Glencoe Science

Chapter Resources

The Solar System

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

Glencoe

New York, New York Columbus, Ohio Chicago, Illinois Peoria, Illinois Woodland Hills, California

Glencoe Science

Photo Credits

Section Focus Transparency 1: (tr) Bettmann/CORBIS, (tl) Bettmann/CORBIS, (br) Roger Ressmeyer/CORBIS; **Section Focus Transparency 2:** Kazuaki Iwasaki/The Stock Market; **Section Focus Transparency 3:** Calvin J. Hamilton; **Section Focus Transparency 4:** Julian Baum/Science Photo Library/Photo Researchers

Mc Graw Hill Glencoe

The McGraw·Hill Companies

Send all inquiries to:
Glencoe/McGraw-Hill
8787 Orion Place
Columbus, OH 43240-4027

ISBN 0-07-866961-8

Printed in the United States of America.

1 2 3 4 5 6 7 8 9 10 071 09 08 07 06 05 04

Reproducible Student Pages

Reproducible Student Pages

■ Hands-On Activities

■ Meeting Individual Needs

Extension and Intervention

■ Assessment

■ Transparency Activities

Hands-On Activities

Inferring Effects of Gravity

Procedure

1. Suppose you are a crane operator who is sent to Mars to help build a Mars colony.
2. You know that your crane can lift 44,500 N on Earth and Mars, but the gravity on Mars is only 40 percent of Earth's gravity.
3. Determine how much mass your crane could lift on Earth and Mars.

Analysis

1. How can what you have discovered be an advantage over construction on Earth?

2. How might construction advantages change the overall design of the Mars colony?

TRY AT HOME Mini LAB

Modeling Planets

Procedure

1. Research the planets to determine how the sizes of the planets in the solar system compare with each other.
2. Select a scale for the diameter of Earth.
3. Make a model by drawing a circle with this diameter on **paper.**
4. Using Earth's diameter as 1.0 unit, draw each of the other planets to scale.

Data and Observations

Planet	Diameter
1. Mercury	
2. Venus	
3. Earth	
4. Mars	
5. Jupiter	
6. Saturn	
7. Uranus	
8. Neptune	
9. Pluto	

Analysis

1. Which planet is largest?

_____

Which planet is smallest?

_____

2. Which scale diameter did you select for Earth?

_____

Was this a good choice? Why or why not?

_____

_____

Planetary Orbits

Lab Preview

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

1. What does the hand icon mean?

2. What must be changed to produce ellipses of different sizes and shapes?

Planets travel around the sun along fixed paths called orbits. As you construct a model of a planetary orbit, you will observe that the shape of planetary orbits is an ellipse.

Real-World Question

How can you model planetary orbits?

Materials

thumbtacks or pins (2)
cardboard (23 cm × 30 cm)
paper (21.5 cm × 28 cm)
metric ruler
string (25 cm)
pencil

Goals

- **Model** planetary orbits.
- **Calculate** the eccentricity of ellipses.

Safety Precautions

Procedure

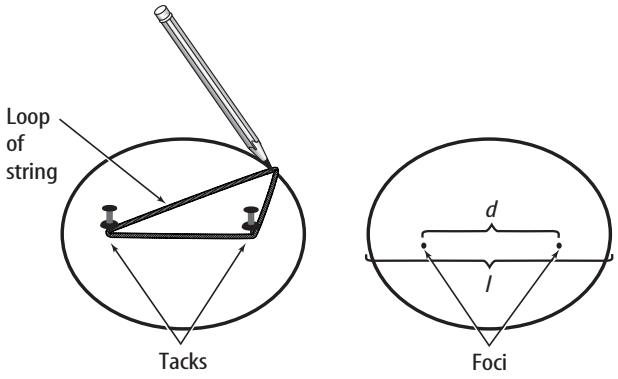
1. Place a blank sheet of paper on top of the cardboard and insert two thumbtacks or pins about 3 cm apart.

2. Tie the string into a circle with a circumference of 15 cm to 20 cm. Loop the string around the thumbtacks. With someone holding the tacks or pins, place your pencil inside the loop and pull it tight.

3. Moving the pencil around the tacks and keeping the string tight, mark a line until you have completed a smooth, closed curve.

4. Repeat steps 1 through 3 several times. First, vary the distance between the tacks, then vary the length of the string. Make a data table to record the changes the sizes and shapes of the ellipses.

5. Orbits usually are described in terms of eccentricity, *e,* which is determined by dividing the distance, *d,* between the foci (fixed points—here, the tacks) by the length, *l,* of the major axis.



6. **Calculate** and record the eccentricity of the ellipses that you constructed.

7. **Research** the eccentricities of planetary orbits. Construct an ellipse with the same eccentricity as Earth's orbit.

LAB (continued)

Data and Observations

Constructed Ellipse	*d* (cm)	*l* (cm)	*e* (d/l)
1. Ellipse A			
2. Ellipse B			
3. Ellipse C			
4. Ellipse D			
5. Ellipse E			
6. Earth's Orbit			

Conclude and Apply

1. **Analyze** the effect that a change in the length of the string or the distance between the tacks has on the shape of the ellipse.

2. **Hypothesize** what must be done to the string or placement of tacks to decrease the eccentricity of a constructed ellipse.

3. **Describe** the shape of Earth's orbit. Where is the sun located within the orbit?

Communicating Your Data

Compare your results with those of other students. **For more help, refer to the Science Skill Handbook.**

Model and Invent

Solar System Distance Model

Lab Preview

Directions: Answer these questions before you begin the Lab.

1. What safety precaution should you take while completing this lab?

2. Would it be a good idea to determine your scale by starting with the planet Mercury and giving it a diameter equal to the width of a sheet of notebook paper? Explain.

Distances between the Sun and the planets of the solar system are large. These large distances can be difficult to visualize.

Real-World Question

Can you design and create a model that will demonstrate the distances in the solar system?

Possible Materials

meterstick
scissors
pencil
string (several meters)
notebook paper (several sheets)

Safety Precautions

Use care when handling scissors.

Goals

- **Design** a table of scale distances and model the distances between and among the Sun and the planets.

Data Source

SCIENCE *Online* Go to the Glencoe Science Web site at **msscience.com** to find information about the distances in the solar system.

Make a Model

1. **List** the steps that you need to take in making your model. Be specific, describing exactly what you will do at each step.
2. **List** the materials that you will need to complete your model.
3. **Describe** the calculations that you will use to get scale distances from the Sun for all nine planets.
4. **Make a table** of scale distances you will use in your model. Show your calculations in your table.
5. **Write** a description of how you will build your model, explaining how it will demonstrate relative distances between and among the Sun and planets of the solar system.

Test Your Model

1. **Compare** your scale distances with those of other students. Discuss why each of you chose the scale you did.
2. Make sure your teacher approves your plan before you start.
3. **Construct** the model using your scale distances.
4. While constructing the model, write any observations that you or other members of your group make, and complete the data table in your Science Journal. Calculate the scale distances that would be used in your model if 1 AU = 2 m.

LAB (continued)

Data and Observations

Planet	Distance to Sun (km)	Distance to Sun (AU)	Scale Distance	Scale Distance (1 AU = 2 m)
1. Mercury	5.97×10^7	0.39		
2. Venus	1.08×10^8	0.72		
3. Earth	1.50×10^8	1.00		
4. Mars	2.28×10^8	1.52		
5. Jupiter	7.78×10^8	5.20		
6. Saturn	1.43×10^9	9.54		
7. Uranus	2.87×10^9	19.19		
8. Neptune	4.50×10^9	30.07		
9. Pluto	5.92×10^9	39.48		

Analyze and Your Data

1. **Explain** how a scale distance is determined.

2. Was it possible to work with your scale? Explain why or why not.

3. How much string would be required to construct a model with a scale distance of 1 AU = 2 m?

4. Proxima Centauri, the closest star to the Sun, is about 270,000 AU from the Sun. Based on your scale, how much string would you need to place this star on your model?

Conclude and Apply

1. **Summarize** your observations about distances in the solar system. How are distances between the inner planets different from distances between the outer planets?
2. Using your scale distances, determine which planet orbits closest to Earth. Which planet's orbit is second closest?

Communicating Your Data

Compare your scale models with those of other students. Discuss any differences.
For more help refer to the Science Skill Handbook.

LAB 1 Laboratory Activity

Venus—The Greenhouse Effect

Because Venus is closer to the Sun, it receives almost twice the amount of solar radiation received by Earth. However, because of its clouds Venus reflects more radiation in to space than does Earth. We might expect Venus, therefore, to have surface temperatures similar to Earth's. However, the Pioneer vehicles to Venus have measured surface temperatures of 460°C. Some scientists explain this high temperature as the "greenhouse effect." When the solar energy strikes the surface of Venus, the energy is absorbed and changed into heat energy. This heat energy is reflected back to the atmosphere where it is trapped.

