Glencoe Science

Chapter Resources

The Nature of Science

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

McGraw Hill

Glencoe

New York, New York  Columbus, Ohio  Chicago, Illinois  Peoria, Illinois  Woodland Hills, California
Reproducible Student Pages

Reproducible Student Pages

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Hands-On Activities
**Mini LAB**

**Inferring from Pictures**

**Procedure**
1. Study the two pictures of the umbrellas in your textbook. Write all of your observations in the table below.
2. Make and record inferences based on your observations.
3. Share your inferences with others in your class.

**Data and Observations**

<table>
<thead>
<tr>
<th>Picture</th>
<th>Observations</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis**

1. Analyze your inferences. Are there other explanations for what you observed?

2. Why must you be careful when making inferences?
Comparing Paper Towels

Procedure
1. Record your observations for this lab in the table below.
2. Cut a 5-cm by 5-cm square from each of three brands of paper towel. Lay each piece on a level, smooth, waterproof surface.
3. Add one drop of water to each square.
4. Continue to add drops until the piece of paper towel no longer can absorb the water.
5. Tally your observations in the data table and graph your results on a separate sheet of paper.
6. Repeat steps 2 through 5 three more times.

Data and Observations

<table>
<thead>
<tr>
<th>Trial</th>
<th>Brand A</th>
<th>Brand B</th>
<th>Brand C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>4</td>
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</tbody>
</table>

Analysis
1. Did all the squares of paper towels absorb equal amounts of water? ________________
2. If one brand of paper towel absorbs more water than the others, can you conclude that it is the towel you should buy? Explain.
   ___________________________________________________________________________
   ___________________________________________________________________________
   ___________________________________________________________________________
3. Which scientific methods did you use to compare paper towel absorbency?
   ___________________________________________________________________________
   ___________________________________________________________________________
Lab Preview

Directions: Answer these questions before you begin the Lab.

1. Why would you need to protect your clothing during this lab?

2. Why should you add the powder gradually?

You can use science skills to answer everyday questions or to solve problems. For example, you might know that the cheapest brand of a product is not always the best value. In this lab, you will test one aspect, or quality, of a product.

Real-World Question

Which brand of powdered beverage mix dissolves best?

Materials

- weighing paper
- 50-mL graduated cylinder
- powdered beverage mixes (3 or 4)
- triple beam balance
- 250-mL beaker
- water
- spoon

*electronic balance
*Alternative materials

Goals

- Determine which brand of powdered beverage mix dissolves best using science skills.

Safety Precautions

WARNING: Never eat or drink anything during science experiments.

Procedure

1. Using the graduated cylinder, measure 50 mL of water and pour the water into the beaker.

2. Measure 20 g of powder from one of the brands of beverage powder.

3. Gradually add the powder to the water. Stir the mixture after each time you add more powder. Stop adding powder when undissolved powder begins to accumulate at the bottom of the beaker.

4. Measure the mass of the remaining powder. Subtract this number from 20 g to find the amount of powder that was dissolved. Record your answer in your data table.

5. Empty the beverage mix into the sink, rinse out your beaker, and repeat steps 1 through 5 for the other brands of beverage mix.

Data and Observations

Table 1

<table>
<thead>
<tr>
<th>Beverage Mix Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beverage mix</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
</tbody>
</table>
Hands-On Activities

### Conclude and Apply

1. **Identify** the beverage-mix powder that dissolved best in the water.

2. **Infer** which beverage-mix brand would taste the best based on the data you collected.

3. **List** the science skills you used during this experiment to help you determine the best beverage mix. Which beverage-mix brand would you buy?

4. **Review** promotional pamphlets. Make a list of inferences about the claims presented.

### Communicating Your Data

Write and perform a 15-s advertisement that tells why people should buy the best-dissolving beverage-mix brand. **For more help, refer to the Science Skill Handbook.**
Use the Internet
When Is the Internet the Busiest?

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

1. What factors do you think affect the speed of the Internet?

2. Why is it important to measure the speed more than once?

Using the Internet, you can get information any time from practically anywhere in the world. It has been called the “information superhighway.” But does the Internet ever get traffic jams like real highways? Is the Internet busier at certain times?

