Maps and globes are models of Earth.

BEFORE, you learned

- The Earth system has four main parts: atmosphere, hydrosphere, biosphere, and geosphere
- Technology is used to study and map the Earth system
- The Earth system’s parts interact to shape Earth’s surface

NOW, you will learn

- What information maps can provide about natural and human-made features
- How to find exact locations on Earth
- Why all maps distort Earth’s surface

KEY CONCEPT
Maps and globes are models of Earth.

Maps show natural and human-made features.

Have you ever drawn a map to help someone get to your home? If so, your map is actually a rough model of your neighborhood, showing important streets and landmarks. Any map you use is a flat model of Earth’s surface, showing Earth’s features as seen from above.

On the other hand, a globe represents Earth as if you were looking at it from outer space. A globe is a sphere that shows the relative sizes and shapes of Earth’s land features and waters.

In this section you will learn how maps and globes provide different types of information about Earth’s surface. They can show everything from city streets to land features to the entire world.

Checking Your Reading: How are maps and globes alike? How are they different?
Relief Map of United States

Mountains appear as ripples on relief maps. Brown colors represent areas high above sea level.

Plateaus are mostly level and are near mountain ranges. They often stand high above sea level.

Plains show little relief on the map. Dark green represents areas at sea level. Lighter greens represent areas up to or above sea level.

Land Features on Maps

When scientists or travelers want to know what the landscape of an area actually looks like, they will often use a relief map. A relief map, such as the one above, shows how high or low each feature is on Earth. A mapmaker uses photographs or satellite images to build a three-dimensional view of Earth’s surface. A relief map shows three main types of land features: mountains, plains, and plateaus.

Mountains stand higher than the land around them. A mountain’s base may cover several square kilometers. A group of mountains is called a mountain range. Mountain ranges connected in a long chain form a mountain belt. The Rocky Mountains in the United States are part of a huge mountain belt that includes the Canadian Rockies and the Andes Mountains in South America.

Plateaus have fairly level surfaces but stand high above sea level. Plateaus are often found near large mountain ranges. In the United States, the Colorado Plateau is about 3350 meters (11,000 ft) above sea level. This plateau includes parts of Arizona, Colorado, New Mexico, and Utah.

Plains are gently rolling or flat features. The United States has two types of plains—coastal plains near the eastern and southeastern shores, and interior plains in the center of the nation. The interior Great Plains cover the middle third of the United States.

How is a plateau different from either a mountain or a plain?
Scale and Symbols on Maps

The maps most people use are road and city maps like the ones above. These maps provide information about human-made features as well as some natural features. To use these maps, you need to know how to read a map scale and a map legend, or key.

1. A **map scale** relates distances on a map to actual distances on Earth’s surface. Notice that on the map of southern Florida above, the scale is in kilometers and miles. On the Miami Beach map, the scale is in meters and yards. The smaller the area a map shows, the more detail it includes.

   The scale can be expressed as a ratio, a bar, or equivalent units of distance. For example, a ratio of 1:25,000 means that 1 centimeter on the map represents 25,000 centimeters (0.25 kilometer) on Earth.

2. A **map legend**, also called a key, is a chart that explains the meaning of each symbol used on a map. Symbols can stand for highways, parks, and other features. The legend on the Miami Beach map shows major points of interest for tourists.

3. A map usually includes a compass rose to show which directions are north, south, east, and west. In general, north on a map points to the top of the page.

**Three Types of Map Scale**

<table>
<thead>
<tr>
<th>Type</th>
<th>Representation</th>
</tr>
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<tbody>
<tr>
<td>Ratio</td>
<td>1:25,000</td>
</tr>
<tr>
<td>Bar scale</td>
<td>0 1 2 3 km</td>
</tr>
<tr>
<td>Equivalent-units scale</td>
<td>1 cm = 1 km</td>
</tr>
</tbody>
</table>

**Reading Tip**

As used here, *legend* does not refer to a story. It is based on the Latin word *legenda*, which means “to be read.”

**CHECK YOUR READING**

What information do map scales and map legends provide?
Latitude and longitude show locations on Earth.

Suppose you were lucky enough to find dinosaur bones in the desert. Would you know how to find that exact spot again? You would if you knew the longitude and latitude of the place. Latitude and longitude lines form an imaginary grid over the entire surface of Earth. This grid provides everyone with the same tools for navigation. Using latitude and longitude, you can locate any place on the planet.

Latitude

Latitude is based on an imaginary line that circles Earth halfway between the north and south poles. This line is called the equator, and it divides Earth into northern and southern hemispheres. A hemisphere is one half of a sphere.

Latitude is a distance in degrees north or south of the equator, which is 0°. A degree is 1/360 of the distance around a full circle. If you start at one point on the equator and travel all the way around the world back to that point, you have traveled 360 degrees.

The illustration below shows that latitude lines are parallel to the equator and are evenly spaced between the equator and the poles. Also, latitude lines are always labeled north or south of the equator to

<table>
<thead>
<tr>
<th>Image Description</th>
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<tbody>
<tr>
<td><strong>Equator</strong> divides Earth into northern and southern hemispheres.</td>
</tr>
<tr>
<td><strong>Prime Meridian</strong> divides Earth into eastern and western hemispheres.</td>
</tr>
<tr>
<td><strong>Latitude</strong> is a distance in degrees north or south of the equator.</td>
</tr>
<tr>
<td><strong>Longitude</strong> is a distance in degrees east or west of the prime meridian.</td>
</tr>
<tr>
<td>You can find a location by noting where latitude and longitude lines cross.</td>
</tr>
</tbody>
</table>

What are the approximate latitudes and longitudes of Cairo, Egypt, and Paris, France?
show whether a location is in the northern or southern hemisphere. For instance, the North Pole is 90° north, or 90°N, while the South Pole is 90° south, or 90°S. Latitude, however, is only half of what you need to locate any spot on Earth. You also need to know its longitude.