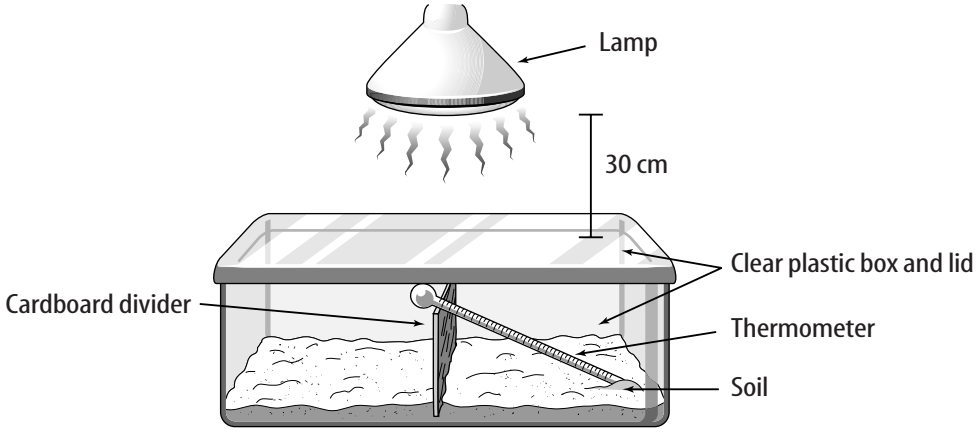
Strategy

You will build a model to show the greenhouse effect.
You will compare this model to Earth.
You will form a hypothesis about temperatures on Venus using data collected from this model and from the *Pioneer* spacecraft.

Materials

soil
clear plastic storage box and lid
cardboard (stiff)
thermometer
heat lamp (mounted)
watch
graph paper
pencils (colored)

Figure 1



Procedure

1. Place about 3 cm of soil in the bottom of the clear plastic box.
2. Thoroughly moisten the soil with water.
3. Cut the piece of cardboard so that it makes a divider for the box. The cardboard should not quite reach the top of the box. Insert the divider into the box.
4. Lean the thermometer against the divider with the bulb end up. (See Figure 1) Put the lid on the box.
5. Position the box and lamp in an area of the room where no direct sunlight reaches. **WARNING:** *Use care handling heat lamp.*
6. Place the heat lamp about 30 cm above the box and direct the light so it shines on the thermometer bulb.
7. Turn off the lamp and allow the thermometer to return to room temperature. Record room temperature under Data and Observations.
8. Turn on the lamp and measure the temperature every minute for 20 min. Record the temperatures in Table 1.
9. Turn off the lamp and allow the thermometer to return to room temperature. Remoisten the soil and repeat step 8 without the lid. Record your data in Table 1.

Laboratory Activity 1 (continued)

Data and Observations

Room temperature: _____

Table 1

Time (min)	Temperature (°C) Lid On	Lid Off
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

On a separate piece of paper, graph the data using two different colors. Plot Temperature on the vertical axis and Time on the horizontal axis.

Laboratory Activity 1 (continued)

Questions and Conclusions

1. Did the temperature increase the most with the lid on or off? Why?

2. Draw a diagram of Earth showing its atmosphere and what occurs due to solar radiation in the atmosphere. List the components of Earth's atmosphere on your diagram. Write a brief explanation of the greenhouse effect on Earth.

3. Compare the greenhouse effect of the activity to the greenhouse effect on Earth. How are they similar? How are they different?

Laboratory Activity 1 (continued)

4. Venus's atmosphere is composed mainly of carbon dioxide, carbon monoxide, water, nitrogen, and sulfuric acid. Venus's atmosphere is 100 times more dense than Earth's atmosphere. From the surface of Venus up to 20 km, there appears to be a clear region of atmosphere. A thick layer of clouds extends from about 50 km to 80 km above the surface of Venus. These clouds are composed of drops of sulfuric acid. Above and below these clouds are other, thinner layers of haze. Venus's ionosphere extends from 100 km to 200 km above the surface. Like the ionosphere of Earth, it has layers. The temperature in the ionosphere of Venus is cooler than the temperature in Earth's ionosphere.

Draw a diagram of Venus showing its atmosphere and what happens to solar radiation in the atmosphere. List the components of Venus's atmosphere on your diagram. Write a brief explanation of the greenhouse effect on Venus.

5. Compare the greenhouse effect on Earth and Venus. Can you think of a reason why the surface of Venus is so much hotter than the surface of Earth?

Strategy Check

_____ Can you build a model to show the greenhouse effect?

_____ Can you compare this model to Earth?

LAB 2 Laboratory Activity

The Behavior of Comets

One way scientists study the behavior and composition of comets is by observing them as they orbit the Sun. Observations made through telescopes and pictures sent back by space probes have led scientists to believe a comet is a mixture of ice and rock. Heat from the Sun vaporizes some of the comet's ice, which releases bits of rock and dust that form a cloud around the comet. Solar winds blowing on the cloud create the comet's tail. The intensity of the solar wind makes the tail point away from the Sun, no matter which direction the comet is facing. Because the comet is vaporizing when it becomes visible from Earth, each time we see a comet, we are witnessing its deterioration.

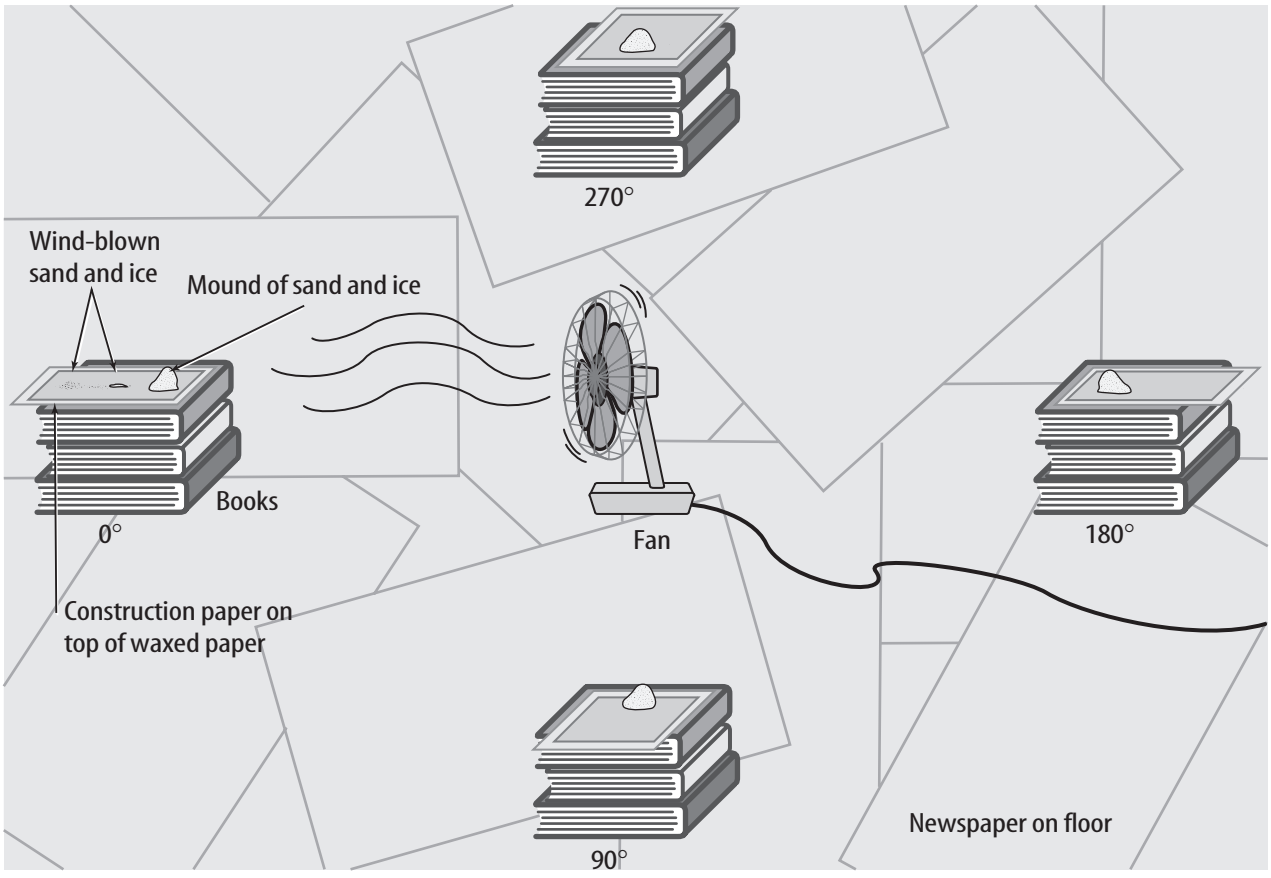
Strategy

You will model and observe the behavior of comets orbiting the Sun.

You will describe the behavior and draw inferences about the life of a comet based on your observations.