Real-World Question
How long does it take data to travel across the Internet at different times of the day?

Goals
- **Observe** when you, your friends, or your family use the Internet.
- **Research** how to measure the speed of the Internet.
- **Identify** the times of day when the Internet is the busiest in different areas of the country.
- **Graph** your findings and communicate them to other students.

Data Source
Visit blue.msscience.com/internet_lab for more information on how to measure the speed of the Internet, when the Internet is busiest, and data from other students.

Make a Plan
1. **Observe** when you, your family, and your friends use the Internet. Do you think that everyone in the world uses the Internet during the same times?

2. How are you going to measure the speed of the Internet? Research different factors that might affect the speed of the Internet. What are your variables?

3. How many times are you going to measure the speed of the Internet? What times of day are you going to gather your data?

Follow Your Plan
1. Make sure your teacher approves your plan before you start.

2. Visit blue.msscience.com/internet_lab. Click on the Web Links button to view links that will help you do this activity.

3. Complete your investigation as planned.

4. **Record** all of your data in your Science Journal.

5 **Share** your data by posting it at the link shown above.
Hands-On Activities

Communicating Your Data

Analyze Your Data
1. What time of day did you find it took the most time to send data over the Internet?

2. Compare your results with those of other students around the country. In which areas did data travel the most quickly?

Conclude and Apply
1. Compare your findings to those of your classmates and other data that were posted at blue.msscience.com/internet_lab. When is the Internet the busiest in your area? How does that compare to different areas of the country?

2. Infer what factors could cause different results in your class.

3. Predict how you think your data would be affected if you had performed this experiment during a different time of the year, like the winter holidays.

Communicating Your Data

Find this lab using the link below. Post your data in the table provided. Combine your data with those of other students and plot the combined data on a map to recognize patterns in Internet traffic.

blue.msscience.com/internet_lab
A Scientific Method

When scientists are asked questions, they might not know the answers. They think of the possible answers, called hypotheses, and experiment to find the correct answers. Using the results of the experiment, they might need to form another hypothesis and test it. This way of solving a problem is called a scientific method.

Strategy
You will predict whether or not red cabbage juice will remain red when chemicals are added to it. You will test your prediction with an experiment. You will observe what happens and record your observations. You will draw conclusions based on your observations.

Materials
- graduated cylinder (25 mL)
- 40 mL red cabbage juice
- test tube rack
- 4 test tubes (18 × 150-mm)
- vinegar (Keep containers closed when not in use.)
- ammonia
- baking soda solution
- labels
- 3 droppers

WARNING: Do not mix ammonia with vinegar. May react vigorously.
WARNING: Ammonia fumes are poisonous. Avoid inhaling the vapors.
WARNING: Do not taste, eat, or drink any materials used in this lab.
WARNING: Inform your teacher if you come in contact with any chemicals.

Procedure
1. In the space below, predict what will happen to the red cabbage juice when vinegar, ammonia, and baking soda solution are added to it.

2. Label four test tubes, 1, 2, 3, and 4.
3. Add 10 mL of red cabbage juice to each test tube.

4. Add 10 drops of vinegar to test tube 1.
5. Add 10 drops of ammonia to test tube 2.
6. Add 10 drops of baking soda solution to test tube 3.
7. Do not add anything to test tube 4. This is the control. The control is the part of the experiment that is not tested.
8. Record your observations in the Table.

Data and Observations

<table>
<thead>
<tr>
<th>Test tube</th>
<th>Substance added</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>2</td>
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</tbody>
</table>

WARNING: Avoid contacting any chemicals with clothes or skin. Rinse with water if spilled.
Laboratory Activity 1 (continued)

Questions and Conclusions
1. a. Was your prediction correct?
   
   ______________________

   b. What part of the scientific method is predicting?
   
