Section Objectives

- **Describe the characteristics and uses of three types of map projections.**
- **Define *scale*, and explain how scale can be used to find distance on a map.**

3.2 Mapping the Earth's Surface

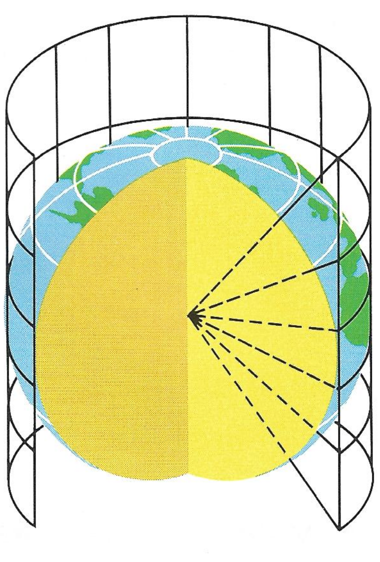
A globe is a familiar model of the earth. Because a globe is spherical like the earth, the locations of surface features and their relative areas and shapes can be represented accurately. A globe is especially useful in studying the larger surface features, such as continents and oceans. However, most globes are too small to show many details of the earth's surface, such as streams and highways. For that reason, a fantastic variety of maps have been developed for studying the earth. The science of map making is called **cartography.** It is a subfield of the earth sciences and geography.

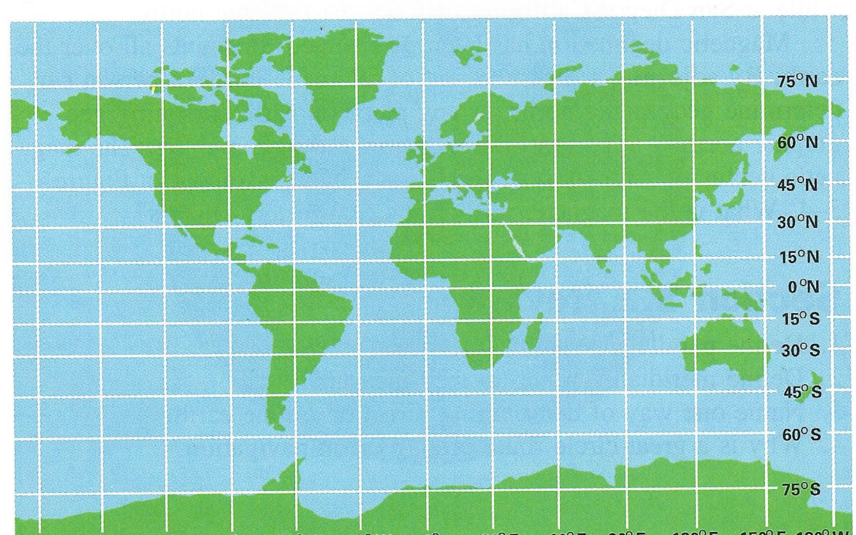
A map is a flat representation of the earth's curved surface. Transferring a curved surface to a flat map, however, causes distortion. For example, if you remove the peel from an orange and attempt to flatten the peel, it will stretch and tear. The larger the piece of peel, the more its shape is distorted as it is flattened. Also distorted are distances between points on the orange peel. Similarly, an area shown on a map may be distorted in size, shape, distance, and direction. The larger the surface area being shown, the greater the distortion. A map of the entire earth, like the peel of an entire orange, would show the greatest distortion. A map of a small area, such as a city, would show only slight distortion.

Map Projections

Over the years, map makers, or *cartographers,* have developed several ways of transferring the curved surface of the earth onto flat maps. A flat map that represents the three-dimensional curved surface of a globe is called a **map projection.** To understand how map projections are made, imagine the earth as a transparent globe with a light inside. If you hold a piece of paper against the globe, shadows appear on the paper that reflect markings on the globe, such as continents, oceans, parallels, and meridians. The way the paper is held against the globe determines the kind of projection made.

Figure 3–5. A light at the center of a transparent globe would project lines on a cylinder of paper (left), producing a Mercator projection (right).





Three common types of map projections are **Mercator, gnomonic** (noe-MON-ick), and **conic projections.** None of these map projections is an entirely accurate representation of the earth's surface. However, each kind of projection has certain advantages and disadvantages that must be considered when choosing a map.

