MIDDLE GRADES
EARTH SCIENCE
STUDENT WORKSHEETS
AND
EDUCATOR'S GUIDE
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UNIT ONE
MAPPING
THE EARTH
GLO-ACADEMY®
MIDDLE GRADES
EARTH SCIENCE - UNIT ONE
MAPPING THE EARTH

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UNIT ONE
STUDENT WORKSHEETS
MAPPING THE EARTH

**GUIDING CONCEPT**
Scientists make maps and globes to model earth’s surface features in order to make them easier to visualize and study.

**FUNDAMENTAL QUESTIONS**
- How do scientists make maps of earth?
- How do scientists use maps to learn about earth’s surface features?

**ACQUIRED KNOWLEDGE AND SKILLS**
At the end of this unit you will be able to demonstrate a variety of new skills. You will be able to ...

* construct a balloon globe with latitude and longitude lines and plot the locations of famous places on your globe,

* find the latitude and longitude of locations on a world map and globe,

* identify the different kinds of maps used by scientists and discuss the limitations of each,

* use a compass to identify and record the positions of landmarks around the horizon,

* use your hand as a sundial to tell time,

* interpret a contour map,

* design and construct a contour model and draw how it looks from a “bird’s eye view.”
It’s been a long time since people drew maps like the one shown. In modern times, scientists and geographers have put their heads together to create new and more accurate models and pictures of the Earth we live on. They even go into space with satellites to create better maps.

A globe is a model of a planetary object. Like other models, it is a smaller version of a real object. A globe can be constructed to represent Earth or any other planet in our solar system. A globe of earth may show our planet’s continents and their positions relative to one another. Or, it can show Earth’s natural surface features, such as mountain ranges and deep ocean trenches. It can also show features such as time zones and national boundaries.

To make it easy to find locations on a globe, mapmakers created two reference lines from which all points on Earth can be plotted. The two reference lines are the equator and the prime meridian. The equator is the imaginary line drawn around the circumference of the Earth. It is equidistant from the North and South Poles. The prime meridian is an imaginary line stretching from the North to the South Pole through the township of Greenwich (England). Scientists chose the town of Greenwich because the meeting where this mapping system was invented was held there.

Other lines drawn parallel to the equator are called latitudes or parallels. Latitudes drawn parallel to the equator measure distances north and south of the equator. The equator is zero degrees latitude. Lines drawn from the North to South Pole are called longitudes or meridians. The prime meridian is zero degrees longitude. Longitudes lines are used to measure locations east and west of the prime meridian.

Think about it!

How is a map different than a globe?

Answer: Maps are flat. Globes are spherical.

Why do we need both latitude and longitude lines to find positions on maps and globes?

Answer: In the same way that points plotted on an “x” and “y” axis to locate a point in space, longitude and latitudes locate a place on a map or globe where they cross.
UNIT ONE - LESSON #1

HOW DO SCIENTISTS FIND LOCATIONS ON A GLOBE?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

- **globe:** __________________________________________________________
  __________________________________________________________

- **reference lines:** __________________________________________________
  __________________________________________________________

- **equator:** _______________________________________________________
  __________________________________________________________

- **prime meridian:** _________________________________________________
  __________________________________________________________

- **equidistant:** ___________________________________________________
  __________________________________________________________

- **North Pole:** ____________________________________________________
  __________________________________________________________

- **South Pole:** ____________________________________________________
  __________________________________________________________

- **Greenwich (England):** ____________________________________________
  __________________________________________________________

- **latitude (parallel):** _____________________________________________
  __________________________________________________________

- **longitude (meridian):** ____________________________________________
  __________________________________________________________
Refer to the first sketch. This quick sketch conveys the meaning of the term “equidistant.” Select five more of the vocabulary terms you defined on the previous page. Draw a picture that conveys the meaning of each term and use the term in a sentence to describe your drawing.