   ______________________

2. Do all chemicals have the same effect on red cabbage juice?
   
   ______________________

3. Why did you record the color changes?
   
   ______________________

   ______________________

4. What steps in the scientific method did you use?
   
   ______________________

5. What is the purpose of the control in an experiment?
   
   ______________________

6. Why is a hypothesis called an educated guess?
   
   ______________________

7. Was your experimenting a way of proving your hypothesis?
   
   ______________________

8. How did your hypothesis change after experimenting?
   
   ______________________

Strategy Check
______ Can you make a prediction?
______ Can you test your prediction and record what happened?
______ Can you draw conclusions based on your observations?
If scientists hypothesized that there are organisms in the air, how could they test their hypothesis? Do you believe that there are organisms in the air? What makes you think so? You can experiment to test your hypotheses.

**Strategy**
You will use a scientific method to determine if organisms are found in the air. You will use tubes containing various foods that may or may not allow for the growth of organisms. You will observe and test for the presence of organisms.

**Materials**
- 4 test tubes (18 x 150-mm)
- test-tube rack
- graduated cylinder
- bouillon soup
- water
- beaker (oven proof, 250-mL)
- hot plate
- 4 test-tube holders
- cotton balls
- labels
- litmus paper (red or blue)

**Procedure**
1. Pour 15 mL of bouillon soup into two test tubes.
2. Add 15 mL of water to two other test tubes.
3. Place each test tube into a test-tube holder and then place all the holders into a small beaker half filled with water. Place the beaker on a hot plate. Allow the tubes to remain in the water for at least 15 min. while boiling.
4. Remove all tubes from the hot water bath. **WARNING:** Do not touch the tubes. They are hot.
5. Place the test tubes in a test-tube rack. Seal one bouillon tube and one water tube securely with a cotton plug. Leave the remaining two tubes open.
6. Label each tube with your name, date, and either “water” or “soup”.
7. Examine all the tubes after one week. Compare the appearance of the two tubes containing soup. Are they cloudy or clear? Hold them towards the light to help decide. Record your observations using the words cloudy or clear under the column marked Appearance in Table 1. Compare the appearance of the two water tubes. Again use cloudy or clear under Appearance in the table.
8. Test each test tube to determine if the liquids are acid, base, or neutral. Remove the cotton plugs and dip a small piece of litmus paper into each tube. Use a new piece of litmus paper for each tube. **HINT:** Blue litmus turns red in an acid and red litmus turns blue in a base. No change in either paper means that the liquid is neutral. Use the words acid, base, or neutral to complete the column marked litmus paper test in the table.
9. Carefully smell each tube. See Figure 1. Record in the column marked Odor in the table whether the tubes smell meaty, spoiled, or have no smell (none).
10. Give all test tubes to your teacher for proper disposal.
Laboratory Activity 2 (continued)

Data and Observations

Table 1

<table>
<thead>
<tr>
<th>Tube</th>
<th>Appearance</th>
<th>Litmus paper test</th>
<th>Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. soup, open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. soup, sealed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. water, open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. water, sealed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions and Conclusions

1. Bacteria growing in a liquid will cause the liquid to become cloudy. Which tube(s) had bacteria growing in them? Which tube(s) remained clear?

2. Bacteria growing in a liquid cause the liquid to change to an acid. Comparing the litmus paper test between the opened and sealed soup tubes, which tube(s) became acid? Which tube(s) remained neutral?

3. Bacteria growing in a liquid often results in a spoiled odor. Which tube(s) had a spoiled odor?

4. Bacteria will grow in liquids only if a food supply is present. Which tube(s) contained food? Which tube(s) had no food available for bacteria (water is not a food)?
5. What evidence do you have that bacteria came into the tubes only from the air?

6. What evidence do you have that bacteria need food in order to live, grow, and increase in number?

7. Why were all the tubes first boiled in hot water? **HINT**: Boiling destroys bacteria.

8. What conclusion can you make if the sealed soup tube became cloudy and had a foul odor?

9. What evidence do you have that you breathe organisms as part of the air?

10. Predict what experimental results might be expected if both tubes of soup and water were boiled and sealed. Explain.

11. Predict what experimental results might be expected if both tubes of soup were boiled but were left open.

12. Predict what experimental results might be expected if both tubes were not boiled and were not sealed.

**Strategy Check**

_____ Did you use a scientific method to test the hypotheses that there are organisms in the air?

_____ Can you determine which tubes do or do not have organisms growing in them?
The Nature of Science

Directions: Use this page to label your Foldable at the beginning of the chapter.

Who?