Mercator Projection

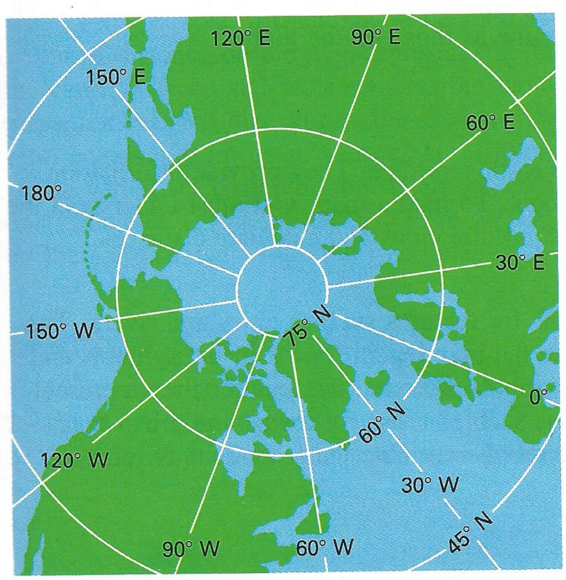
If you were to wrap a cylinder of paper around a lighted globe, a Mercator projection like the one shown in Figure 3–5 would result. The meridians on a Mercator projection appear as straight parallel lines with an equal amount of space between lines. On a globe, however, the meridians come together at the poles. A Mercator projection, though accurate near the equator, distorts distances between regions of land and distorts the sizes of areas near the poles.

Though distorted, a Mercator projection has several advantages. All compass directions appear as straight lines with the four main points of the compass located along the four sides of the map. All parallels and meridians are shown clearly, and latitude and longitude are easily measured with a ruler. Also, the shapes of the land and water bodies are shown correctly. These qualities make the Mercator projection a valuable tool for navigation. The major disadvantage is that areas far from the equator, such as Alaska and Norway, have an exaggerated size and appear much larger than they do on a globe.

Gnomonic Projection

A sheet of paper touching a lighted globe at only one point produces a gnomonic projection, as shown in Figure 3–6. On a gnomonic projection, little distortion occurs at the point of contact, which is usually one of the poles. However, the unequal spacing between parallels causes a distortion in both direction and distance that increases as the distance from the point of contact increases.

Despite distortion, a gnomonic projection is a great help to navigators in plotting routes used in air travel. As you know, a great circle is the shortest distance between two points on the globe. When projected onto a gnomonic projection, it appears as a straight line. Therefore, by drawing a straight line between any two points on a gnomonic projection, navigators can readily find the great-circle route.



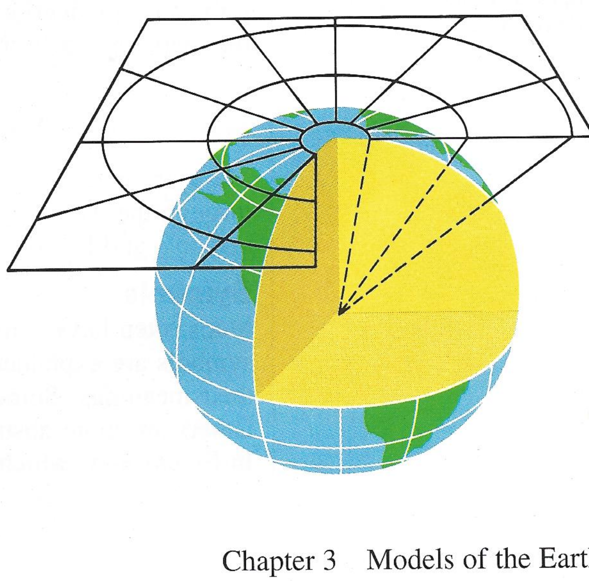


Figure 3–6. This gnomonic projection (left) is produced as points on a globe are projected onto a sheet of paper in contact with the North Pole of the globe.

