____________________________________

Meeting Individual Needs
Section 1  •  Electric Charge

Directions: Write the correct term in the numbered spaces. The boxed letters spell the word missing in question 13.

1. Exerts a force on anything that has an electric charge (2 words)
2. Material that does not allow an electric current to pass through it easily
3. What like charges do
4. Accumulation of electric charges on an object (2 words)
5. Materials that usually are good conductors of electricity
6. What unlike charges do
7. Metal that is often used in wires that conduct electricity
8. Material that is often used to insulate wires that conduct electricity
9. Any material that allows electricity to pass through it easily
10. Neutral particles found in the nucleus of an atom
11. Positively charged particles that are found in the nucleus of an atom
12. Negatively charged particles that are found outside the nucleus of an atom
13. An _____________________________ is a device that can detect the presence of electric charges.
Directions: For each of the following write, the letter of the term that best completes each statement.

1. A power rating lists the ______ required to operate an appliance.
   a. voltage    b. watts

2. A closed path through which electrons can flow is ______.
   a. voltage    b. a circuit

3. A fuse will melt if the ______ in a circuit becomes too high.
   a. current    b. resistance

4. Current is almost always the flow of ______.
   a. electrons    b. protons

5. A current has two or more branches in a ______.
   a. series circuit    b. parallel circuit

6. A car battery is an example of a ______.
   a. wet cell    b. dry cell

7. The tendency for a material to oppose the flow of electrons is called ______.
   a. voltage    b. resistance

8. Current has only one loop to flow through in a ______.
   a. parallel circuit    b. series circuit

9. Current is measured in ______.
   a. volts    b. amperes

10. Electrical energy is equal to ______ × time.
    a. power    b. voltage

11. Electrical power is equal to ______ × voltage difference.
    a. current    b. ohms

12. Ohm’s law states that the current equals ______ divided by the resistance.
    a. amperes    b. voltage difference

13. A dry cell is used in a flashlight to convert ______ to light.
    a. electrical energy    b. static electricity

14. Thin wires have a ______ resistance to electron flow than do thicker wires.
    a. greater    b. lesser

15. One thousand watts of power used in 60 minutes is ______.
    a. 16.7 amperes    b. 1 Kilowatt-hour
Key Terms
Electricity

Directions: Use the clues below to identify the term described by each statement. Write the term in the blank to the left. Then circle each term in the puzzle. Terms can go across, up and down, backward, or diagonally.

1. circuit that has only one path
2. circuit that has more than one path
3. The symbol V stands for ______.
4. That which can open or close a circuit
5. The flow of current through wire is on ______ current.
6. ______ difference is measured in volts.
7. The symbol Ω stands for ______.
8. A flashlight battery is an example of a ______.
9. a material that allows electrons to move through it
10. tendency for a material to oppose the flow of electrons
11. Transferring charge by touching is charging by ______.
12. units used to measure the rate of electron flow
13. The unit of electric energy is the Kilowatt-______.
14. Electrical ______ is expressed in watts.

PARALLEL CIRCUIT
SAROHELECTRIPIT
EVMOLAJEGATLOVC
RQOHODRYDARRWTO
IUWOLLCEYRDEON
EIEMETERINSURET
SEHQMPPERESARRA
CVOLMALBERTIMYC
IUIINSTEINWVODT
RVRMECNATSIERE
COLIGHTBULBESER
ULSCIENCEHCTIWS
ITCONDUCTORTWIN
TSUARELECTRICRY
Instrucciones: Completa las oraciones tachando las palabras incorrectas.

La electricidad 1. (estática, paralela) ocurre cuando un cuerpo acumula 2. (cargas, circuitos) al ganar o perder 3. (ramificaciones, electrones) que se mueven con mayor facilidad en un 4. (conductor, aislador) que en un 5. (conductor, aislador).

Electricidad en forma de 6. (corriente, series) fluye de cuerpo en cuerpo de un voltaje 7. (bajo, alto) a un voltaje 8. (bajo, alto). Un(a) 10. (batería, generador) o un(a) 11. (batería, generador) en una planta de energía puede producir esta(e) 9. (paralelo, diferencia) de voltaje. Los(Las) 12. (cargas, circuitos) eléctricos(as) pueden estar conectados(as) en 13. (series, ramificaciones) con un(a) 14. (bucle, corriente) a través del(de la) cual pueden fluir o pueden estar conectados(as) en 15. (estática, paralelo) con dos o más 16. (series, ramificaciones) para la electricidad.