What?

When?

Why?

1871

a cholera epidemic in London

Dr. John Snow

to find the source of the cholera and prevent it from making anyone else sick
Meeting Individual Needs
Overview
The Nature of Science

Directions: Scientists go through several steps as they solve problems. Read the following stages in problem solving. Then write the letter of each stage that is described below on the lines provided.

A. Recognize the problem.

B. Form a hypothesis.

C. Test your hypothesis.

D. Analyze your data.

E. Draw conclusions.

____ 1. After taking measurements for 2 hours, Danita tried to make sense of the numbers.

____ 2. James added a fertilizer to half of the plants and plain water to the other half.

____ 3. Donna wondered why she could never grow flowers in her garden.

____ 4. Luis thought the plants would grow with the addition of nutrients.

____ 5. The students looked at the data and realized that the plants needed a lot of fertilizer.
Directed Reading for Content Mastery

Section 1 - What is science?
Section 2 - Doing Science

Directions: Use the following terms to complete the crossword puzzle.

bias    meter    trials    data
observe  variable  hypothesis  experiment

Across
5. A statement or prediction that can be tested
6. Factor that can change in an experiment
7. Unit of length in the SI system
8. The different times an experiment is done

Down
1. An important step scientists must do
2. A way of testing an idea
3. Information gathered during an experiment
4. The slanting of information

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Section 3  Science and Technology

Directions: List three examples of modern technology for each category.
Health
1. 
2. 
3. 

Communications
4. 
5. 
6. 

Entertainment
7. 
8. 
9. 

Directions: Answer the following question on the lines provided.
10. How do computers help scientists learn more about bacteria?


Key Terms
The Nature of Science

Directions: Use the following terms to complete the sentences below.

current | independent variable | control
model | dependent | science
hypothesis | technology | scientific methods

descriptive research | experimental research design

1. A(n) ________________________________________ represents something that is too big, too small, too fast, or too slow to observe directly.

2. A variable that stays the same in an experiment is a(n) _____________________.

3. The variable that is changed in an experiment is the _____________________.

4. A(n) ________________________________________ is a sample that is treated like other experimental groups except the independent variable is not applied to it.

5. A prediction that can be tested is a(n)_________________________________.

6. __________________________________________ is a way to investigate what is happening around us.

7. __________________________________________ is the application of science to make products or tools people use.

8. When your research is based mostly on observations, it is called _________________________________.

9. When your research tests a hypothesis by the observation of a series of carefully controlled steps, it is called _________________________________.

10. ________________________________ are ways, or steps to follow, to try to solve problems.

11. The factor being measured in an experiment is the _________________ variable.
Instrucciones: Los científicos usan varios pasos para resolver problemas. Lee los siguientes pasos para resolver problemas. Luego escribe la letra de cada paso que se describe a continuación.

A. Reconocer el problema

B. Formular una hipótesis.

C. Probar la hipótesis.

D. Analizar los datos.

E. Sacar conclusiones

1. Después de tomar medidas durante 2 horas, Danita trató de entender las cifras.

2. James regó la mitad de sus plantas con fertilizante disuelto en agua y la otra mitad sólo con agua.

3. Donna se pregunta por qué no puede cultivar flores en su jardín.

4. Luis pensó que las plantas crecerían si les añadía nutrientes.

5. Los alumnos se fijaron en la información y se dieron cuenta de que las plantas necesitan bastante fertilizante.
Sección 1: ¿Qué es la ciencia?
Sección 2: Usa la ciencia

Instrucciones: Usa los siguientes términos para completar el crucigrama.