Materials

newspaper
small electric fan
books or boxes
waxed paper
ruler
red, green, or blue construction paper (the color should make water drops easy to see)
sand (not dirt)
ice (crushed, not in cubes)



Laboratory Activity 2 (continued)

Procedure

1. Working in groups of four students, place newspaper on your lab table or the floor near an electric outlet. Put the fan in the middle of the newspaper. Place books or boxes at four positions around the fan. The first position should be 0° The next are at 90°, 180°, and 270°. Be sure to cover books with wax paper to protect them against any water spills.
2. Take a piece of colored construction paper about 23 cm × 15 cm and place it with its longer edge away from the fan. Do this for each position. See Figure 1. Then get a small mixture (about a tablespoon) of sand and ice and mound it on the paper at the end nearest the fan. Draw a line on the page around the mound of sand and ice.
3. Have one student carefully turn on the fan at the 0° position and observe the effect the blowing wind has on the ice/sand mixture. Let the fan run for three minutes and then turn it off. Record your observation in the table provided.
4. Turn the fan so that it is pointing to the 90° position and repeat the procedure. Continue until the fan has run on all four positions and then repeat for position 0°. Turn the fan to the 90° position. Carefully turn on the fan one more time. Be sure to record all your observations in the table.
5. When you are finished, take your paper and carefully place it on the ground or tabletop. Try not to move any of the particles as you move the paper. Take your ruler and measure the distance the water drops and sand moved from their original position at the front of the paper. Record these distances in the last column of the table.

Data and Observations

Fan Position (deg.)	Description of Behavior of Ice and Sand	Distance of Particle Distribution (cm)
1. 0°		
2. 90°		
3. 180°		**Water:** **Sand:**
4. 270°		**Water:** **Sand:**
5. 0° Second trial		**Water:** **Sand:**
6. 90° Second trial		**Water:** **Sand:**

Laboratory Activity 2 (continued)

Questions and Conclusions

1. What is one behavior of the ice and sand you observed?

2. How would you explain what you saw?

3. How does this behavior demonstrate the similarities between your experiment and what we observe in a comet orbiting the Sun?

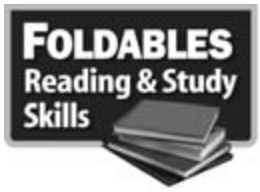
4. Where does the water and dust from a melting comet go?

5. Using your answer from question 4, would you expect a comet to always die out? Explain your answer.

Strategy Check

_____ Can you model the behavior of a comet orbiting the Sun?

_____ Can you describe this behavior based on what you know about the composition of comets?



The Solar System

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

Compare & Contrast

Inner Planets

Outer Planets

Mars

Saturn

Earth

Venus

Neptune

Uranus

Pluto

Jupiter

Mercury

small, rocky planets with iron cores

made mostly of lighter substances

made mostly of rock and ice

four planets closest to the sun

five planets farthest from the sun

most of these planets have rings

most have many moons

have zero, one, or two moons

most have an atmosphere of helium, hydrogen, or methane

most have an atmosphere of mostly carbon-dioxide

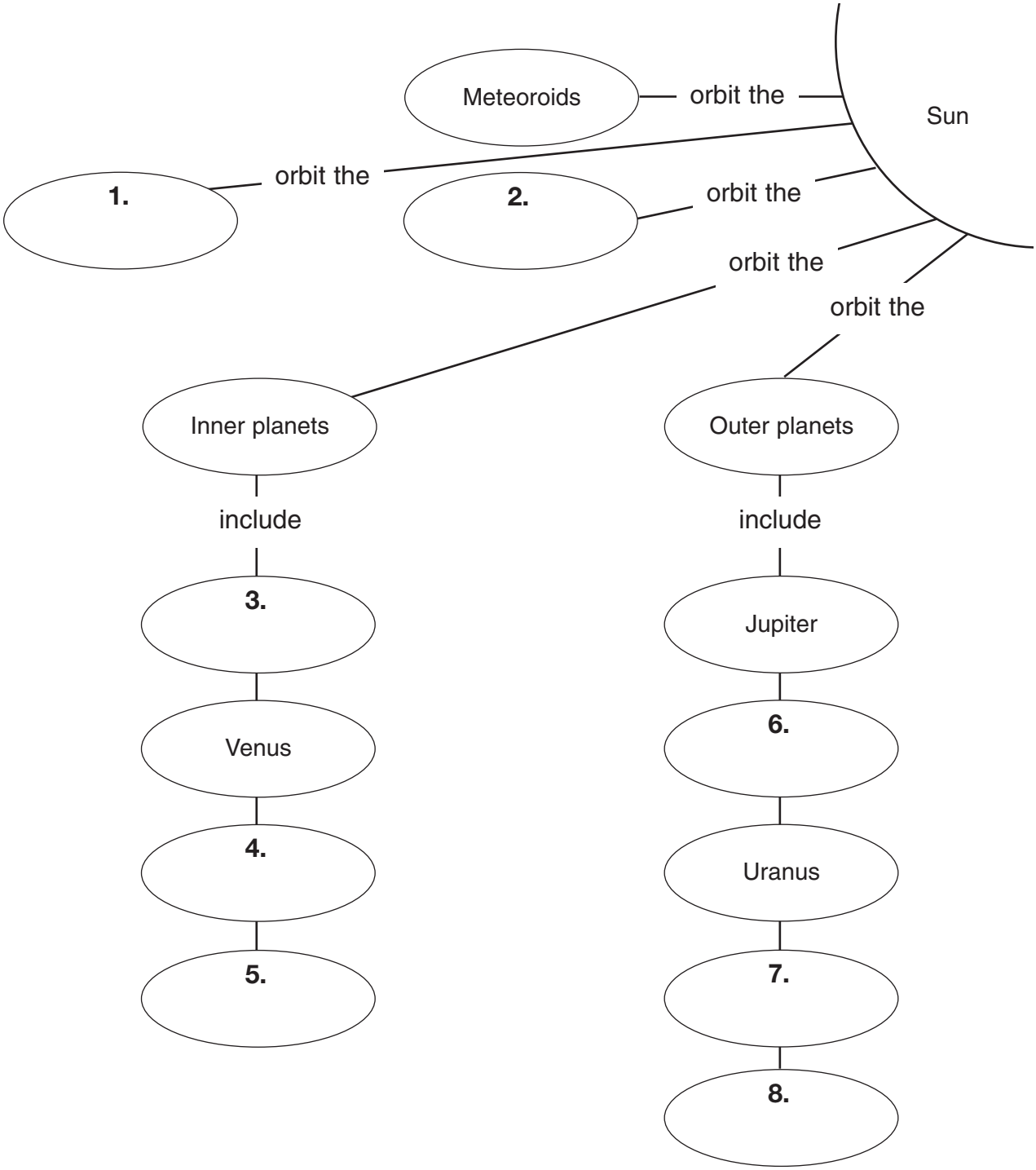
Meeting Individual Needs

Directed Reading for Content Mastery

Overview The Solar System

Directions: *Complete the concept map using the terms in the list below.*

Pluto	**Mars**	**Saturn**	**Mercury**
Asteroids	**Neptune**	**Comets**	**Earth**

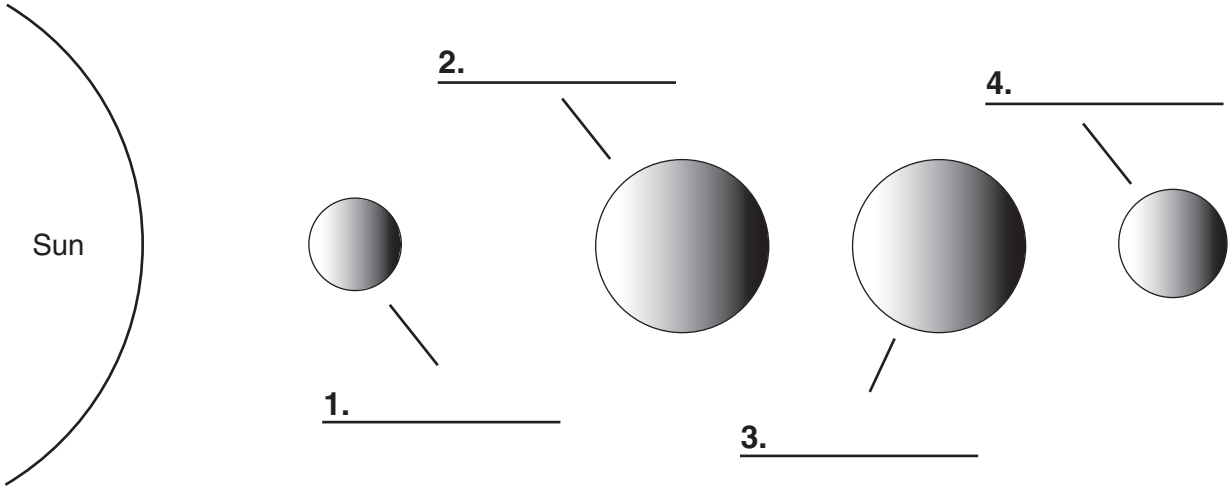


Name Date Class

Directed Reading for Content Mastery

Section 1 - The Solar System
Section 2 - The Inner Planets

Directions: *Study the following diagram. Then identify each inner planet by filling in the blanks.*



Directions: *List the inner planets in order below. Then write two facts about each of them on the lines provided.*