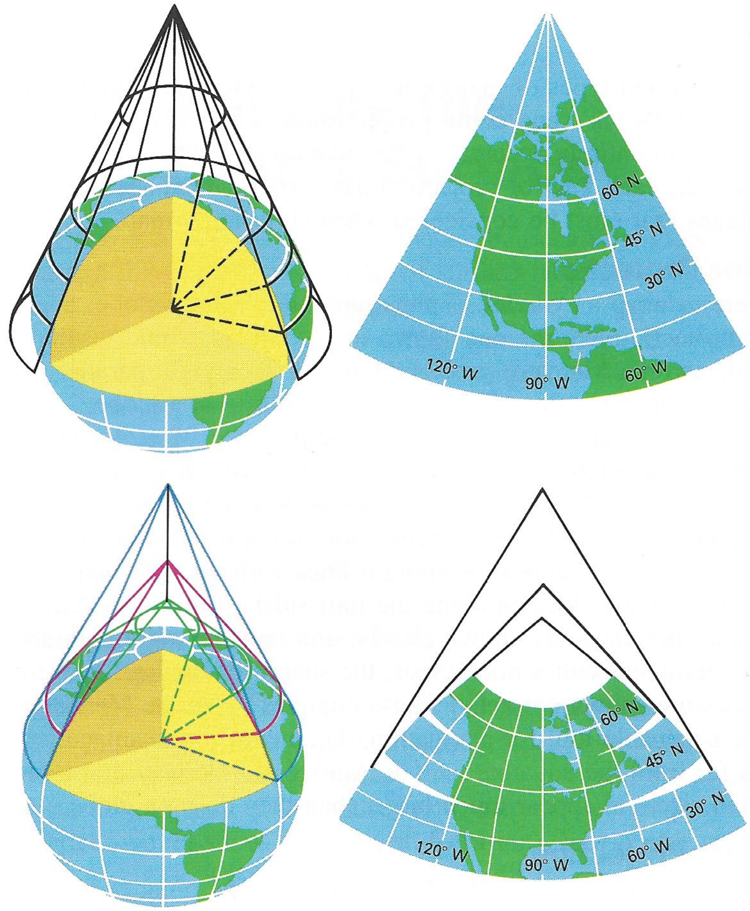


Figure 3–7. In the top left illustration, the cone comes in contact with the globe along the parallel of latitude at 30° N, producing the conic projection shown top right. In the bottom left illustration, a conic projection is made using a series of cones, each touching the globe at a different parallel. The conic projections are then assembled to form the polyconic projection shown bottom right.

Conic Projection

A paper cone placed over a lighted globe so that the axis of the cone aligns with the axis of the globe produces a conic projection. The cone touches the globe along one parallel of latitude. As shown in Figure 3–7, areas near the parallel of latitude where the cone and globe are in contact are distorted the least.

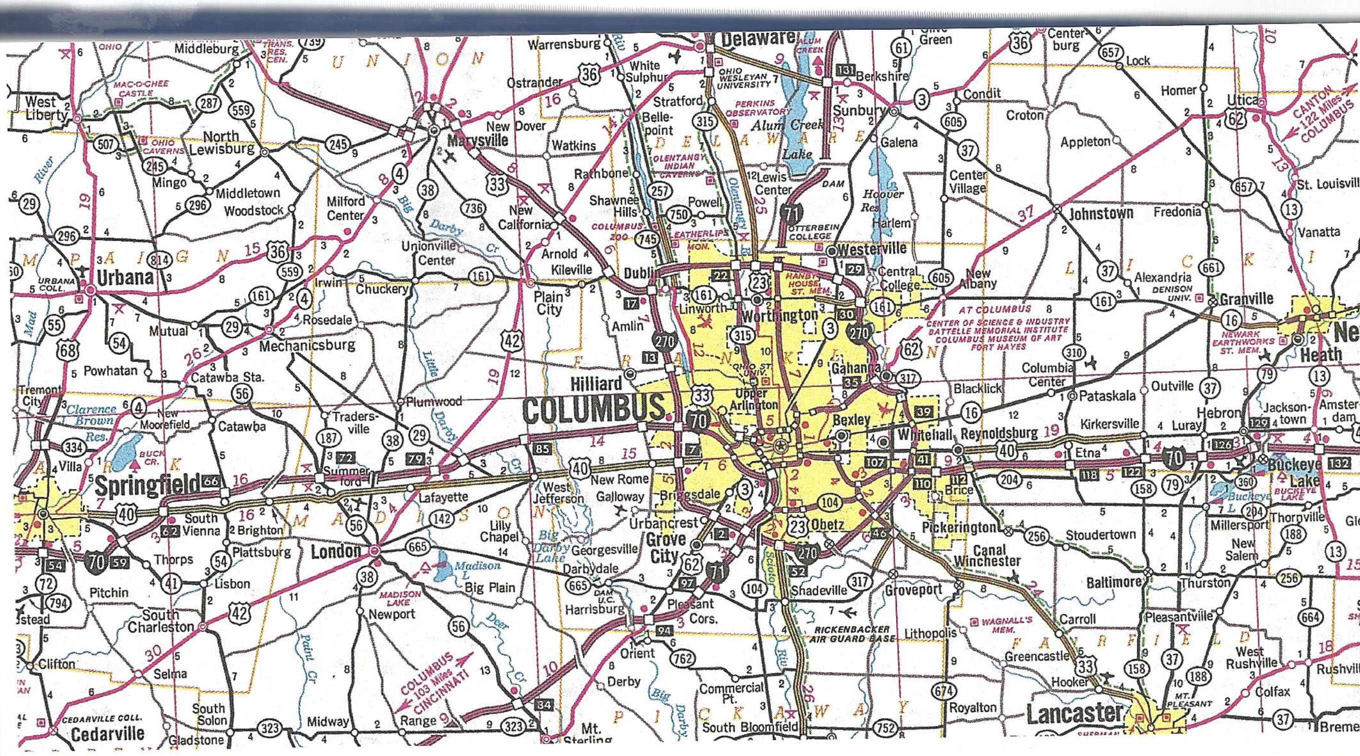
A series of conic projections may be used to map a number of neighboring areas. Each cone touches the globe at a slightly different latitude, as Figure 3–7 shows. Fitting the adjoining areas together then produces a continuous map. Maps made in this way are called **polyconic projections.** The relative size and shape of small areas on the map are nearly the same as those on the globe.