The three circles are the same distance apart or equidistant.
HOW TO MAKE A BALLOON GLOBE

Inflate a round balloon and refer to the illustration below. Neatly identify the North Pole of the balloon globe by marking the top of the balloon with an “N.” Identify the South Pole with an “S” at the bottom. Carefully draw the equator around the balloon equidistant from the North and South Poles. Then draw five neat latitude lines around the balloon as shown in the illustration. Make sure the lines are equidistant from one another. Draw a straight perpendicular line through the poles completely around the balloon. Label that line the prime meridian on one side of the globe. On the opposite side of the globe label the line I.D.T. This is the International Date Line. Then draw five longitude lines, again at right angles to the latitude lines, around the balloon through the poles. Make sure these lines are also equidistant from one another.

There are two (2) latitude lines in the left-hand diagram that are not labeled. Can you label them?
FINAL QUESTION

Write an A, B, C, D, and E at the following locations on the diagram:

(A) 30º north latitude (n.lat.)/60º west longitude (w.long.)
(B) 30º south latitude (s.lat.)/30º east longitude (e.long.)
(C) 60º n. lat./30º w.long.
(D) 0º lat./30º w.long.
(E) 90º n.lat./30º e.long.

Why isn’t it necessary to identify a north or south direction when you use 0º latitude?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

What did you discover when you plotted 90º n. lat./30º e. long?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
FINDING OUR WAY AROUND THE PLANET
*ALL YOU NEED IS LATITUDE AND LONGITUDE *

Taking the lead from one of the world’s first great mapmakers, Gerhard Kremer Mercator (b.1512; d.1594), modern geographer’s still use latitude and longitude lines to find locations on a map.

Refer to the illustration on the Lesson #2 Worksheet. In that diagram, the distance from the equator to the North or South Pole is only one quarter of a circle. Since all circles are 360° in circumference, both the North and South Pole are 90° latitude from the equator. The equator is 0° latitude.

Half way around the world, either east or west of the prime meridian is a distance of 180°. The prime meridian is 0° longitude.

To locate any place on the planet, we simply find the longitude and latitude lines that cross at that location. For example: Reno, Nevada, USA, is located at about 120° west longitude, 40° north latitude.

Half way around the world is the International Dateline. The International Dateline is an imaginary line drawn at about 180° longitude. It marks the beginning of the new day as the Earth rotates on its axis. When the International Dateline line is directly opposite the sun at midnight, a new calendar day begins on Earth. The new day always begins at the International Dateline.

When Mercator drew one of his first maps of Europe, he included longitude lines, drawn like the spokes of a wheel, coming out of the North Pole. Look closely at the map at left and see if you can identify them. Mercator’s first early maps of the European continent were nearly as accurate as modern maps drawn from modern satellite images.

***************************

Think about it!

Why are there both east and west longitude lines?

Answer: There are both east and west longitude lines because there is an Eastern and Western Hemisphere.

Why are there both north and south latitude lines?

Answer: There are both north and south latitude lines because there is Northern and Southern Hemisphere.
UNIT ONE - LESSON #2

HOW DO SCIENTISTS USE MAPS TO FIND LOCATIONS ON EARTH'S SURFACE?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

equator: __________________________________________________________
__________________________________________________________________

prime meridian: ___________________________________________________
__________________________________________________________________

latitude: __________________________________________________________
__________________________________________________________________

longitude: __________________________________________________________
__________________________________________________________________

International Dateline: _____________________________________________
__________________________________________________________________

Select four of the terms you defined then draw a picture that conveys the meaning of each term. Use the term in a sentence to describe your drawing as you did in LESSON #1.
READ A MAP OF THE WORLD

Most latitude and longitude maps are accurate to the nearest 5° or 10°. Use a world map to estimate the correct latitude and longitude of the major world capitals listed below. Then plot the positions of these cities on your balloon globe.