<table>
<thead>
<tr>
<th>Sesgo</th>
<th>Metro</th>
<th>Pruebas</th>
<th>Datos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observación</td>
<td>Variable</td>
<td>Hipótesis</td>
<td>Experimento</td>
</tr>
</tbody>
</table>

Horizontales
2. Las diferentes veces que se repite un experimento
3. Una afirmación o predicción que puede ponerse a prueba
6. Factor que cambia en un experimento
7. Un paso muy importante que los científicos deben hacer
8. Unidad de longitud en SI

Verticales
1. Una forma de probar una idea
4. Parcialización de la información
5. Información que se recoge en un experimento
Lectura dirigida para
Dominio del contenido

Sección 3 = Ciencia y tecnología

**Instrucciones:** Enumera tres ejemplos de tecnología moderna que se usa en cada categoría.

Salud
1. ________________________________________________________________
2. ________________________________________________________________
3. ________________________________________________________________

Comunicaciones
4. ________________________________________________________________
5. ________________________________________________________________
6. ________________________________________________________________

Entretenimiento
7. ________________________________________________________________
8. ________________________________________________________________
9. ________________________________________________________________

**Instrucciones:** Responde cada pregunta en las líneas dadas.

10. ¿Cómo ayudan las computadoras a los científicos a aprender más sobre las bacterias?
    ________________________________________________________________
    ________________________________________________________________
    ________________________________________________________________
    ________________________________________________________________
    ________________________________________________________________
    ________________________________________________________________
1. Un(a) ________________ representa algo demasiado grande, demasiado pequeño, demasiado rápido o demasiado lento para ser observado directamente.

2. La variable que permanece igual en un experimento es la ________________.

3. La variable que cambia en un experimento es la ________________.

4. Un(a) ________________ es una muestra que se trata como cualquier grupo experimental, excepto que no se le aplica la variable.

5. Una predicción que puede ponerse a prueba es un(a) ________________.

6. El(La) ________________ es una forma de investigar lo que sucede a nuestro alrededor.

7. El(La) ________________ es la aplicación de la ciencia para fabricar productos o herramientas que la gente puede usar.

8. Cuando tu investigación se basa sobre todo en la observación se le llama ________________.

9. Cuando tu investigación pone a prueba una hipótesis por medio de una serie de pasos cuidadosamente controlados se le llama ________________.

10. Los(Las) ________________ son maneras, o pasos, que se siguen para tratar de resolver un problema.

11. El factor que se mide en un experimento es la variable ________________.
**What is science?**

**Directions:** In the sentences below (labeled 1 and 2), a code letter has been substituted for each letter of the alphabet. To find out what the sentences say, use the following key to decode them. In the key, the code letters are shown directly below the alphabet letter each stands for. Write the correct letter above each code letter, then read the sentences aloud.

**Key**

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| Z | Y | X | W | V | U | T | S | R | Q | P | O | N | M | L | K | J | I | H | G | F | E | D | C | B | A |

1. 

<table>
<thead>
<tr>
<th>H</th>
<th>X</th>
<th>R</th>
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2. 

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</table>

**Directions:** Answer the following question on the lines provided.

3. List some examples of the types of information that could be found in a scientist’s journal.

   ____________________________
   ____________________________
   ____________________________

4. Explain why observing using only your senses can be misleading.

   ____________________________
   ____________________________
   ____________________________
   ____________________________
   ____________________________
Doing Science

Directions: Complete the following sentences using the words below. Some of the words might not be used.

variable models trials experiment
control metric bias hypothesis
experimental research design English descriptive research

1. A method of solving scientific problems based mostly on observations is ________________________________.

2. A(n) ________________________________ is a method of answering scientific questions by testing a hypothesis through the use of a series of carefully controlled steps.

3. Prior knowledge, new information, and previous observations are used to form an(n) ________________________________.

4. A(n) ________________________________ is a sample treated like other experimental groups except that the variable is not applied.

5. Computer ________________________________ help modern scientists do their work.

6. After a hypothesis is developed, a(n) ________________________________ is often designed to test the hypothesis.

7. Multiple ________________________________ of an experiment ensure valid results.

8. Experiments are reliable only if one ________________________________ at a time is tested.

9. The International System of Units is based on the ________________________________ system.

10. A random sample is one way to reduce ________________________________ when choosing people for an experiment.

Directions: Match the SI unit with what it measures by writing the correct letter in the space provided.

_____ 11. meter a. mass
_____ 12. kilogram b. volume
_____ 13. square meter c. length
_____ 14. cubic meter d. area
1. Scientific ____________________ often challenges old ways of thinking or doing things.

2. People of all races, ages, sexes, cultures, and professions practice ____________________.

3. Some scientific discoveries have been made by people pursuing a(n) ____________________.

4. Scientific ____________________ are constantly incorporated into products that influence our style of living.

5. Thanks to modern information technology, information about new scientific discoveries is available ____________________.