Instrucciones: Usa los siguientes términos para llenar los espacios en blanco de las preguntas 16 a la 20.

16. Este es un circuito _______________. 17. Este es un circuito _______________.
18. ¿En cuál circuito brillarán menos los bombillos a medida que se agregan más bombillos? _______________________________________________________________________
19. ¿En cuál circuito se apagarán ambas luces si se apaga una de ellas?
   _______________________________________________________________________
20. ¿Cuál circuito se usa para abastecer la electricidad a los hogares?
   _______________________________________________________________________
Sección 1 • Carga eléctrica

Instrucciones: Escribe el término correcto en los espacios numerados. Las letras de los cuadrados verticales deben llenar el blanco de la Pregunta 13.

1. Ejerce una fuerza sobre todo lo que tenga carga eléctrica.
2. Material que no permite que una corriente eléctrica pase fácilmente a través de él.
3. Lo que hacen las cargas iguales.
4. Acumulación de cargas eléctricas en un cuerpo.
5. Materiales que son generalmente buenos conductores de electricidad.
6. Lo que hacen las cargas opuestas.
7. Metal que se usa frecuentemente en alambres para conducir electricidad.
8. Partículas con carga negativa que se encuentran fuera del núcleo del átomo.
9. Cualquier material que permite el paso libre de la electricidad.
10. Partículas neutras que se encuentran en el núcleo de un átomo.
11. Partículas con carga positiva que se encuentran en el núcleo del átomo.
12. Material que se usa frecuentemente como aislante en alambres que conducen electricidad.
13. Un(a) ________________ es un instrumento que permite detectar las cargas eléctricas y determinar si son positivas o negativas.
Instrucciones: Escribe la letra del término que complete correctamente cada oración.

1. La evaluación de potencia incluye el(los) ______ requeridos para usar un dispositivo eléctrico.
   a. voltaje  
   b. vatios

2. El camino cerrado por el cual pueden fluir los electrones es un(a)_____.
   a. voltaje  
   b. a circuito

3. Un fusible se fundirá si la _____ en el circuito es demasiado alta.
   a. corriente  
   b. resistencia

4. Por lo general, la corriente es el flujo de ______.
   a. electrones  
   b. protones

5. En un(a) ______ la corriente tiene dos o más rutas por donde fluir.
   a. circuito en serie  
   b. circuito en paralelo

6. La batería de un auto es un ejemplo de una ______.
   a. célula húmeda  
   b. célula seca

7. La tendencia de un material a oponerse al paso de los electrones se llama ______.
   a. voltaje  
   b. resistencia

8. En un ______ la corriente tiene solamente una ruta por donde fluir.
   a. circuito en paralelo  
   b. circuito en serie

9. La corriente se mide en ______.
   a. voltios  
   b. amperios

10. La energía eléctrica es igual a ______ × tiempo.
    a. potencia  
    b. voltaje

11. La potencia eléctrica es igual a ______ × diferencia de voltaje.
    a. corriente  
    b. ohmnios

12. La Ley de Ohm establece que la corriente es igual a ______ dividido(a) entre la resistencia.
    a. amperios  
    b. diferencia de voltaje

13. En una linterna, se usa una célula seca para convertir ______ en luz.
    a. energía eléctrica  
    b. energía estática

14. Los alambres finos tienen ______ resistencia al flujo de electrones que los alambres más gruesos.
    a. más  
    b. menos
**Instrucciones:** Usa las pistas para identificar los términos descritos. Escríbelos en los espacios a la izquierda y enciérrelos en un círculo en la sopa de letras. Éstos pueden aparecer horizontales, verticales, al revés o en diagonal.