(A) Washington, D.C.:  _____ ___ lat/_____ ___ long
(B) London, England:  _____ ___ lat/_____ ___ long
(C) Paris, France:  _____ ___ lat/_____ ___ long
(D) Moscow, Russia:  _____ ___ lat/_____ ___ long
(E) Beijing, China:  _____ ___ lat/_____ ___ long
(F) Melbourne, Australia:  _____ ___ lat/_____ ___ long
(G) Bombay, India:  _____ ___ lat/_____ ___ long
(H) Cairo, Egypt:  _____ ___ lat/_____ ___ long
(I) Buenos Aires, Argentina:  _____ ___ lat/_____ ___ long
(J) Ottawa, Canada:  _____ ___ lat/_____ ___ long

Think of five places you would like to visit in the future. Find those places on your map of the world then plot them on your balloon globe?

(1) __________________:  _____ ___ lat/_____ ___ long
(2) __________________:  _____ ___ lat/_____ ___ long
(3) __________________:  _____ ___ lat/_____ ___ long
(4) __________________:  _____ ___ lat/_____ ___ long
(5) __________________:  _____ ___ lat/_____ ___ long
FINAL QUESTION

Use the globe shown to draw continents you might find on an alien planet. The first continent is drawn for you along with the location of a city inhabited by the planet's alien humanoids. Choose a prime meridian then draw your continents. Name a few cities on each continent and give their latitudes and longitudes.

Name each city.

(1) __________________: _____ ____ lat/_____ ____ long
(2) __________________: _____ ____ lat/_____ ____ long
(3) __________________: _____ ____ lat/_____ ____ long
(4) __________________: _____ ____ lat/_____ ____ long
(5) __________________: _____ ____ lat/_____ ____ long
(6) __________________: _____ ____ lat/_____ ____ long
(7) __________________: _____ ____ lat/_____ ____ long
(8) __________________: _____ ____ lat/_____ ____ long
(9) __________________: _____ ____ lat/_____ ____ long
(10) __________________: _____ ____ lat/_____ ____ long
For centuries, mapmakers have had problems transferring images of landmasses from round, three-dimensional globes flat to two-dimensional maps. Examine the map to the right. You can see that all the longitude line are drawn parallel to one another. They do not cross at the poles like longitude lines do on a regular globe. Stretching the map into the shape of a flat rectangle distorts to the shape of continents. Look at the continent of Antarctica at the South Pole. On this map, the continent almost stretches from one side of the map to the other. It doesn’t looks anything at all like the real Antarctic continent!

Try cutting open the balloon globe you made in Lesson #1 along longitude lines to the equator. Then try and stretch the parts of the balloon so that it forms a perfect rectangle like a normal map. You will notice that any landmasses drawn on the balloon globe also stretch and become oddly distorted.

The map shown below attempts to decrease the amount of distortion we see on a flat rectangular map. In this map the longitude lines are drawn closer and closer together as they approach the poles.

The world’s first great mapmaker, Gerhard Kremer Mercator (b.1512; d.1594), drew many of his maps with longitude lines parallel to one another. Maps like these are generally called Mercator Projections. The American mapmaker Arthur Robinson (b.1916; d.2005) created the kind of map seen at lower left. These kinds of maps lessen distortion problems.

Think about it!

Why does drawing longitude lines parallel to one another on a map cause landmasses to appear distorted?

Spread apart landmasses at polar latitudes to appear cross at the poles, separating them cause

Answer: Since all longitude line on a globe

ROBINSON PROJECTION
UNIT ONE - LESSON #3

WHAT ARE THE DIFFERENT KINDS OF MAPS USED BY SCIENTISTS?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

distortion: __________________________________________________________
__________________________________________________________________

projection: ________________________________________________________
__________________________________________________________________

landmass: _________________________________________________________
__________________________________________________________________

map projection: _____________________________________________________
__________________________________________________________________

Mercator (cylindrical) projection: _____________________________________
__________________________________________________________________

Robinson projection: _________________________________________________
__________________________________________________________________

Select four of the terms you defined then draw a picture that conveys the meaning of each term. Use the term in a sentence to describe your drawing as you did in LESSON #1.
Shine a flashlight onto a ruler so that you can see the ruler's shadow on a wall. Observe how the shadow changes as you tilt the flashlight so that the light hits the ruler at different angles. Record your observations.