5. Planet: _____

Planet Facts: _____

_____

_____

6. Planet: _____

Planet Facts: _____

_____

_____

7. Planet: _____

Planet Facts: _____

_____

_____

8. Planet: _____

Planet Facts: _____

_____

_____

Meeting Individual Needs

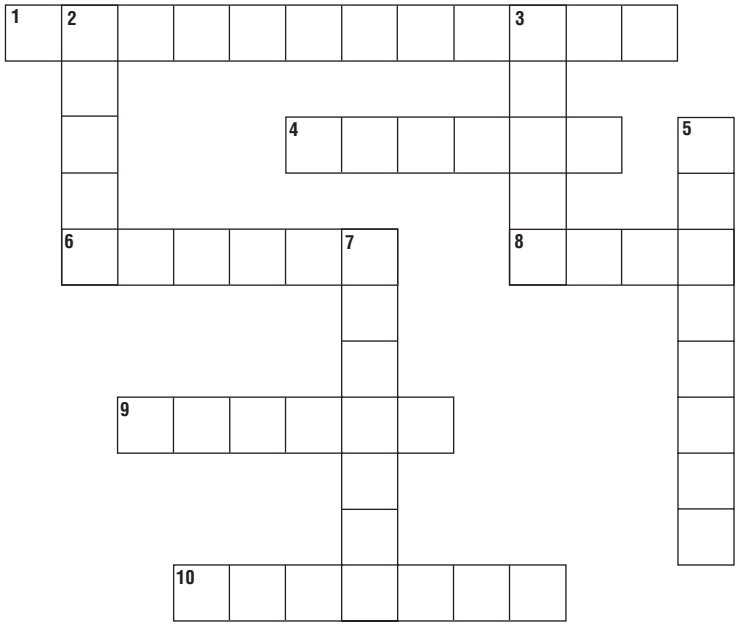
Name Date Class

Directed Reading for Content Mastery

Section 3 ▪ The Outer Planets
Section 4 ▪ Other Objects in the Solar System

Directions: *Use the clues below to complete the crossword puzzle.*

comets	**Saturn**	**Oort**	**rings**	**meteors**
asteroid	**Pluto**	**Neptune**	**Uranus**	**Great Red Spot**



Across

1. Large storm on Jupiter

4. Its axis of rotation is tilted on its side.

6. Sixth planet from the Sun with a complex ring system

8. The _____ Cloud contains many comets.

9. Large dirty snowballs that orbit the Sun

10. Shooting stars

Down

2. Found around Saturn

3. Solar system's smallest planet

5. A piece of rock similar to the material that formed into the planets

7. Its orbit sometimes makes this the farthest planet from the Sun.

Name Date Class

Directed Reading for Content Mastery

Key Terms
The Solar System

Directions: *Complete the following sentences using the terms listed below.*

solar system	**Saturn**	**Mercury**	**comet**	**meteorite**
Neptune	**Venus**	**Pluto**	**Great Red Spot**	**asteroid**
meteor	**Earth**	**Jupiter**	**Mars**	**Uranus**

1. After it hits Earth, a meteoroid is called a(n) _____.
2. The planet _____ is sometimes called Earth's twin.
3. The planet _____ and its moon may be a double planet.
4. The _____ is a giant storm on Jupiter.
5. A(n) _____ is made of dust and rock particles mixed with frozen water, methane, and ammonia.
6. The planet _____ apparently shrank in diameter.
7. The _____ belt lies between the orbits of Mars and Jupiter.
8. The _____ has nine planets.
9. Methane gives _____ its distinctive blue-green color.
10. Because its density is so low, the planet _____ would float in water.
11. The planet _____ is one astronomical unit from the Sun.
12. Io, Europa, Callisto, and Ganymede are all moons of _____.
13. The planet _____ is fourth from the Sun.
14. A meteoroid that burns up in Earth's atmosphere is called a(n) _____.
15. The axis of rotation of _____ is tilted on its side.

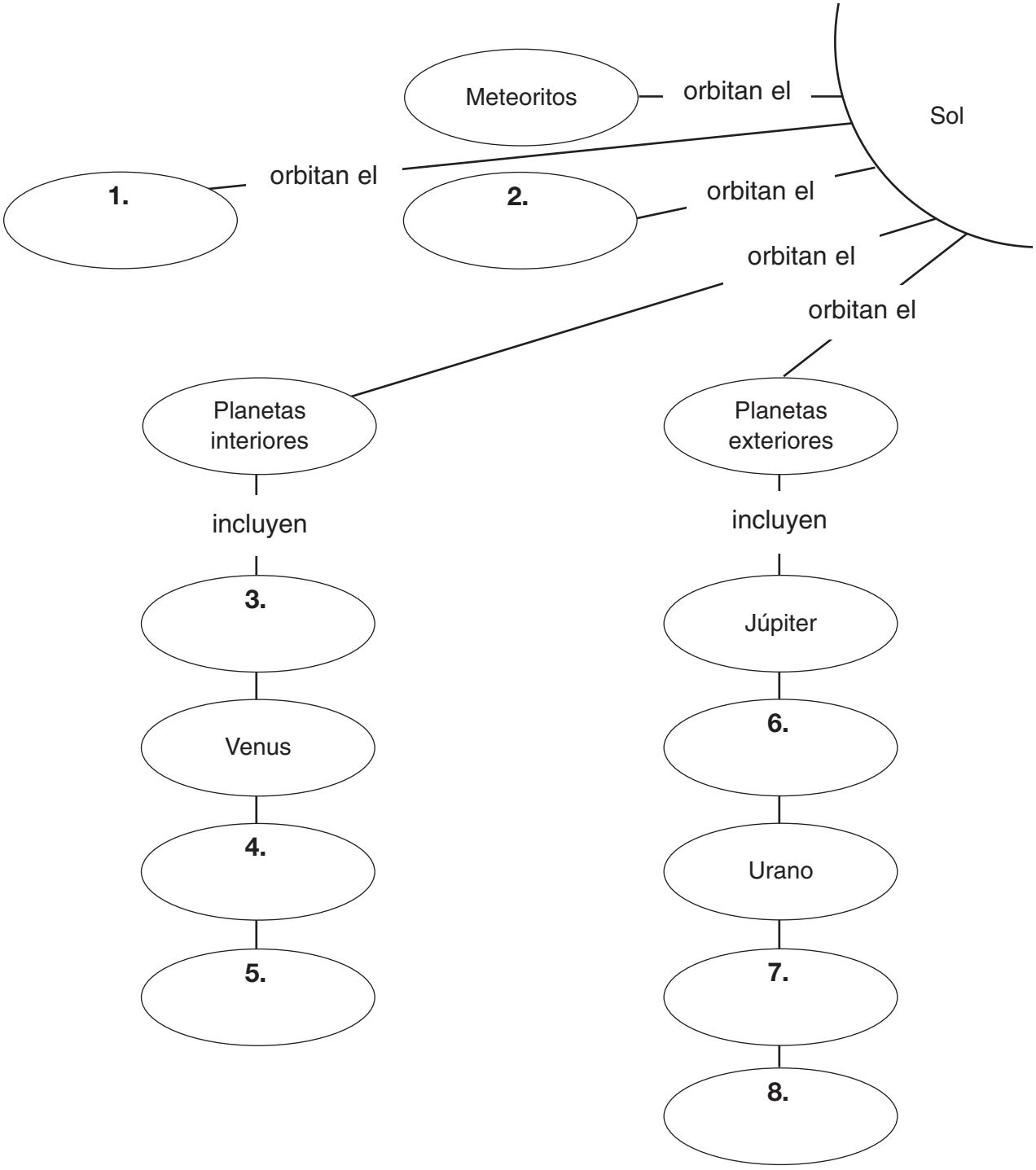
Meeting Individual Needs

Lectura dirigida para Dominio del contenido

Sinopsis
El sistema solar

Instrucciones: *Completa el mapa de conceptos usando los siguientes términos.*

Plutón	**Marte**	**Saturno**	**Mercurio**
asteroides	**Neptuno**	**cometas**	**La Tierra**

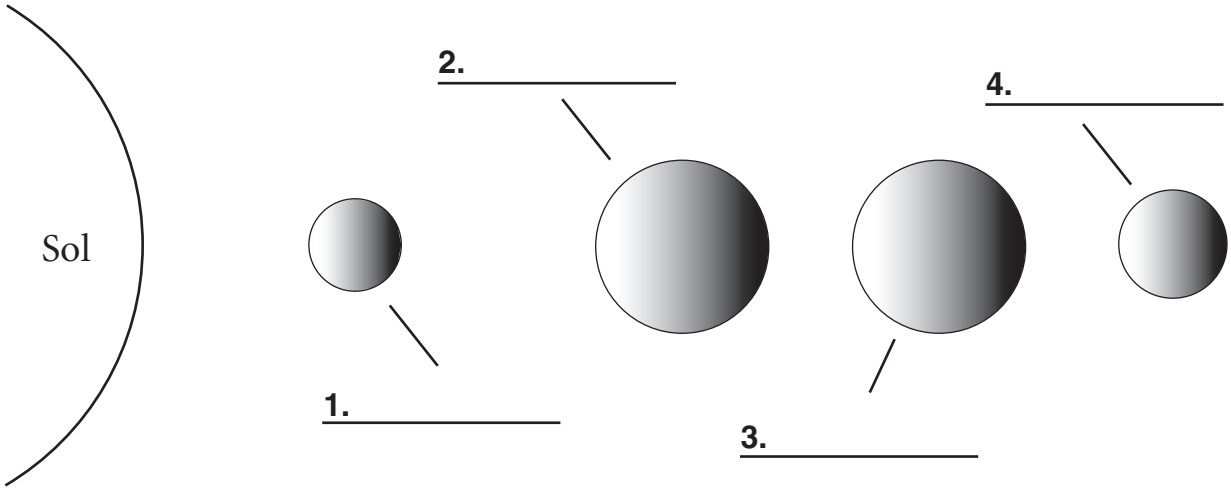


Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

Sección 1 ■ El sistema solar
Sección 2 ■ Los planetas interiores

Instrucciones: *Estudia el siguiente diagrama. Llena los espacios en blanco para identificar cada planeta interior.*