1. Circuito con una única ruta.
2. Circuito con más de una ruta.
3. El símbolo • significa _____.
4. El símbolo ꞌ(significa _____.
5. El símbolo ꞌ(significa _____.
6. La diferencia de _____ se mide en voltios.
7. El símbolo Ω significa _____.
8. La batería de una linterna es un ejemplo de _____.
9. Material que permite el flujo de electrones.
10. Tendencia de un material a oponerse al flujo de electrones.
11. La transferencia de carga por contacto es _____.
12. Unidades que se usan para medir el flujo de electricidad.
13. La unidad de energía eléctrica es el kilovatio-______.
14. La _____ eléctrica se expresa en vatios.

**Satisfaces las necesidades individuales**
Electric Charge

Directions: Identify each of the following as a conductor or an insulator by putting a c or an i in the blank.

1. metal doorknob ______
2. carpet ______
3. silver ______
4. gold ______
5. wood ______
6. rubber ______
7. copper ______
8. bulletin board ______
9. clothing ______
10. plastic ______
11. metal coat hanger ______
12. paper clip ______

Directions: Describe how each of the following pairs of charges will react.

13. positive and positive

14. positive and negative

15. negative and negative

Directions: Answer the following questions in complete sentences.

16. What is an electroscope and how does it work?

17. What is the difference in the charges on a balloon rubbed in your hair and a glass rod rubbed with silk? Why?
Electric Current

Directions: Circle the term in parentheses that makes each statement true.

1. A negatively charged object has (more, fewer) electrons than an object that is neutral.

2. Electrons flow from areas of (higher, lower) voltage to areas of (higher, lower) voltage.

3. Voltage difference is measured in (amperes, volts).

4. Electrons passing through a lamp (gain, lose) some voltage as they light the lamp.

5. Voltage (varies, is the same) in all parts of a series circuit.

6. The current in a circuit is measured in (volts, amperes).

7. Current is almost always the flow of (electrons, protons).

8. When a dry cell is connected in a series, the flow of electrons moves from the (positive, negative) terminal to the (positive, negative) terminal.

9. In a dry cell, the carbon rod releases electrons and becomes the (positive, negative) terminal.

10. The voltage difference between the two holes in a wall socket is (12 volts, 120 volts).

11. A car battery is an example of a (dry, wet) cell.

12. Resistance is measured in (ohms, volts).

13. Copper has a (higher, lower) resistance to electron flow than tungsten.

14. According to Ohm’s law, \( I = \frac{V}{R}, V = \frac{I}{R} \)

15. The symbol for ohm is (\( \Omega \), °).

16. In the equation \( I = \frac{V}{R} \), \( I \) is expressed in (ohms, amperes).

17. In the equation \( I = \frac{V}{R} \), \( V \) is expressed in (volts, ohms).

18. The (+, −) terminal of a dry cell identifies the location of the carbon rod.

19. A wire with a resistance of 3Ω has a (greater, lesser) resistance to electron flow than a wire with a resistance of 5Ω.

20. If two copper wires are the same length, but different thicknesses, the (thinner, thicker) wire has greater resistance.
**Section 3 Reinforcement**  

**Electricity**

**Directions:** Use the terms and statements below to complete the table.

rate at which electrical energy is converted to another form of energy

The current has only one loop to flow through.

<table>
<thead>
<tr>
<th>kilowatt</th>
<th>parallel circuit</th>
<th>series circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>watt</td>
<td>insulation to melt</td>
<td>a fire</td>
</tr>
</tbody>
</table>

The current has more than one branch.

<table>
<thead>
<tr>
<th>kW</th>
<th>fuses</th>
<th>circuit breakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Power = current $\times$ voltage difference</td>
<td>$P = I \times V$</td>
</tr>
</tbody>
</table>

### Important Facts About Electric Circuits

1. There are two types of electric circuits.

   Two types of circuits:
   
   a.  
   b.  

   Definitions of these circuits:
   
   c.  
   d.  

2. A household circuit can contain many appliances.

   Too many appliances can cause:
   
   a.  
   b.  

   For protection, household circuits contain:
   
   c.  
   d.  

3. The electrical power of a circuit can be measured.

   Definition of electrical power:
   
   a.  