Reading a Map

Maps are models of the earth's surface. They provide information through the use of symbols. To read a map, you must understand the symbols and be able to find directions and calculate distances.

Symbols

Maps often have symbols for features such as cities and rivers. The symbols are explained in the map **legend,** a list of the symbols and their meanings. Some symbols resemble the features they represent. Others are more abstract, such as those for towns and urban areas. In Figure 3–8, which symbols resemble the features they represent?



Direction on a Map

Once you understand the legend, you must determine the compass directions. Maps are usually drawn with north at the top, east at the right, west at the left, and south at the bottom. Parallels run from side to side, and meridians run from top to bottom. Directions should always be determined in relation to the parallels and meridians.

Map Scale

To be accurate, a map must be drawn to **scale.** The scale of a map indicates the relationship between distance as shown on the map and actual distance. As Figure 3–8 shows, a map scale can be expressed as a graphic scale, a fractional scale, or a verbal scale.

A graphic scale is a printed line divided into equal parts and labeled. The line represents a unit of measure, such as kilometers or miles. Each part of the scale represents a specific distance on the earth. To find the actual distance between two points on the earth, you first measure the distance between the points as shown on the map. Then you compare that measurement with the map scale.

A second way of expressing scale is a ratio, or a fractional scale. For example, a fractional scale such as 1:25,000 indicates that 1 unit of distance on the map represents 25,000 of the same unit on the earth. A fractional scale remains the same with any system of measurement. In other words, the scale 1:100 could be read as 1 in. equals 100 in. or as 1 cm equals 100 cm.

A verbal scale may be the statement, "One centimeter equals one kilometer." This means that 1 cm on the map represents 1 km on the earth. What would the fractional scale be on such a map?

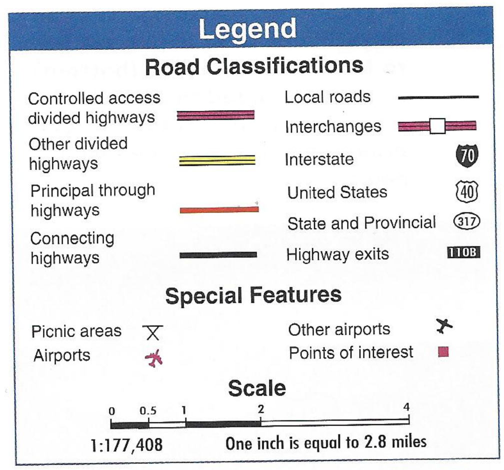


Figure 3–8. When using the road map shown above, a map scale is needed. Three types of map scales are shown on this legend. The map legend also explains the other symbols used on this map.

Section 3.2 Review

1. Name three common map projections.
2. What is a map legend?
3. Explain why all maps are inaccurate representations in some way.