Instrucciones: *Enumera los planetas interiores en orden. Escribe dos hechos sobre cada uno en el espacio que dado.*

5. Planeta: _____

Hechos sobre el planeta: _____

_____

_____

6. Planeta: _____

Hechos sobre el planeta: _____

_____

_____

7. Planeta: _____

Hechos sobre el planeta: _____

_____

_____

8. Planeta: _____

Hechos sobre el planeta: _____

_____

_____

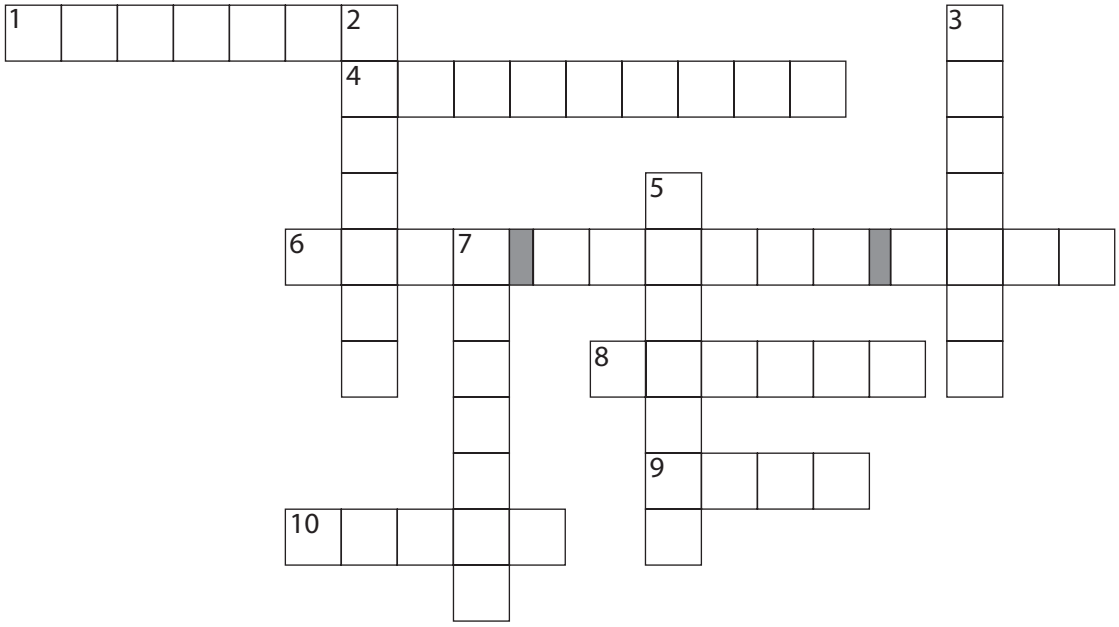
Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

Sección 3 ▪ Los planetas exteriores
Sección 4 ▪ Otros astros en el sistema solar

Instrucciones: *Usa las pistas para completar el siguiente crucigrama..*

cometas **Saturno** **Oort** **anillos** **meteoro**
asteroides **Plutón** **Neptuno** **Urano** **Gran Mancha Roja**



Horizontales

1. Grandes bolas de nieve sucia que giran alrededor del Sol.

4. Trozo de roca de composición similar a la de los planetas.

6. Gran tormenta en Júpiter.

8. Planeta más pequeño del sistema solar.

9. La nube de _____ contiene muchos cometas.

10. Su eje de rotación está inclinado de lado.

Verticales

2. Sexto planeta a partir del Sol, con un sistema complejo de anillos.

3. Estrellas fugaces.

5. Se encuentran alrededor de Saturno.

7. Su órbita lo hace a veces el planeta más alejado del Sol.

Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

Términos claves El sistema solar

Instrucciones: *Completa cada oración con el término correcto de la siguiente lista.*

sistema solar	**Saturno**	**Mercurio**	**cometa**	**meteorito**
Neptuno	**Venus**	**Plutón**	**Gran Mancha Roja**	**asteroides**
meteoro	**la Tierra**	**Júpiter**	**Marte**	**Urano**

1. Después de chocar con la Tierra, un meteoroide se llama _____.
2. El planeta _____ se conoce a veces como el gemelo de la Tierra.
3. El planeta _____ y su luna podrían ser un planeta doble.
4. El(La) _____ es una tormante gigantesca en Júpiter.
5. Un(a)_____ está hecho de polvo y trozos de roca mezclados con agua congelada, metano y amoníaco.
6. El diámetro del planeta_____ parece haberse encogido.
7. El cinturón de_____está entre las órbitas de Marte y Júpiter.
8. El(La) _____tiene nueve planetas.
9. El metano produce el distintivo color verde azulado de_____.
10. Como su densidad es tan baja, el planeta_____ flotaría en agua.
11. El planeta _____está a una unidad astronómica del Sol.
12. Io, Europa, Calisto, y Ganímedes son lunas de_____.
13. El planeta_____ es el cuarto a partir del Sol.
14. Un meteoroide que se quema en la atmósfera de la Tierra es un(a) _____.
15. El eje de rotación de_____está inclinado de lado.

Name Date Class

SECTION 1 Reinforcement

The Solar System

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

1. Name the two models of the solar system and explain the difference between them.

2. State what scientists hypothesize regarding the formation of the Sun and the planets.

3. Name the inner and outer planets and contrast the two groups of planets.

Directions: *In the chart below, list the discoveries about the solar system made by each scientist.*

4. Copernicus	
5. Galileo	
6. Kepler	

Meeting Individual Needs

Name Date Class

SECTION 2 Reinforcement

The Inner Planets

Directions: *Write the names of the inner planets as headings in the chart in the order of their position from the Sun. Then fill in the chart using information from your textbook.*

	1.	2.	3.	4.
Size and composition	5.	6.	7.	8.
Atmosphere	9.	10.	11.	12.
Temperatures	13.	14.	15.	16.
Surface features	17.	18.	19.	20.
Moons (number/ names)			21.	22.
Space probes	23.	24.		25.

Meeting Individual Needs

Name Date Class

SECTION 3 Reinforcement

The Outer Planets

Directions: *List the outer planets across the top of the chart in the order of their usual position from the Sun. Then fill in the chart using information from your textbook.*

	1. (Fifth from Sun)	2. (Sixth from Sun)	3. (Seventh from Sun)	4. (Eighth from Sun)	5. (Ninth from Sun)
Size and composition	6.	7.	8.	9.	10.
Atmosphere	11.	12.	13.	14.	15.
Below the atmosphere	16.	17.	18.	19.	20.
Notable features	21.	22.	23.	24.	25.
Moons (number/ names)	26.	27.	28.	29.	30.
Space probes	31.	32.	33.	34.	

Meeting Individual Needs

Name Date Class

SECTION 4 Reinforcement

Other Objects in the Solar System

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

1. What is the Oort Cloud, and where is it located?

2. What is an asteroid, and where are most asteroids located?

Directions: *Identify Figure 1 and its parts, then answer the question that follows.*

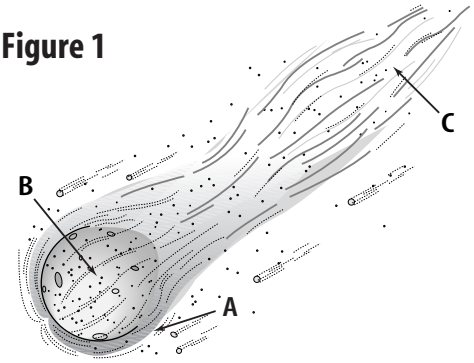
3. Figure 1: _____

A. _____

B. _____

C. _____

Figure 1



4. How does a comet begin and end?

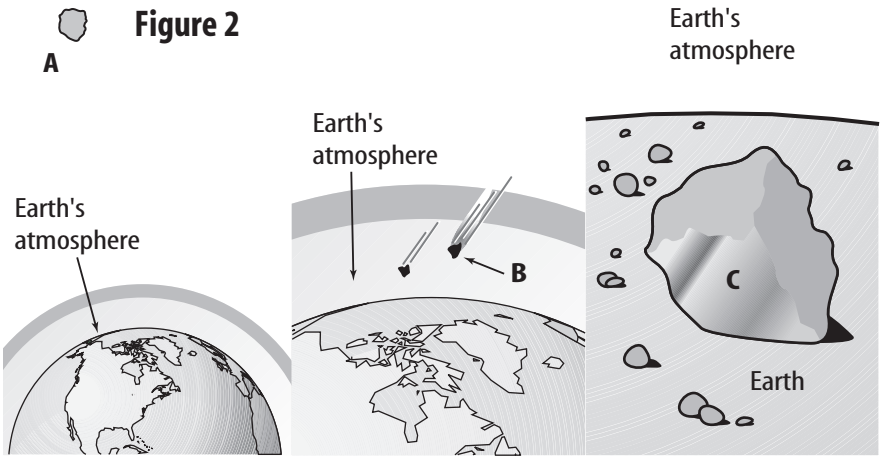
Directions: *Identify the parts of Figure 2, then answer the question that follows.*

5. A. _____

B. _____

C. _____

Figure 2



6. What two space objects produce meteorites?

Meeting Individual Needs

SECTION 1 Enrichment

Discovering New Planets

Five of the planets in our solar system were discovered thousands of years ago. The five are Mercury, Venus Mars, Saturn, and Jupiter. Pluto, Neptune, and Uranus, on the other hand, were discovered within about the last 200 years.