flashlight shining straight on the ruler  flashlight shining at an angle on the ruler

______________________________  ________________________________
______________________________  ________________________________
______________________________  ________________________________
______________________________  ________________________________
______________________________  ________________________________
______________________________  ________________________________
______________________________  ________________________________
______________________________  ________________________________

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Imagine placing a bright light at the center of the earth. If we surrounded the planet with a cylinder of photographic film we can imagine capturing the shadows cast by the landmasses. Just as the shadow of the ruler changed shape when you held the flashlight at different angles, the landmasses would cast distorted shadows on the film. The continents would appear to spread and grow, the shadows appearing larger than they really are. This is what happens in a Mercator (or cylindrical) projection when we draw longitude line parallel to one another instead of letting them cross at the poles as they do on a globe.

**MERCATOR MAP**

A Robinson projection draws longitude lines on a flat map so that they come closer together at the poles. This helps to decrease the distortion of the landmasses.

**A Robinson Map**  **A Conical Projection and Polar Map**

Imagine wrapping a cone of photographic film around the North Pole instead of a cylinder as we imagined above. Cutting and flattening the cone would give us a view of the earth from above the pole. All the longitude lines would cross as they do on a globe.
FINAL QUESTION

Write a short essay describing the drawbacks of flat maps.
A compass is a freely moving magnetized needle that always points north. One of the first compasses was invented by the Chinese astronomer Shen Kua (b. 1031; d.1095) in the 11th Century.

The fact that a compass always points north makes it possible to find due north and to plot the positions of landmarks around the horizon. The horizon is the outer boundary of the earth, as far as the eye can see, where the level surface of the earth meets the sky. Refer to the illustration on the Lesson #4 Worksheet.

Since the horizon surrounds us in a full 360° circle, a chart can be created to record the positions of objects on the horizon. This kind of record is called an azimuth chart. Azimuth is a measure of degrees around the horizon. North on an azimuth chart is 0° azimuth. One quarter the way, or 90° azimuth, around the horizon is due east. Half way, or 180° azimuth, around the horizon is due south. Three quarters the way, or 270° azimuth, around the horizon is due west.

Compass technology has improved a lot since the 11th Century. Geologists who study the Earth’s natural landscape and minerals, use handheld compasses similar to the one shown at lower left. Ship navigators use much more sophisticated marine compasses that correct for the pitch and roll of a ship at sea.

Think about it …

Why do you think scientists decided to make due north equal to 0° azimuth?

* THE TOOL CAN BE USED TO MAKE A RECORD OF LANDMARKS ON THE HORIZON *

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UNIT ONE - LESSON #4

HOW DO SCIENTISTS USE A COMPASS TO RECORD LANDMARKS ON THE HORIZON?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

compass: ____________________________________________________________
__________________________________________________________________

Shen Kua: ____________________________________________________________
__________________________________________________________________

horizon: ____________________________________________________________
__________________________________________________________________

azimuth chart: _______________________________________________________
__________________________________________________________________

north: ______________________________________________________________
__________________________________________________________________

south: ______________________________________________________________
__________________________________________________________________

east: ________________________________________________________________
__________________________________________________________________

west: _______________________________________________________________
__________________________________________________________________
Select six of the terms you defined then draw a picture that conveys the meaning of each term. Use each term in a sentence to describe your drawings.

Imagine you are standing the center of the circle shown in the illustration to see how you can use a compass to find positions along the horizon.
Use a compass to find due north. If you do not have a compass you can suspend a bar magnet horizontally from a string. After a few moments the pole of the bar magnet marked “N” will point north. This direction is 0° azimuth. Label the remaining directions using degrees azimuth on the AZIMUTH CHART below. Identify some familiar landmarks (such as houses, light poles, trees, and mountains) and use the compass to find and record their locations on the chart.