   Unit of electrical power:
   
   b. Name:  
   c. Abbreviation:  
   d. Term for 1,000 units:  
   e. Abbreviation for 1,000 units:  

   Determining the electrical power of a circuit:
   
   f. Expression:  
   g. Formula:  

---

*Meeting Individual Needs*
Electricity in Everyday Life

For each of the following activities, predict what you will observe. Do each activity and write down your actual observation. Give an explanation for your results.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Prediction</th>
<th>Result and explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Run a plastic comb through your hair several times. Hold the comb next to a stream of running water.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Tie two inflated balloons together with a string. Hold the balloons next to each other and rub both with a piece of wool.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Hold a piece of newspaper flat against the wall. Stroke across the surface of the newspaper with your hand.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Stretch a piece of clear plastic food wrap over a glass jar and fold down the sides.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Add an antistatic dryer sheet to some clothes in a dryer. Turn the dryer on for 15 minutes.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Voltaic Cell

In 1780, Luigi Galvani, an Italian scientist, had frogs’ legs lying close to an electrostatic machine. Someone happened to touch a nerve in a frog’s leg with a metal scalpel. A spark jumped from the machine, through the scalpel, into the frog’s leg—and the leg twitched. He discovered that if he touched the frog’s leg with the free ends of two wires made of copper and iron joined together, the leg twitched. Galvani reasoned that this twitch might result from electricity in the frog’s leg.

Count Volta

Another Italian scientist, Count Alessandro Volta, challenged this idea. He found that the copper and iron wires were producing the electricity in the leg. It was the current that caused the frog’s leg to twitch. He reasoned that the frog’s leg itself was not important. Rather, it was the salts and acids dissolved in the tissues of the leg that produced the electric current with two unlike metals.

Safety Precautions

Caution: Sulfuric Acid can burn the skin and damage clothing and furniture. Immediately rinse any spills with water.

1. When you close the switch, the needle of the voltmeter moves, indicating that a flow of electrons is passing from the cell. What happens when you open the switch? Why?

2. What is the voltage produced by your copper-zinc cell? _____________________________

3. Use arrows to indicate on the diagram the direction in which the electrons flow.

4. In what direction does the electricity flow in this cell? _____________________________

5. Is the voltaic cell a device for changing chemical energy to electrical energy, or vice versa? Explain. _____________________________

6. What is the source of the flow of electrons in your voltaic cell? _____________________________
Designing and Analyzing Circuits

A new school is being built and the architects have planned a planetarium for the science wing. A planetarium is a specially designed room with a domelike ceiling where such things as star groupings, movement of the planets, and rotation and revolution of Earth are simulated and studied. A door will lead from the hall into the planetarium. Once a program has begun, the room must be in total darkness and the hall door should not be opened. Since the planetarium door cannot be locked because of fire safety rules, the Planetarium Director wants two lights in the hallway above the door that would let people know whether a program is in progress. If a green light is on, the door can be opened. If a red light is on, the planetarium is in use and the door should not be opened.

Examine the diagram below. Correctly connecting these circuit parts will allow the Planetarium Director to communicate the proper message. Draw in the wiring so that the double throw switch can be used to turn on either the green or red lamp but not both at the same time. Answer the following questions in the spaces provided.

1. Look at the part of your circuit that connects the battery, switch, and red bulb. Do you have them wired in series or parallel? ________________________________
2. Look at the part of your circuit that connects the battery, switch, and green bulb. Do you have them wired in series or parallel? ________________________________
3. Are the two circuits, including the red and green lamps, wired in series or in parallel? _________
4. When the switch is in the position shown in the drawing, which bulb is lit? ________________
5. When the double throw switch is turned to the left, which lamp will light? ________________
6. When the double throw switch is turned to the right, which lamp will light? ________________
7. Draw a diagram of your circuit.
Section 1  Electric Charge

A. Protons have ____________ electric charge; electrons have ____________ electric charge.
   1. In most atoms, the charges of the protons and electrons cancel each other out and the atom has no _____________.
   2. Atoms become charged by gaining or losing _____________.
   3. Static electricity—the accumulation of excess ________________ on an object

B. Electrically charged objects obey the following rules:
   1. Law of conservation of charge—charge may be transferred from object to object, but it cannot be ___________ or ___________
   2. Opposite charges ___________, and like charges _________.
   3. Charges can act on each other even at a ____________, because any charge that is placed in an electric field will be pushed or pulled by the field.
   4. Electrons move more easily through conductors, like _____________.
   5. Electrons do not move easily through ________________, such as plastic, wood, rubber, and glass.