The Discovery of Uranus

The planet Uranus was discovered in 1781 by Sir William Herschel, an astronomer, when he was surveying the night sky through a telescope.

The discovery of Uranus led to the discovery of Neptune. Once Uranus was discovered, astronomers carefully studied everything about it that they could, including its orbit. They found that Uranus didn't follow the orbit they calculated it should follow. The only logical explanation that could account for the different orbit was that gravity from an unseen planet was exerting force on Uranus's orbit. In 1843, astronomer John C. Adams used mathematics to predict where the unseen planet was located. Urbain Leverrier, another astronomer, made the same prediction in 1846. On the basis of Leverrier's prediction, two astronomers in Germany located Neptune through a telescope.

The Discovery of Pluto

The ninth planet, Pluto, was discovered in 1905, when astronomer Percival Lowell determined that something must be causing irregularities in the orbits of both Uranus and Neptune. And he believed that the "something" was a planet. He predicted where this planet would be but was never able to find it. In 1930, astronomer Clyde Tombaugh, with the help of a powerful telescope, photographed the part of the sky where Lowell said the planet would be. He was able to capture a picture of Pluto on film, thus proving its existence. Interestingly, as it turned out, astronomers now think that Pluto is too small to account for the irregularities in the orbits of Uranus and Neptune.

A Tenth Planet?

Is there a tenth planet? Some astronomers hypothesize that a tenth planet—Planet X—may exist beyond Neptune. The existence of Planet X would explain the irregularities in Uranus' and Neptune's orbits. Most astronomers, however, think that Planet X does not exist. They argue that the orbits of Uranus and Neptune would be more strongly affected if there were a tenth planet. Furthermore, for an object to influence the orbits of Uranus and Neptune it would have to be big and dense enough to be visible to astronomers.

1. Why were only five of the planets discovered by the 1700's?

_____

2. What invention made it possible to discover Uranus?

_____

3. Why do you think Uranus and Neptune were discovered before Pluto?

_____

_____

4. What do astronomers now believe about Pluto's affecting Uranus's and Neptune's orbits?

_____

_____

Meeting Individual Needs

SECTION 2 Enrichment

Exploring the Inner Planets

Ancient Romans named the planet Mercury after the swift messenger of their gods. Soon, a new U.S. probe called *MESSENGER* will be heading for Mercury. The National Aeronautics and Space Administration (NASA) and the Jet Propulsion Laboratory (JPL) are sending the probe to Mercury in the year 2004. *MESSENGER* stands for MErcury Surface, Space, ENvironment, GEochemistry and Ranging mission. Its mission is to become a satellite of Mercury and send back information about the nature of the planet.

Some of the questions scientists have about Mercury come from the limited knowledge we already have. These are some of the answers MESSENGER is designed to provide.

Questions About Mercury

1. Mercury is very dense, but how did it get to be so dense?
2. It has a crust with many craters on it, but what is the structure of the crust and what is it made of?
3. It has a thin atmosphere, but what is in the atmosphere?
4. It has polar caps made of ice, but how do the caps freeze so near the Sun?
5. It has a magnetic field, but is this because it has a liquid outer core?

Another remarkable feature of the expedition is that the energy for the flight will come from using the gravitational pull of Earth and Venus to launch the probe like a sling-shot toward Mercury. This means *MESSENGER* can be built to be very light-weight since it will not carry much fuel. The probe will also investigate Venus. It will constantly send back a variety of signals, including radio and digital signals that will give us color pictures of the planets.

The following is the schedule for the mission:

- Launch dates: March 23–August 6, 2004
- Venus flybys: October 25, 2006; June 6, 2007 (the probe will orbit Venus)
- Mercury flybys: January 15, 2008; (2) October 6, 2008
- Mercury orbit and insertion: September 30, 2009

1. Approximately how long will it take the *MESSENGER* probe to get to Mercury? _____
2. Once it has reached Mercury, what is it supposed to do?

_____

_____

3. What are two questions scientists hope to answer from this probe?

_____

_____

_____

4. How will the probe get most of its traveling energy?

_____

_____

SECTION 3 Enrichment

Europa

Europa is the fourth largest of Jupiter's 17 moons. It is slightly smaller than our own Moon. The *Voyager* missions sent back pictures of Jupiter's satellites, and only Europa was distinctly odd. Instead of the cratered and impacted surfaces of the other moons, Europa has a smooth surface. This puzzled scientists until images from the *Galileo* probe showed a finely cracked outer layer that looks very much like ice.

Ice and Possibility of Life

The idea that Europa may be covered with ice has excited scientists from many fields. They have hypothesized that the ice may be floating on an ocean, which has led them to the idea that life may exist on Europa. The scientists think that where there is an ocean, there exists a possibility of finding living organisms.

The hypothesis that the finely cracked outer layer of this moon is a layer of ice floating on an ocean also provides a possible explanation of how the cracks, called flexi cracks, were formed. The hypothesis is based on Europa's orbit varying between two other large moons. These moons cause tides to occur on Europa, just as the Moon's gravitational force moves tides back and forth on Earth. In this hypothesis, the water in Europa's ocean would rise and fall, bending and breaking the surface ice in the observed pattern of flexi cracks.

Volcanic Activity

A second hypothesis about Europa leads scientists to consider the possibility of life on that moon. This hypothesis concerns volcanic activity. Europa is an inner moon of Jupiter and, because of the strong gravitational pull of the planet, it is believed to be volcanically active. Its sister moon, Io, has had many volcanic eruptions photographed by the *Voyager* and *Galileo* probes. If the inner core of Europa is molten, it is possible that the surface may be warmed by hydrothermal vents. On Earth we have found many types of life forms thriving in the dark near hydrothermal vents. NASA's Project Neptune is developing technologies for ocean observation which may one day be used to explore Europa.

1. What evidence suggests water may be present on Europa?

2. Why would signs of volcanism be important to find?

3. How might flexi cracks be formed?

SECTION 4 Enrichment

New Information from an Old Comet

Halley's comet was observed as early as 239 B.C. Since the first record of its appearance, the comet has been a great mystery. In 1986, the European Space Agency (representing a number of countries in Europe), the then Soviet Union, and Japan sent space probes to get a closer look at Halley's comet. These probes provided us with startling new information about the comet.

The most exciting new information was the detail of the comet's elongated, peanut-shaped nucleus. Scientists think the comet has a nucleus composed of some combination of rock and ice. It measures 15 km × 8 km × 8 km and contains several shallow craters. Each crater is about 1 km in diameter. Halley's comet's mass is 1017 g. It has an average density of about 09.3 g/cm^3. The nucleus is covered with a layer of dust which retains heat. Each large dust grain is thought to consist of many tiny particles with spaces in between. Some of these spaces are filled with ice, and others are empty. When Halley's comet is closest to the Sun, temperatures can rise to about 77°C.

On the side of the comet facing the Sun, ice changes to water vapor. Jets of water vapor with dust particles spray from the comet. Near the Sun, several tons of gas and dust are emitted each second in the jets. Halley's comet nears Earth every 76 years and will be visible again in 2061.

1. Why do we have new information about Halley's comet?

2. What countries sent space probes to investigate Halley's comet?

3. What is the shape of the nucleus?

4. Calculate the volume of the nucleus.

5. What and where are the jets?

6. Name an object with the same diameter as a crater on Halley's comet's nucleus, or name something as long as the diameter of a crater.

7. Describe what you think you would see if you could stand on the sunward side of Halley's comet.

Name Date Class

Note-taking Worksheet

The Solar System

Section 1 The Solar System

A. Ideas about the night sky have _____ over time.

1. _____-centered model—early Greeks thought planets, Sun, Moon, and stars rotated around Earth.

2. _____-centered model—Nicholas Copernicus and Galileo Galilei observed that the Moon revolved around Earth and that Earth and the other planets revolved around the Sun.

3. _____ view—_____ _____ includes Sun, nine planets, many small objects, and a huge volume of space.

a. Sun is the _____ of the solar system

b. All other objects in the solar system _____ around the Sun.