AZIMUTH CHART

- NORTH (0°)
- EAST (90°)
- SOUTH (180°)
- WEST (270°)
写一个短故事，包含几段文字，讲述你如何使用指南针和方位图找到回家的路，因为你在森林里迷路了。
They come in all shapes and sizes: square ones and round ones, huge ones and pocket size! But they all do the same thing. They tell time. They are sundials!

Being able to tell time was just as important to our ancestors long ago as it is to us today. Knowing the time of day allowed early hunters to get back to the safety of their caves before nightfall. Knowing the cycle of the seasons, by keeping records of the day’s changing length, was critical to their ability to sew and harvest healthy crops.

Sundials are designed to track the motion of the sun across the sky. A sundial can be as simple as a stick in the ground. For the sundial to be accurate, however, it must be placed at a specific angle to the ground. The angle of the stick depends on the latitude where you live. For example, a sundial in Sao Paolo, Brazil, is placed about 23.5° from the ground. That is because Sao Paolo is located at 23.5° south latitude. A common protractor can be used to measure the angle of tilt.

After hundreds of years of keeping track of the changing length of the day from one season to the next, ancient scientists were able to invent more accurate calendars. Calendars were also used to record the motions of other celestial objects beside the sun, such as the moon and stars.

Think about it …

What time is it where the European sundial at right is located?

Answer: Since Europe is in the Northern Hemisphere, the sundial is located in Europe. The time is probably late afternoon wherever and the shadow is pointing east. The sun must be in the west. The time is probably late afternoon whenever and the shadow is pointing east. The sun must be in the west.
UNIT ONE - LESSON #5

HOW DID ANCIENT SCIENTISTS USE A SUNDIAL TO TELL TIME?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

sundial: ______________________________________________________________

________________________________________________________________________

calendar: ______________________________________________________________

________________________________________________________________________

ceelestial object: _______________________________________________________

________________________________________________________________________

protractor: ______________________________________________________________

________________________________________________________________________

Draw a picture that conveys the meaning of each term. Use each term in a sentence to describe your drawings.
Find where you live on a world map. Record the latitude where you live:

________________________ latitude

Examine the illustrations below and follow the directions to make your palm-sundial. Use your palm-sundial to record the time of day a few times in the morning and a few times in the afternoon. Compare the time of day indicated by your sundial to a clock.

**HOW TO MAKE A PALM SUNDIAL**

(1) Refer to the illustration on the next page. If a protractor is not available, you can trace and cut out the tracing of the protractor below.

(2) Insert a pencil between your thumb and forefinger as shown in the hand-diagrams.

(3) Use the protractor to angle your pencil at the same angle as the latitude where you live. Always hold your palm facing up and horizontal to the ground when you read the time of day.

(4) Use a compass to find due north. When you face in the direction indicated in the illustration the pencil casts a shadow on your hand. The shadow will point to the time of day as shown.

(5) On the next page, record the actual clock time of day at the same time you read your palm-sundial.
A PALM SUNDIAL

use left hand when facing west before noon

use right hand when facing east after noon

CLOCK TIME

SUNDIAL TIME

Final Question

Why do you think the angle of the pencil must be the same as the angle of latitude where you live when reading your sundial?
As you have certainly observed, the surface of the earth is not flat. There are hills and valleys, mountains and canyons, river basins and sloping coastlines. How can a bulging, three-dimensional hill or mountain be illustrated on a flat, two-dimensional map. The drawing of Earth’s surface features is called topography. A map that shows the Earth’s topography is called a topographic or contour map.

Topographic maps use contour lines to show the elevation of features above and below sea level. All points on a contour line are the same elevation above or below sea level. Sea level is the starting elevation from which all other elevations are compared. Sea level is at an elevation of zero feet (or zero meters).

The map at upper right is a contour map. The “curvy” lines are contour lines. Each contour represents a particular elevation above or below sea level. The map at lower right is a shaded relief map that tries to give the viewer a three-dimensional view of the actual hills and valleys in the same region.