6. Modern technology has led to the ____________________ of new information.

Directions: Answers the following questions on the lines provided.

7. What is meant by the statement “Science can provide information that people use to make decisions”?

   ________________________________________________
   ________________________________________________
   ________________________________________________

8. Name three aspects of everyday life that have been greatly changed by new technologies.

   ________________________________________________
   ________________________________________________
   ________________________________________________
Science versus Pseudoscience

Science is information about our world and universe that is gathered in a very specific manner. You have learned that scientists have numerous techniques for getting that information. Journals and investigations are parts of science. Science skills require observing, measuring, comparing, and analyzing what you have observed. Pseudoscience, or false science, is information that has not gone through a tested process. Newspaper or magazine articles may be pseudoscience. Sometimes advertisements are pseudoscience. A cereal that claims to be “the best” for your body because it has more vitamins might not have been scientifically tested. It is very important to be sure that when someone makes a “scientific” claim that you know whether it is science or pseudoscience.

Directions: Read the two paragraphs below, and then answer the questions on the lines provided.

“Evan noticed that hummingbirds came to drink from the red flowers in his front yard. He thought that hummingbirds must like only red flowers. He watched them for five days. Every day hummingbirds came to drink from the red flowers. He told his teacher and family members that hummingbirds like only red flowers.”

“Shaniqua noticed that hummingbirds came to drink from the red flowers in her front yard. She wondered if hummingbirds liked only red flowers. For five days she placed some yellow, pink and blue flowers near the red ones. She wrote down in her journal what she observed. Out of 87 visits the hummingbirds made to the flowers, the hummingbirds went to the red flowers 72 times. She told her teacher and family members that hummingbirds preferred red flowers.”

1. Which student had a scientific result to tell family members?

2. Was Evan’s conclusion science or pseudoscience? Explain your answer.

3. How could Evan have worded his statement to make it correct?

4. What two important things did Shaniqua do to support her statement?

5. Can you think of something Shaniqua did not consider in her study?
One of the most widespread myths about science and scientists is the idea that experiments and good data can prove a hypothesis. The fact is a hypothesis can never be proven. No scientific piece of information has ever been proven to be correct. You might think that lots of things have been proven scientifically. Have we not proven that Earth revolves around the Sun? While this is a very well-supported idea, according to the scientific method it has not been proven.

**How many can you watch?**

Consider the following scientific study. Suppose you observed that honeybees seem to fly only during the day and not when it is dark. You write a hypothesis that says that honeybees fly only during the day. You set up a well-constructed experiment that lasts for 20 years. Every day for 20 years you note that the honeybees fly only during the day. You never once observed them flying at night. It might seem that you have proven your hypothesis. But have you really? Have you looked at every honeybee in your state? In your country? On the planet? Have you watched every honeybee that was ever born? No, of course not. That would be impossible.

What you have done in examining your results is use a special field of mathematics called statistics. Statistics provides mathematical ways of explaining scientific observations. For example, suppose in your experiment you watched 40 bee hives. In statistics this would be called a sample since it represents only a small portion of the whole population of bees on Earth. You can infer from your sample that all bees will behave the same way, but you can't be positively sure. What if one bee, on the other side of the world, flew out of its hive to search for flowers at night? You never saw it, but it might have happened.

**What If?**

Science must allow for the possibility that something exists which might disprove a hypothesis, or it is not good science. What if some day, far in the future, a giant asteroid knocks Earth out of its orbit? Earth will no longer rotate around the Sun. Our hypothesis that Earth revolves around the Sun would be wrong. Hopefully, that will never happen. But the possibility does exist. It is the possibilities of things happening that prevent us from proving anything. But it is also the possibilities that make science challenging and exciting.

1. Why can scientists never prove their findings?

________________________________________________________________________

2. In scientific experiments, why are samples used?

________________________________________________________________________

3. Write down one thing you thought was a proven fact. Then write one thing to consider that might disprove your fact.

________________________________________________________________________
Telemetry is an automated communication process that people use in industry, medicine, oceanography, meteorology, wildlife biology, and broadcast journalism. Data are collected at remote or inaccessible locations, such as the ocean floor, and transmitted to receiving equipment. Receiving equipment can perform a variety of functions. It might monitor the data, display it, record it, or perform all three functions.