B. How the _____ system formed

1. A _____ of gas, ice, and dust slowly formed

2. A cloud of material in the nebula slowly _____ in space.

3. Shock waves might have caused the cloud to _____, and the matter was squeezed into less space.

4. The cloud became more _____, rotated faster, heated up, and flattened to form a disk

5. As the cloud contracted, it grew warmer, triggering a _____ fusion reaction that created the Sun.

6. The leftover _____ became the planets and asteroids.

a. First four _____ planets—small and rocky with iron cores

b. Last five _____ planets—large and lightweight except for Pluto

C. Planet _____

1. Copernicus—planets had _____ orbits around the Sun.

2. Johannes Kepler—German mathematician

a. Discovered that the planet orbits were _____ and that the Sun was not directly in the center of the orbits

b. Determined that planets do not orbit the Sun at the same _____

Meeting Individual Needs

Note-taking Worksheet (continued)

Section 2 The Inner Planets

A. _____—closest to the Sun, second-smallest planet

1. Weak magnetic field suggests an _____

2. Has many _____ and high cliffs

3. No true _____, so surface temperatures range from very hot to very cold

B. _____—second from the Sun and similar to Earth in size and mass

1. Extremely dense _____ of clouds

2. _____ gas traps solar energy.

a. Causes an intense _____ effect

b. Results in surface _____ between 450°C and 475°C

C. _____—third planet from the Sun

1. Average distance between Earth and the Sun is _____ million km

2. _____ exists on surface as solid, liquid, and gas.

3. More than _____ percent of surface covered with water

4. _____ protects surface from most meteors and Sun's radiation

D. _____—fourth planet from the Sun

1. Called _____ _____ because iron oxide in rocks makes them reddish-yellow

2. Polar ice caps made mostly of frozen carbon dioxide and frozen _____

3. Has largest _____ in the solar system

4. Soil shows _____ evidence of life.

5. Has gullies and deposits of soil and rocks, which may indicate the presence of liquid _____

6. Thin atmosphere of mostly _____

7. Strong _____ caused by differences in temperature between day and night

8. Is tilted on its axis, which causes _____

9. Two small _____: Phobos and Deimos

Note-taking Worksheet (continued)

Section 3 The Outer Planets

A. _____—fifth planet from the Sun, largest planet in the solar system

1. _____— primarily hydrogen and helium

a. Below atmosphere, _____ hydrogen and helium are suspected.

b. Solid rocky _____ may exist below liquid level.

c. The _____ is the most spectacular of Jupiter's many constant high-pressure gas storms.

2. Has at least 61 _____—four are relatively large and have atmospheres

a. _____—is very volcanically active; the closest large moon to Jupiter

b. _____—composed mostly of rock; may have an ocean of water under a thick layer of ice

c. _____—largest moon in solar system, even larger than planet Mercury

d. _____—cratered rock and ice crust may surround a salty ocean and rock core

B. _____—sixth planet from the Sun, second largest in the solar system, lowest density

1. Thick outer _____ of hydrogen, helium, ammonia, methane, and water vapor

2. Might have a small, rocky _____

3. Each large _____ composed of thousands of ringlets of ice and rock particles

4. Has at least 31 _____

a. Largest moon, _____, is larger than the planet Mercury.

b. Thick _____ on Titan prevent scientists from seeing surface.

C. _____—seventh planet from the Sun, large and gaseous

1. Has thin, dark _____

2. _____ of hydrogen, helium, and methane

3. Methane makes the planet _____ in color.

4. Axis of rotation nearly _____ to plane of orbit

D. _____—usually the eighth planet from the Sun, large and gaseous

1. Bluish-green-colored _____ similar to that of Uranus

2. Storms on Neptune reveal an _____ and rapidly changing atmosphere

3. Has at least eleven _____, of which pinkish Triton is largest

Note-taking Worksheet (continued)

E. _____—usually the ninth planet from the Sun, occasionally closer to the Sun than Neptune, smallest planet in the solar system

1. Has a thin _____ and a solid, rocky surface
2. Discovered in 1978, _____ Charon is half the planet's size.
3. *Hubble Space Telescope* reveals group of icy _____ named Kuiper Belt beyond Neptune's orbit.

Section 4 Other Objects in the Solar System

A. _____—dust and rock particles combined with frozen water, methane, and ammonia

1. _____ comet orbits the Sun every 76 years.
2. _____—large group of comets surrounding solar system beyond Pluto
3. Amateur astronomers discovered Comet _____ in 1995
4. Comet structure—large _____ of frozen rock and ice
   - **a.** Ice and dust _____ as comet nears Sun.
   - **b.** Vaporized material forms bright cloud called _____ around comet nucleus.
   - **c.** Solar wind pushes on gas and dust in the coma, causing the particles to form a tail that always points away from the _____.
   - **d.** Eventually, most of the ice in the comet's nucleus vaporizes, leaving only small _____.

B. Small pieces of the old comet's nucleus

1. _____—name given to small pieces of comet when they move through space
2. _____—small meteoroid that burns up in Earth's atmosphere
3. _____—occur when Earth's orbit passes through a group of meteoroids that enter the atmosphere
4. _____—meteoroid that strikes Earth

C. _____—rock similar to that which formed planets

1. Most asteroids lie in an asteroid belt located between _____ and _____.
2. Jupiter's gravity may have kept these asteroids from forming a _____.
3. Some _____ moons may be asteroids pulled from the asteroid belt.
4. Asteroid sizes range from very tiny to _____ in diameter.
5. The *Near Earth Asteroid Rendezvous* probe indicates _____ 433 Eros has been in many collisions over time.

Assessment

Chapter Review

The Solar System

Part A. Vocabulary Review

Directions: *If a statement is true, write* **true** *in the blank. If a statement is false, change the italicized term to make the statement true, and write the new term in the blank.*

_____ **1.** A *meteor* is a meteoroid that burns up in Earth's atmosphere.

_____ **2.** A *meteoroid* is composed of dust, rock particles, and frozen gases and has a nucleus, coma, and tail.

_____ **3.** The heavily cratered planet closest to the Sun is *Pluto*.

_____ **4.** On the third planet from the Sun, *Mars*, water exists as a solid, liquid, and gas.

_____ **5.** The Martian atmosphere is much *thinner* than Earth's.

_____ **6.** The largest gaseous planet, *Saturn*, has 61 moons.

_____ **7.** A belt of *meteoroids* (small, planetlike fragments) lies between the inner planets and outer planets.

_____ **8.** A gaseous planet with thin, dark rings and 21 satellites is *Neptune*.

_____ **9.** *Meteorites* are small pieces of dust and rock moving in space.

_____ **10.** The Sun and all objects orbiting it make up the *solar system*.

_____ **11.** A large, gaseous planet with the lowest density and 31 moons is *Saturn*.

_____ **12.** The second planet from the Sun, which has moonlike phases and a surface heat of over 450°C caused by the greenhouse effect, is *Mercury*.

_____ **13.** An *astronomical unit* is the average distance between Earth and the Sun.

_____ **14.** A *comet* is a meteoroid that strikes Earth.

_____ **15.** The reddish-yellow planet that has polar ice caps and is the fourth planet from the Sun is *Jupiter*.

_____ **16.** A large, blue-green, gaseous planet similar to Uranus is *Neptune*.

_____ **17.** A large, swirling gas storm on Jupiter is the *Io*.

_____ **18.** The *outer planets* are Mars, Earth, Venus, and Mercury.

_____ **19.** Usually the outermost planet of the solar system is *Neptune*.

_____ **20.** The *inner planets* are Pluto, Uranus, Neptune, Saturn, and Jupiter.

Chapter Review (continued)

Part B. Concept Review

Directions: *Answer the questions on the lines provided.*

1. Compare and contrast Venus and Earth.

2. Compare and contrast Pluto with the other outer planets.

3. State the hypothesis about how the solar system was formed.

4. Describe the origin and structure of a comet.

5. List evidence that large amounts of water were once present on Mars.

6. What is unique about Uranus?

7. List three discoveries made by the *Voyager* space probes.

Transparency Activities

Name Date Class

SECTION 1 Section Focus Transparency Activity

Far Out

How far has the study of the solar system come? In the early 1600s, Galileo Galilei developed telescopes for astronomical observations. Almost four hundred years later, the United States sent the Galileo space probe to Jupiter!

1. **Before the telescope was developed, how did people study planets?**
2. **Why did NASA name its Jupiter space probe after Galileo?**
3. **Why did it take more than six years for the Galileo probe to get into orbit around Jupiter?**

Name Date Class

SECTION 2 Section Focus Transparency Activity

Really Far Out

When you see images of Earth from space, it's fun to try to pick out the United States and the area where you live. But where does Earth live? This NASA image is of our galaxy, which is called the Milky Way. Our entire solar system is just a tiny part of the Milky Way.