C. Transferring electric charge
   1. Charging by ____________
      a. The process of transferring charge by ____________ or ____________
      b. Example: static electricity from your feet ___________ the carpet
   2. Charging by ____________
      a. The rearrangement of electrons on a neutral object caused by a nearby_________ object
      b. Example: a negatively charged balloon near your sleeve causes an area of your sleeve to become ____________ charged
   3. Static ____________
      a. A transfer of charge through the ______ between two objects because of a buildup of static electricity
      b. Example: ____________
   4. Grounding—using a ____________ to direct an electric charge into the ground

D. The presence of electric charges can be detected by an ________________.
Section 2  Electric Current

A. The flow of charges through a wire or conductor is called electric __________.

1. Current is usually the flow of ______________

2. Electric current is measured in ___________ (A).

3. Charges flow from ________ voltage to _______ voltage.
   a. A voltage difference is the ________ that causes charges to move.
   b. Voltage difference is measured in ________ (V).

4. For charges to flow, the wire must always be connected in a closed path, or __________.

B. Sources of electricity:

1. A ____________ battery produces a voltage difference between its zinc container and its carbon suspension rod, causing current to flow between them.

2. A ____________ battery contains two connected plates made of different metals in a conducting solution.

3. ________________ have a voltage difference across the two holes of an electrical outlet, and a generator at a power plant provides this voltage difference.

C. Resistance—the tendency for a material to oppose the flow of electrons, changing electrical energy into ___________ energy and ________

1. All materials have some electrical ______________.

2. Resistance is measured in ________ (Ω).

3. Making wires thinner, longer, or hotter _____________ the resistance.

D. Ohm’s law—the current in a circuit equals the voltage difference divided by the __________

Section 3  Electrical Circuits

A. Circuits rely on generators at power plants to produce a voltage difference across the outlet, causing the charge to ________ when the circuit is complete.

1. Series circuit—the current has only one ________ to flow through
   a. The parts of a series circuit are wired one after another, so the amount of current is the ________ through every part.
   b. ________________—if any part of a series circuit is disconnected, no current flows through the circuit
   c. Example: strings of ________________
2. **Parallel circuit**—contains two or more ____________ for current to move through
   a. Individual parts can be ____________ without affecting the entire circuit.
   b. Example: the electrical system in a ____________

B. Household circuits use ____________ circuits connected in a logical network.
   1. Each branch receives the standard ________________ from the electric company.
   2. Electrical energy enters your home at the ____________ breaker or ________ box and branches out to wall sockets, major appliances, and lights.
   3. Guards against overheating electric wires:
      a. ________________—contains a small piece of metal that melts if the current becomes too high, opening the circuit and stopping the flow of current
      b. ________________—contains a small piece of metal that bends when it gets hot, opening the circuit and stopping the flow of current

C. Electrical energy is easily converted to mechanical, thermal, or __________ energy.
   1. **Electrical power**—the rate at which ______________ energy is converted to another form of energy
      a. Electrical power is expressed in ______________(W).
      b. Power = current × ______________
      c. \[ P \text{ (watts)} = I \text{ (amperes)} \times \text{__________} \]
   2. To calculate the amount of energy an appliance uses:
      a. The unit of electrical energy is the ________________, which equals 1000 watts of power used for one hour.
      b. Energy = power × __________
      c. \[ E \text{ (kWh)} = P \text{ (kW)} \times \text{__________} \]
Assessment
# Electricity