The first telemetry system was installed in an electric power office in Chicago in 1912. The system used telephone lines to transmit data to tell workers in the office how well electric power plants were operating. Because such systems were used to monitor performance, they were called supervisory systems.

Modern Telemetry

By the 1960s, scientists developed a telemetry system that required a signal before it would transmit its information. Today, this system is used throughout the world to monitor oil pipelines. Oceanographers use it also to record salinity, water temperature, and surface meteorological information from all the oceans of the world.

Radiosonde

In the 1930s, aerospace telemetry was developed to be used with a balloon-borne system called the radiosonde. From about 50,000 m up in the atmosphere, the radiosonde measures meteorological data. Using radio waves, it sends information, such as temperature, barometric pressure, and humidity to receivers on Earth. Nearly all aerospace telemetry systems that are used in space rely on computers to analyze the large amount of data they collect.

Radio telemetry, also called aerospace telemetry, has proven to be flexible and worthwhile in a variety of areas. It can transmit data from inside internal combustion engines and steam turbines. Microminiature transmitters can be surgically implanted or swallowed by patients to monitor a specific condition or function in the body. In wildlife biology, scientists attach transmitters to animals to learn more about the individual’s habitat, territorial boundaries, den locations, and even predator-prey interactions. This information can provide insight about whole groups of animals. Grizzly bears were among the first animals that biologists studied using radio telemetry for a very nontechnological reason: they were strong enough to carry those early transmitters, which were large and weighed about one kilogram. Technology has advanced since then. More recent projects have tracked mammals with transmitters weighing less than 30 g.

Advances in Telemetry

In more advanced radio telemetry, satellites receive an initial signal, then transmit it to the main receiver. This is how television and radio stations can broadcast live from locations around the world. Wildlife biologists also use this newer technology. In the old system, the scientist had to be in the field, rather close to the animal. But now, using satellite transmitters, a biologist can track animal migration routes that are hundreds and even thousands of kilometers long, without ever leaving the office. Manatees, whales, and cranes are just a few of the animals that have been studied using satellite telemetry.

1. List three ways that telemetry plays a role in people’s lives.

2. What are the advantages of satellite telemetry over the original radio telemetry?
Section 1  What is science?

A. Science—a way or a process used to investigate what is happening around you
   1. Scientists observe, investigate, and ____________ to find answers.
   2. Scientists also use prior ____________ to predict what will occur in investigations.
   3. ____________ is the application of science to make products or tools that people can use.

B. Communication in science
   1. Thousands of scientific ____________ and magazines report the results and conclusions of experiments every year.
   2. You can also keep scientific data and results in a ____________ Journal.

Section 2  Doing Science

A. Scientific methods—ways, or steps to follow, to ______________

B. Descriptive research—answering a scientific question by making ____________ about the question
   1. State the research ____________.
   2. Describe the ____________, or how you will carry out your investigation.
   3. Eliminate ____________, or expected results.
   4. Select the best ____________ for the investigation.
      a. A ____________ represents things that happen too slowly, too quickly, or are too big, small, dangerous or expensive to observe directly.
      b. Scientists around the world use a system of measurements called the ____________ to make observations.
   5. Design data ____________, or ways to accurately record results and observations.
   6. Analyze your ____________ and figure out what your results mean.
   7. Draw ____________.
C. Experimental research design—answering a scientific question by observation of a

1. Form a hypothesis, which is a __________ that can be tested.
2. Plan the __________.
   a. Independent variable—the factor in the experiment that is __________
   b. Dependent variable—the factor in the experiment that is being _________
   c. Constants—variables that stay the ________
3. Use a control—a sample that is treated like the other experimental groups except that the __________ variable is not applied to it.
4. Conduct several __________ of the experiment.
5. __________ your results and draw conclusions.

