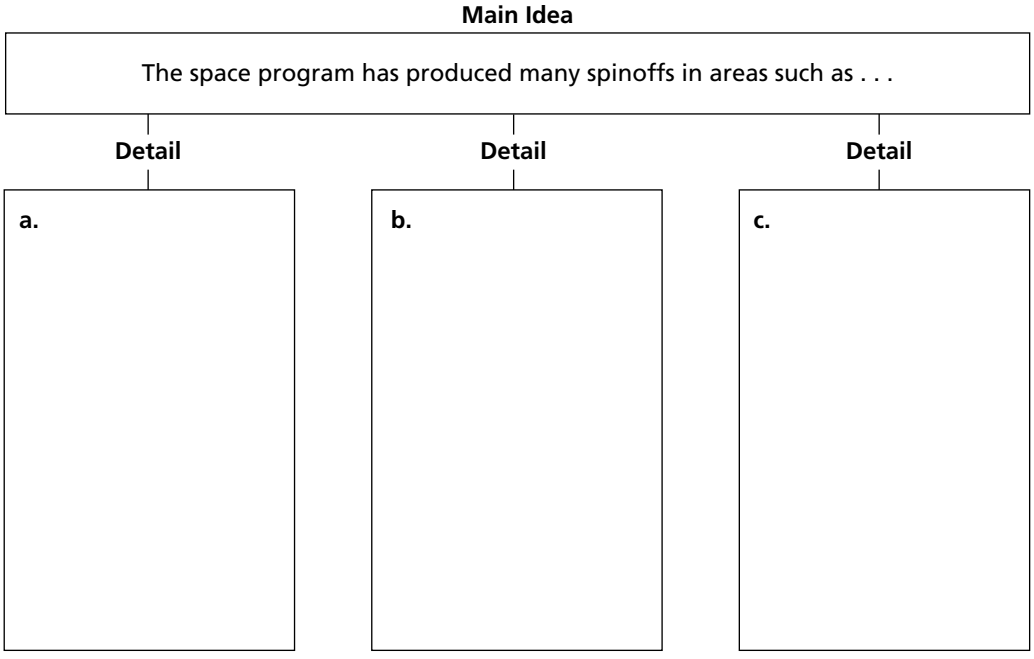
Name _____ Date _____ Class _____

Using Space Science on Earth

This section describes how conditions in space differ from those on Earth, the benefits of space technology for society, and the uses of satellites orbiting Earth.

Use Target Reading Skills

As you read about space spinoffs, fill in the detail boxes that explain the main idea in the graphic organizer below.



The Challenges of Space

1. List three conditions in space that differ from those on Earth.

   a. _____

   b. _____

   c. _____

2. A place that is empty of all matter is a(n) _____.

3. Is the following statement true or false? In space, temperatures are extreme because there is no air. _____

4. **a.** Why does an astronaut experience weightlessness in space?

   _____

   _____

   _____

   b. What is this condition called?

   _____

Using Space Science on Earth *(continued)*

Space Spinoffs

5. An item that has uses on Earth but was developed for space is called a(n) _____.

6. What are three examples of medical spinoffs from the space program?

a. _____

b. _____

c. _____

Match the materials or devices used in space with the item in which they are used on Earth.

Used in Space	Used on Earth
____ **7.** Batteries for space power systems	**a.** athletic shoes
____ **8.** Lightweight spacecraft components	**b.** tennis rackets
____ **9.** Astronauts' moon boots	**c.** video games
____ **10.** Insulation against radiation	**d.** pacemakers
____ **11.** Lunar rover operation	**e.** insulation for houses

Satellites

12. Name three ways that satellites are used for communications.

a. _____

_____

b. _____

_____

c. _____

_____

13. What does it mean for a satellite to be in geosynchronous orbit?

_____

_____

14. Circle the letter of each sentence that is true about satellites.

a. Most communications satellites are placed in a geosynchronous orbit.
b. In remote sensing, a satellite must directly contact Earth.
c. Satellites can collect data on conditions above, at, and below Earth's surface.
d. Satellites are being replaced by computers that produce images from data.

Name _____ Date _____ Class _____

Using Space Science on Earth

Guide for Reading

- How are the conditions in space different from those on Earth?
- How has space technology benefited modern society?
- What are some uses of satellites orbiting Earth?

Astronauts who are launched into space face conditions that are very different from those on Earth. **Conditions in space that differ from those on Earth include the near vacuum of space, temperature extremes, and microgravity.** Space is nearly a vacuum. A **vacuum** is a place that is empty of all matter. Except for a few stray molecules, most of space is empty.

Astronauts in orbit feel weightlessness because they are falling through space together with the spacecraft. Scientists call this condition **microgravity.** Long periods of microgravity can cause health problems for astronauts. Scientists are trying to discover how to reduce or reverse the effects of microgravity on humans.