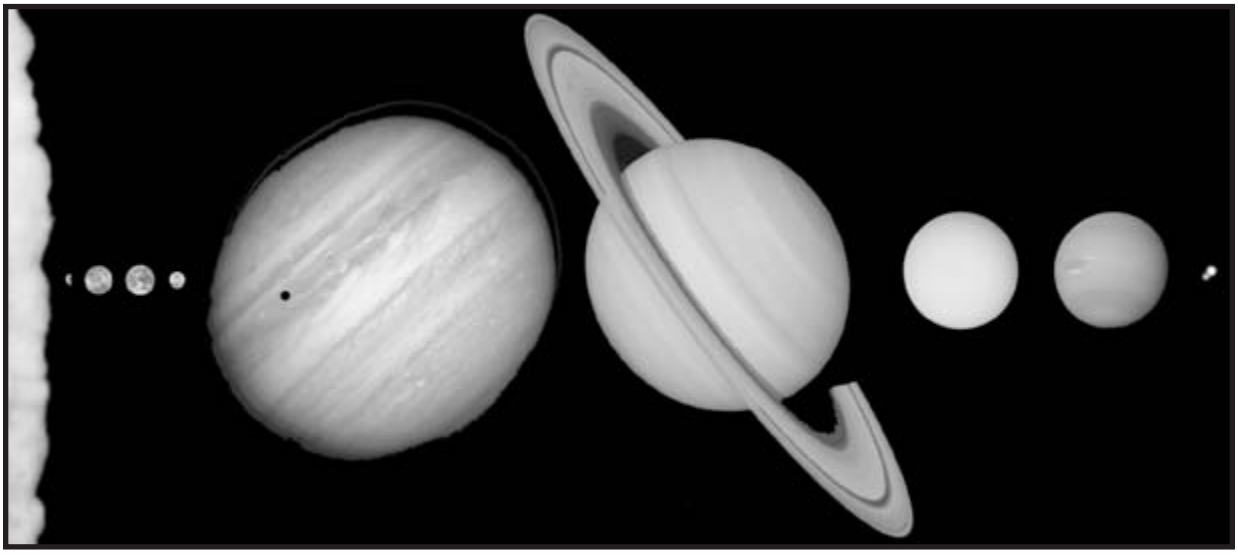
1. **How might other planets in the solar system be studied?**
2. **What characteristics of our environment nurture life on Earth?**
3. **Why might it be difficult to study Mercury, the planet closest to the Sun?**

Name Date Class

SECTION 3 Section Focus Transparency Activity

Relative Dimensions

This image was designed to show the relative sizes of the planets in our solar system. The Sun is so huge that only its rim fits on the left side of the image. The nine planets are presented in order from Mercury to Pluto.



1. **What's the very first thing you notice about the four planets closest to the Sun compared to the outer planets?**
2. **Which planet is an exception to this observation?**
3. **What do you think the small black spot on Jupiter is? Which planet is the black spot closest to in size?**

SECTION 4 Section Focus Transparency Activity

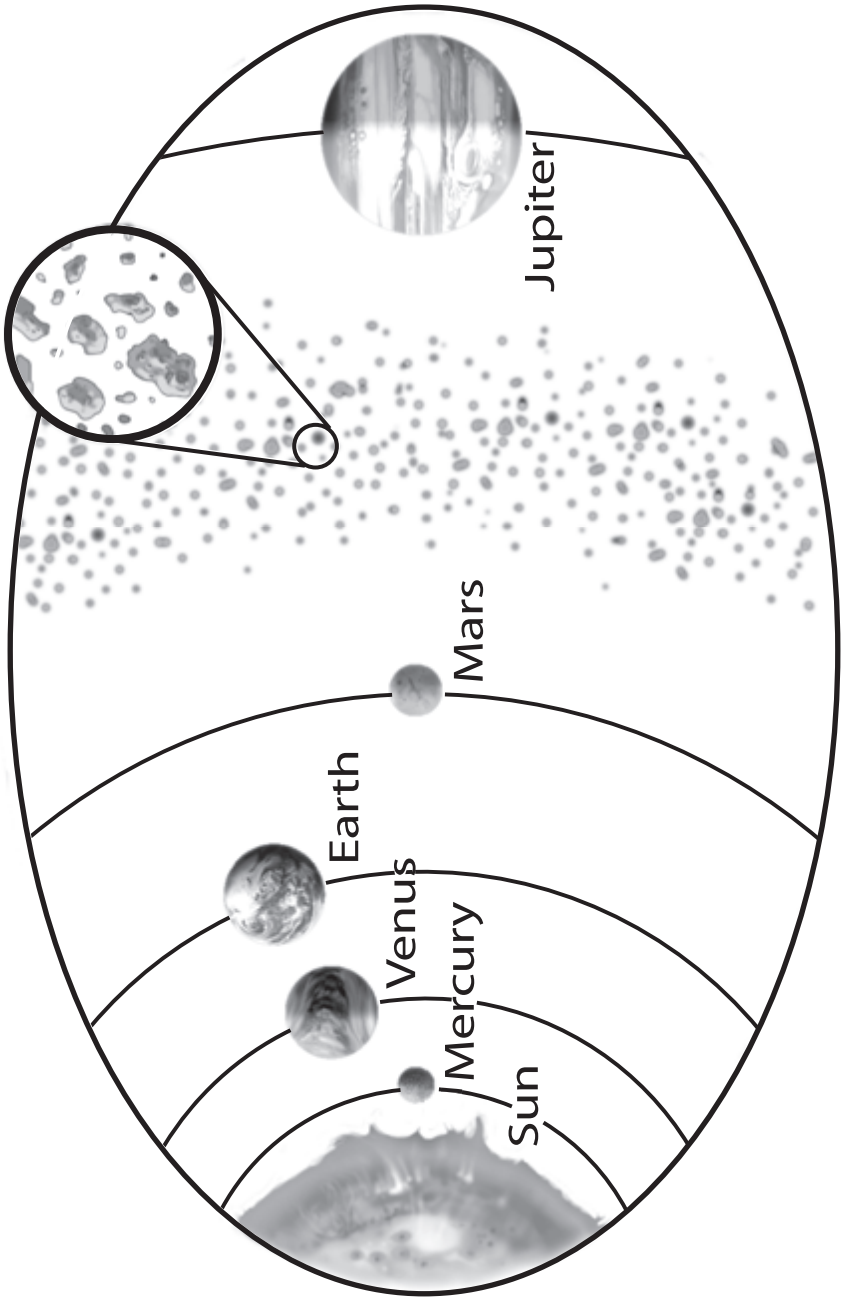
We Don't Even Live There Yet!

Since the start of the space age in 1957, human-generated debris have been accumulating in orbit around Earth. Space junk ranges in size from tiny flecks of paint to dead satellites and burned-out rocket stages.

1. **What might happen to junk that falls out of orbit and into Earth's atmosphere?**
2. **Is debris left on the Moon as great a potential problem as debris in orbit? Explain.**
3. **How does space junk pose a threat to orbiting satellites?**

SECTION 4 Teaching Transparency Activity

Asteroid Belt



Teaching Transparency Activity (continued)

1. What lies between the orbits of Mars and Jupiter?

2. What is the largest planet in the solar system?

3. Name the inner planets.

4. How are the inner planets alike?

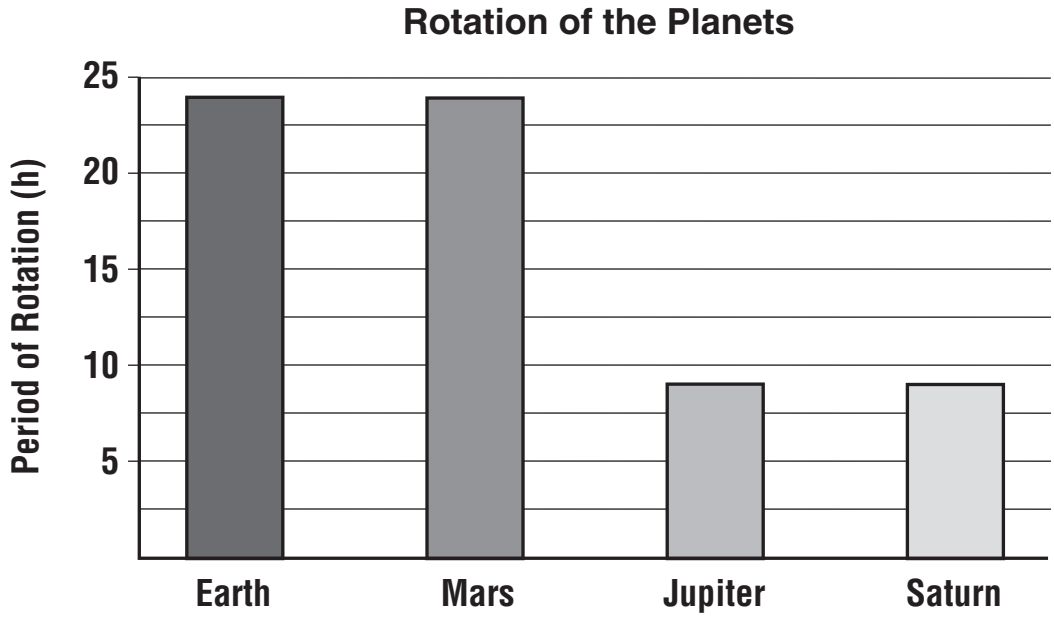
5. What is the largest object in the solar system?

6. From the diagram, which two planets are most alike in size?

Assessment Transparency Activity

The Solar System

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



1. Which two planets have the same period of rotation?

A Earth and Saturn
B Mars and Jupiter
C Earth and Jupiter
D Jupiter and Saturn

2. Which of the following is caused by the rotation of Earth on its axis?

F The change between day and night
G The changing of the seasons
H The changing of the phases of the moon
J The movement of water downhill

3. The period of rotation of a planet is the time it takes to ___.

A travel around the Sun
B spin once on its axis
C travel around Earth
D complete one change of season