Think about it …

The arrows drawn in each map are pointing to the same area where contour lines are drawn close together. What kind of surface feature is represented by contour lines drawn this way?

Answer: Contour lines drawn close together indicate a steep or very steep slope or cliff. Closely placed lines show that elevation above sea level rises quickly over a short distance.
UNIT ONE - LESSON #6
HOW DO CONTOUR MAPS HELP DESCRIBE ELEVATIONS ABOVE SEA LEVEL?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

topography: ________________________________________________________________
__________________________________________________________________________

contour map: ______________________________________________________________
__________________________________________________________________________

contour lines: _____________________________________________________________
__________________________________________________________________________

elevation: _________________________________________________________________
__________________________________________________________________________

sea level: _________________________________________________________________
__________________________________________________________________________

Select four of the terms you defined then draw a picture that conveys the meaning of each term. Use each term in a sentence to describe your drawings.
Examine the contour map below then answer the questions on the back of the worksheet. Each line represents the same elevation above sea level. Any point on the line labeled “100,” for example, is 100 feet above sea level. The dotted lines show features that are sloping down. The labeled line at lower left shows the scale of the map. It represents a distance of one mile.

Describe the hill on the left. Your description should answer these questions: How high is the hill? Which side of the hill is the steepest? Which side has the gentlest slope? Add any other conclusions you can draw from the map.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

Describe the hill on the right. Your description should answer the questions asked above. How does the hill on the right differ from the hill on the left? Add any other conclusions you can draw from the map.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

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FINAL QUESTION

Draw the contour map of a hill that rises to 500 feet above sea level. The western face of the hill is a steep cliff. The eastern side of the hill slopes gently from its top down to sea level.
ConTour Maps Are used To Make 3-D Models

Models are usually a lot more fun to look at and handle than maps. We can walk around or tilt a model to view it from different angles to see all of the different features of the model. For this reason, scientists sometimes use contour maps to make three-dimensional models. They use contour maps drawn from computer images taken of the surface of the Earth and other planets in our Solar System.

Modern scientists use satellites and computers to map the surface of the Earth. The surface of the a planet viewed from a satellite appears flat, even though we know that it has a rough surface. With the information transmitted from orbiting satellites, mapmakers program their computers to produce three-dimensional images of earth’s surface features. These images show contour lines that are drawn on a flat two-dimensional, contour map. Then, scientists use the contour maps to construct 3-D models or computer graphics that they can examine from any direction they choose.

3D picture of the Tithonium Chasma on Mars made from contour lines

Think about it ...

Where would you find contour lines drawn close together on a contour map of a model of Tithonium Chasma?

Answer: Contour lines would be drawn close together where there is a slope or steep cliff.
UNIT ONE - LESSON #7

HOW DO WE USE CONTOUR MAPS TO MAKE MODELS OF EARTH'S SURFACE?

Discuss the GLO ACADEMY® NEWS with your instructor then define the lesson vocabulary terms in your own words.

two-dimensional: ________________________________________________________________
______________________________________________________________________________

three-dimensional: ______________________________________________________________
______________________________________________________________________________

contour maps: _________________________________________________________________
______________________________________________________________________________

contour lines: _________________________________________________________________
______________________________________________________________________________

topography: ________________________________________________________________
______________________________________________________________________________

Select four of the terms you defined then draw a picture that conveys the meaning of each term. Use each term in a sentence to describe your drawings.

[Blank spaces for drawings]
Use a pencil, a pen, or a felt tipped marker to draw shapes like the ones shown below on a piece of cardboard. You may draw more than the shapes shown. Carefully cut out the pieces with a scissor, and label each with a contour elevation (100 feet, 200 feet, and so on). Trace each contour map piece in the space below, one top of the other, in the order you will stack and glue them to make you contour model. Then, stack and glue the pieces together, with the largest one at the bottom, so that your model creates a hill. You can stack two piles to make two hills that reach different elevations like the one illustrated.
Place your completed model on a table and view it from the north, south, east, and west. Draw each view.

view from the north

view from the south

view from the east

view from the west
FINAL QUESTION

Before scientists sent roving robots to explore the surface of Mars they took thousands of the photographs of the planet from orbiting probes. The probes mapped the topography of the planet using radar to determine the elevations of hills, mountains, and valleys. Write a brief paragraph describing the kinds of problems they might have encountered had they not done this. In your paragraph explain how contour maps proved useful in avoiding these problems.