Many types of engineers and scientists have worked together to develop many new materials and devices for use in space. Many of these items have proven useful on Earth as well. An item that has uses on Earth but was originally developed for use in space is called a **space spinoff.** Often spinoffs are modified somewhat for use on Earth. **The space program has produced thousands of products that affect many aspects of modern society, including consumer products, new materials, medical devices, and communications satellites.**

Today, hundreds of satellites are in orbit around Earth solely for the purpose of relaying television and other signals from one part of the planet to another. **Satellites are used for communications and for collecting weather data and other scientific data.** Observation satellites are used for many purposes, including tracking weather systems, mapping Earth's surface, and observing changes in Earth's environment. Observation satellites collect data through **remote sensing,** which is acquiring information about Earth's surface without being in direct contact with it. Satellites are placed in different orbits, depending on their purpose. Most communications satellites are placed in a **geosynchronous orbit,** in which the satellite orbits Earth at the same rate that Earth rotates and thus stays over the same place on Earth all the time.

Name _____ Date _____ Class _____

Using Space Science on Earth

Answer the following questions in the spaces provided.

Understanding Main Ideas

1. Name three conditions in space that are different from those on Earth.

_____

_____

2. Many types of engineers and scientists worked together to respond to the challenges of living in space. Name three ways they have dealt with those challenges.

_____

_____

3. Name a space spinoff for each category.

Medical _____

Material _____

Consumer _____

4. How do people experience the benefits of satellites?

_____

_____

5. Name three ways in which observation satellites are used.

_____

_____

Building Vocabulary

Write a definition for the following terms on the lines below.

6. geosynchronous orbit _____

_____

7. remote sensing _____

_____

8. vacuum _____

_____

9. microgravity _____

_____

10. space spinoff _____

_____

Name _____ Date _____ Class _____

Geosynchronous Orbits and Polar Orbits

When a satellite is in a geosynchronous orbit, its speed is such that it seems to hang over one spot on Earth. All satellites in geosynchronous orbits are about 36,000 kilometers above Earth's surface. But a satellite's speed and altitude aren't the only requirements for geosynchronous orbit—the satellite must also be in orbit over the equator.

Another kind of orbit is called a *polar* orbit. This is an orbit that passes over both the North Pole and the South Pole.

On the map below, draw a line to represent the path a satellite in a low polar orbit might take as it passes over the United States. An easy way to do this is to start with your pencil on the **X** (a place in Canada) and begin to move it straight south (down) to represent the direction of movement of the satellite. At the same time, move the paper to the east (right) to represent the motion of Earth. Your result will be a line moving from northeast to southwest. You can see that it is the combination of the satellite's motion and Earth's rotation that determines the path a satellite in polar orbit takes over Earth.

Answer the following questions on a separate sheet of paper.

1. A satellite in a polar orbit traces a curved path over the surface of Earth. Explain why.
2. Why does a geosynchronous satellite *not* trace a path over the surface of Earth?
3. Suppose that the satellite in polar orbit whose path you drew takes two hours to complete one orbit. After two hours, Earth will have rotated two hours to the east, and the satellite will be passing over the place represented by the **Y** on the map. About where will it be in two more hours?
4. How often would the satellite in question 3 pass over the same point on Earth?
5. Television signals cannot pass through Earth. If you wanted to launch a satellite that would be used to transmit television images from the United States to Europe 24 hours a day, would you put it into a geosynchronous orbit or a polar orbit? Explain.
6. If you wanted to launch a satellite that could take photographs of the entire surface of Earth, what kind of orbit would you put it in? Explain.

Name _____ Date _____ Class _____

Space Spinoffs

Problem

Which blanket protects better against heat loss?

Skills Focus

graphing, drawing conclusions

Materials

1 foil blanket piece
1 cloth blanket piece
3 thermometers
1 beaker, 600 mL
ice
3 identical small test tubes
hot water
3 identical large test tubes
cotton balls
cellophane tape or rubber bands
tap water

Procedure

1. Use the data table on the next page to record your observations.
2. Wrap the outside of one small test tube with the foil blanket piece. Wrap a second small test tube with the cloth blanket piece. Use tape or rubber bands to secure the blankets. Leave the third small test tube unwrapped.
3. Fill each of the three small test tubes half full with hot water. Be sure to use the same volume of water in each test tube. Insert a thermometer into each small test tube. Use cotton to "seal" the top of the small test tube and to hold the thermometer in place. Then, insert each small test tube into a larger test tube.
4. Put ice in the beaker, and fill the beaker two-thirds of the way with water.
5. Put the large test tubes into the ice water. Do not let water enter the test tubes. Record the starting temperatures of all three thermometers.
6. Allow the test tubes to sit in the ice water bath for about 10 minutes. Note the temperature of each thermometer every minute and record the results in your data table.

Space Spinoffs *(continued)*

Data Table

Time (minutes)	Temperature (°C)		
	Foil-Wrapped Thermometer	Cloth-Wrapped Thermometer	Unwrapped Thermometer

Analyze and Conclude

Write your answers on a separate sheet of paper.

1. **Graphing** Graph the temperature over time for each of the thermometers.
2. **Calculating** Calculate the difference between the starting and ending temperatures of each thermometer. Which thermometer was best protected against heat loss?
3. **Controlling Variables** What was the purpose of the third, unwrapped, small test tube?
4. **Interpreting Data** Which type of blanket protects better against heat loss? Explain.
5. **Communicating** Write an advertisement for the blanket that proved to be the best insulator. In the ad, describe the test procedures you used to justify your claim. Also explain why this blanket would benefit consumers.

Design an Experiment

The activity you just completed tested how well different materials protected against the loss of heat. Design an experiment that would test how well the same blankets would protect against an increase in heat. Obtain your teacher's approval before conducting your experiment.