**Longitude**

Longitude is based on an imaginary line that stretches from the North Pole through Greenwich, England, to the South Pole. This line is called the **prime meridian**. Any place up to 180° west of the prime meridian is in the Western Hemisphere. Any place up to 180° east of the prime meridian is in the Eastern Hemisphere.

**Longitude** is a distance in degrees east or west of the prime meridian, which is 0°. Beginning at the prime meridian, longitude lines are numbered 0° to 180° west and 0° to 180° east.

Longitude lines are labeled east or west to indicate whether a location is in the eastern or western hemisphere. For example, the longitude of Washington, D.C., is about 78° west, or 78°W. The city of Hamburg, Germany, is about 10° east, or 10°E. If you understand latitude and longitude, you can find any spot on Earth’s surface.

**Global Positioning System**

The Global Positioning System (GPS) is a network of satellites that are used to find the latitude, longitude, and elevation, or height above sea level, of any site. Twenty-four GPS satellites circle Earth and send signals that are picked up by receivers on the surface. At least three satellites need to be above the horizon for GPS to work. A computer inside a receiver uses the satellite signals to calculate the user’s exact location—latitude, longitude, and elevation. GPS is an accurate, easy method for finding location.

GPS devices are used by many people, including pilots, sailors, hikers, and map makers. Some cars now have GPS receivers and digital road maps stored in their computers. A driver types in an address, and the car’s computer finds the best way to get there.
Map projections distort the view of Earth’s surface.

The most accurate way to show Earth’s surface is on a globe. A globe, however, cannot show much detail, and it is awkward to carry. People use flat maps for their detail and convenience. A projection is a way of representing Earth’s curved surface on a flat map. Mapmakers use different types of projections, all of which distort, or misrepresent, Earth’s surface in different ways.

Cylindrical Projection

The Mercator projection shows Earth as if the map were a large cylinder wrapped around the planet. The outlines of the landmasses and seas are then drawn onto the map. As shown in the diagram on page 209, the cylinder is unrolled to form a flat map. Latitude and longitude appear as straight lines, forming a grid of rectangles.

The Mercator projection is useful for navigating at sea or in the air. It shows the entire world, except for regions near the poles, on one map. Sailors and pilots can draw a straight line from one point to

**INVESTIGATE Map Projections**

How do you show the curved Earth on a flat surface?

**PROCEDURE**

1. Work with a small group. For a model of a hemisphere, use the top section of a 2-liter plastic bottle that your teacher has cut.
2. Carefully draw three or four latitude lines and six or eight longitude lines on the bottle.
3. Place a piece of clay in the center of a piece of poster board. Press the bottle top into the clay.
4. Shine a flashlight downward above the center of the model. Trace the lines on the poster board to make your projection.

**WHAT DO YOU THINK?**

What are the similarities and differences between your model and your projection?

**CHALLENGE** Draw a shape on the plastic bottle to represent a landmass. Use the flashlight again to project the hemisphere. How did the shape of your landmass appear when it was projected onto a flat surface?
another to plot a course. The problem with Mercator maps is that areas far away from the equator appear much larger than they really are. On the map below, Greenland looks bigger than South America. In reality, South America is about eight times larger than Greenland.

![Mercator projection](image)

**Mercator projection** Latitude and longitude lines form a grid of rectangles. Areas away from the equator are distorted.

### Conic Projections

Conic projections are based on the shape of a cone. The diagram below shows how a cone of paper might be wrapped around the globe. The paper touches the surface only at the middle latitudes, halfway between the equator and the North Pole.

When the cone is flattened out, the latitude lines are curved slightly. The curved lines represent the curved surface of Earth. This allows the map to show the true sizes and shapes of some landmasses.

Conic projections are most useful for mapping large areas in the middle latitudes, such as the United States. However, landmasses near the equator or near the north or south pole will be distorted.

![Conic projection](image)

**Conic projection** Latitude lines are slightly curved. Only mid-latitude areas are the correct size and shape.

What are the main uses of Mercator and conic projections?
Planar Projections

Planar projections were developed to help people find the shortest distance between two points. They are drawn as if a circle of paper were laid on a point on Earth’s surface. As you look at the diagram below, notice how the shape of the sphere is transferred to the flat map. When a planar map represents the polar region, the longitude lines meet at the center like the spokes of a wheel.

A planar map is good for plotting ocean or air voyages and for showing the north and south polar regions. However, landmasses farther away from the center point are greatly distorted.

The Mercator, conic, and planar projections are all attempts to solve the problem of representing a curved surface on a flat map. Each projection can show certain areas of the world accurately but distorts other areas.

Planar projection Only areas near the center point are the correct size and shape.

What areas does the planar projection show accurately?

**KEY CONCEPTS**

1. What natural and human-made features can maps show? Give two examples of each.
2. Explain how latitude and longitude can help you locate any place on Earth.
3. Why do all flat maps distort Earth’s surface?

**CRITICAL THINKING**

4. **Provide Examples** Imagine that your family is on a long car trip. What symbols on a road map would you pay the most attention to? Explain.
5. **Apply** Use a world map to find the approximate latitudes and longitudes of Moscow, Russia; Tokyo, Japan; Denver, Colorado; and La Paz, Bolivia.

**CHALLENGE**

6. **Apply** Working with a partner or with a small group, select the shortest airline route from Chicago to London, using a globe and a Mercator map. Hint: Notice that as you go farther north on the globe, the longitude lines become closer together.