## Part A. Vocabulary Review

**Directions:** Match each term in Column II with its description in Column I by writing the correct letter in the space provided.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>____  1. allows electrons to move through it easily</td>
<td>a. wet cell</td>
</tr>
<tr>
<td>____  2. closed path through which electrons flow</td>
<td>b. voltage difference</td>
</tr>
<tr>
<td>____  3. accumulation of electric charges on an object</td>
<td>c. parallel circuit</td>
</tr>
<tr>
<td>____  4. circuit with more than one path</td>
<td>d. resistance</td>
</tr>
<tr>
<td>____  5. tendency of a material to oppose electron flow</td>
<td>e. lightning rod</td>
</tr>
<tr>
<td>____  6. does not allow electricity to move through it easily</td>
<td>f. circuit</td>
</tr>
<tr>
<td>____  7. push that causes charges to move</td>
<td>g. static electricity</td>
</tr>
<tr>
<td>____  8. Surrounds electric charge and exerts force on other charges</td>
<td>h. dry cell</td>
</tr>
<tr>
<td>____  9. rate at which electrical energy is changed to another energy form</td>
<td>i. Ohm’s law</td>
</tr>
<tr>
<td>____ 10. flow of electrons through a conductor</td>
<td>j. conductor</td>
</tr>
<tr>
<td>____ 11. circuit with only one path</td>
<td>k. electric field</td>
</tr>
<tr>
<td>____ 12. unit of electrical energy</td>
<td>l. electric power</td>
</tr>
<tr>
<td>____ 13. Current is equal to the voltage difference of a circuit divided by its resistance.</td>
<td>m. kilowatt hour</td>
</tr>
<tr>
<td>____ 14. car battery</td>
<td>n. electric power</td>
</tr>
<tr>
<td>____ 15. metal rod that directs lightning to Earth</td>
<td>o. electric current</td>
</tr>
<tr>
<td>____ 16. device that detects electric charges</td>
<td>p. insulator</td>
</tr>
<tr>
<td>____ 17. flashlight</td>
<td>q. series</td>
</tr>
</tbody>
</table>
Part B. Concept Review

Directions: Use the diagram below to complete the following.

1. Will the voltage in this circuit be greater at A or B? Why?

2. What causes current to flow from one terminal of the battery to the other?

3. If the battery is a 9-volt battery and the resistance in the circuit is 18 ohms, how much current is flowing through the circuit?

Directions: Answer the following questions on the lines provided.

4. What is the function of circuit breakers and fuses?

5. What is lightning?
Transparency Activities
What happens when you put clothes in a dryer? As the clothes tumble, they rub against other articles of clothing and the walls of the dryer. As you can see below, the result could be a bit of static cling.

1. If you line-dry clothes, will they have static cling? Why or why not?
2. As you separate clothes that are clinging together, what might you see and hear? Is this similar to anything else that you can think of?
Go with the Flow

Do you see how the water flows down the cliff? Water takes the path of least resistance—it flows where it’s easiest for water to go. Electric currents flow and experience resistance, too.

1. Which do you think has more energy, the waterfall in the picture or Niagara Falls, which are higher and have more water flowing over? Explain your answer.

2. How do people use the energy in water currents?
One Big Electric Bill

How common is the use of electric power? Look at the image below of Earth at night. You can pick out areas like Europe and the east and west coasts of the United States because of all the electric lights.

1. If electric lights are an accurate gauge of electricity usage, what areas use the most electricity?
2. What areas use the least electricity?
3. The blue area does not represent the use of electricity. What would you guess it is?
Series and Parallel Circuits

- Conductor
- Lightbulbs
- Battery

Teaching Transparency Activity
1. What is the main difference between a series circuit and a parallel circuit?

2. What kind of material makes up the object labeled “conductor” on the transparency?

3. Explain what happens in a series circuit if one of the lightbulbs stops shining.

4. If one lightbulb in a parallel circuit stops shining, how are the other lightbulbs connected in the circuit affected?

5. What kinds of circuits are used in the wiring of most homes?
Assessment Transparency Activity

Electricity

Directions: Carefully review the graph and answer the following questions.

1. Pedro tested four different brands of batteries. He found that the first kind lasted 15 hours, the second kind lasted 22.5 hours, the third kind lasted 25 hours, and the fourth kind lasted 6.5 hours. Which represents the second kind?
   A Q
   B R
   C S
   D T

2. According to the graph, which battery lasted the LEAST amount of time?
   F Q
   G R
   H S
   J T

3. About how much longer did battery T last than battery Q?
   A 2 hours
   B 7 hours
   C 10 hours
   D 15 hours