Section 3 Science and Technology

A. Scientific discoveries lead to new products that influence your __________.
   1. Entertainment
   2. Convenience
   3. Health

B. Science provides __________ that people use to make decisions.

C. However, science cannot decide whether the new information is ________ or _________, moral or immoral.
Assessment
Part A. Vocabulary Review

Directions: Write the correct term in the spaces beside each definition. The boxed letters should spell the words that describe the most important scientific tool.

1. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

2. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

3. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

4. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

5. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

6. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

7. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

8. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

9. ______ ______ ______ ______ ______ ______ ______ ______ ______ ______

1. use of knowledge to make products or tools
2. a prediction or statement that can be tested
3. SI is used for this purpose
4. sample treated like other experimental groups except no variable is used
5. sample taken without bias
6. a factor in an experiment that can change
7. a way or a process to investigate what is happening around us
8. way to organize and record results and observations
9. The boxed letters spell: _________________________________

Part B. Concept Review

1. Number these steps for doing an experiment in the correct order in the blanks provided.

_______ a. Test your hypothesis. _________ d. Form a hypothesis.

_______ b. Analyze your data. _________ e. Communicate your results.

_______ c. Recognize the problem. _________ f. Draw conclusions.
Chapter Review (continued)

Directions: Correctly complete each sentence by underlining the best of the three choices in parentheses.

2. Scientists use (observations, experiments, observations and experiments) to find answers to questions.

3. In today's society, there is/are usually (only one, a pair of, several) scientist[s] working on a problem at one time.

4. (Making a detailed plan, Making a model, Identifying the problem) is the first step a scientist would take to solve a problem.

5. Modern (communications technologies, satellite tracking systems, DVDs) have led to a globalization of science.

6. Information about new scientific discoveries is (limited to scientists, available to people in the United States, available to people worldwide).

Directions: Answer the following questions on the lines provided.


8. What are some ways that data can be recorded in a science journal?
Transparency Activities
These students are exploring the natural world. By making and recording careful observations, the students can learn about this aquatic ecosystem.

1. How are these students working together as they explore?
2. Do you act like a scientist in your everyday life? How?
Cookies are a tasty treat to bite into. Have you ever changed a recipe to try and make it better? That’s what Charlie is doing. He’s adding more butter because he thinks the cookies will taste better.

1. How is Charlie’s changing the recipe similar to a scientific experiment? What, specifically, did Charlie change?

2. How will Charlie tell if his experiment is a success?
Yes, but can it walk the dog?

In 1970, Congress passed the Occupational Safety and Health Act (OSHA). This act encouraged the use of automation, a technology that includes robots.

1. What are some advantages of using robots in factories such as the one shown?
2. What are some disadvantages?
Scientific Method

1. Form a Hypothesis!
2. Test your hypothesis
3. Analyze your data
4. Draw conclusions
5. Recognize the problem

Recognize the problem
Teaching Transparency Activity (continued)

1. How is the information on the transparency helpful to use when investigating a topic or problem?

2. Why is it important to list what you already know about a problem?

3. After you state your hypothesis, what should you do next?

4. Before drawing a conclusion, what should be done after analyzing the data collected from your experiment?

5. What are some different ways you could share what you learned with others?
Directions: Carefully review the table and answer the following questions.

<table>
<thead>
<tr>
<th>Beaker</th>
<th>Mass of water (g)</th>
<th>Temperature of water (°C)</th>
<th>Mass of sugar added (g)</th>
<th>Dissolving time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100</td>
<td>20</td>
<td>10</td>
<td>36</td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>40</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
<td>60</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>D</td>
<td>100</td>
<td>80</td>
<td>10</td>
<td>13</td>
</tr>
</tbody>
</table>

1. About how much faster did the sugar in beaker C dissolve than the sugar in beaker B?
   - A 7 s
   - B 8 s
   - C 13 s
   - D 21 s

2. Based on the data in the table, which variable is being investigated?
   - F the mass of the sugar added
   - G the shape of the container
   - H the temperature of the water
   - J the mass of the water

3. Which hypothesis was probably being tested by collecting these data?
   - A Sugar dissolves easily in water.
   - B Sugar dissolves more quickly when it is in a large amount of water.
   - C Sugar dissolves more slowly when it is in a large amount of water.
   - D Sugar dissolves more quickly when it is in warmer water.