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
Circle the letter of the best answer.

1. Which reference line lets us measure distances from north to south?
   (A) prime meridian
   (B) international date line
   (C) equator
   (D) contour line
   (E) none of the above

2. Which reference line lets us measure distances from east to west?
   (A) prime meridian
   (B) international date line
   (C) equator
   (D) contour line
   (E) none of the above

Use the diagram below to match each letter to its proper latitude and longitude in questions #3 through #6.

3. Which of the following gives the correct latitude and longitude of Q?
   (A) 0° lat./60° w. long.
   (B) 0° lat./60° e. long.
   (C) 60° n.lat./30° w. long.
   (D) 60° s.lat./30° e. long.
   (E) 30° n.lat./60° e. long.

4. Which of the following gives the correct latitude and longitude of R?
   (A) 0° lat./60° w. long.
   (B) 0° lat./60° e. long.
   (C) 60° n.lat./30° w. long.
   (D) 60° s.lat./30° e. long.
   (E) 30° n.lat./60° e. long.

5. Which of the following gives the correct latitude and longitude of S?
   (A) 0° lat./60° w. long.
   (B) 0° lat./60° e. long.
   (C) 60° n.lat./30° w. long.
   (D) 60° s.lat./30° e. long.
   (E) 30° n.lat./60° e. long.

6. Which of the following gives the correct latitude and longitude of T?
   (A) 0° lat./60° w. long.
   (B) 0° lat./60° e. long.
   (C) 60° n.lat./30° w. long.
   (D) 60° s.lat./30° e. long.
   (E) 30° n.lat./60° e. long.
7. Which map creates the most distortion nearest the poles?
   (A) a polar projection
   (B) a Mercator projection
   (C) a Robinson projection
   (D) a conical projection
   (E) none of these maps distorts earth’s surface features

8. Which of the following tools helps to determine direction?
   (A) a sundial
   (B) a suspended bar magnet
   (C) a pendulum
   (D) a ruler
   (E) a spring scale

9. A compass always points …
   (A) north
   (B) south
   (C) east
   (D) west
   (E) Both A and B are correct

10. What two things determine the time indicated on a sundial?
    (A) the sun’s position and brightness
    (B) the time of season and day
    (C) the sundial’s height above the ground
    (D) the sundial’s latitude and the sun’s position
    (E) None of the above matters.

MATCHING TERMS: In the blanks, write the letter of the phrase that best defines each term. Match the term to its word or phrase that best defines it.

   ____ 11. latitude  (A) prime meridian
   ____ 12. longitude  (B) equator
   ____ 13. azimuth  (C) horizon
   ____ 14. projection  (D) contour
   ____ 15. topography  (E) distortion

16. What is azimuth?
    (A) degrees around the horizon
    (B) degrees above the horizon
    (C) distance from the prime meridian
    (D) distance from the equator
    (E) none of the above

17. Which statement is TRUE?
    (A) Sundials are a recent invention.
    (B) Contour maps illustrate degrees above the horizon.
    (C) The first compass was invented in the early 1800’s.
    (D) Globes produce less distortion than flat maps.
    (E) Calendars do not tell time.

18. What is the International Date Line?
    (A) another name for the prime meridian
    (B) another named for the equator
    (C) another name for the Earth’s axis or rotation
    (D) the longitude line where the new day begins
    (E) 90° latitude
Examine the contour map shown and answer questions #19 and 20. Elevation is shown in meters.

19. Which hill is higher?
   (A) The hill in the east is higher.
   (B) The hill in the west is higher
   (C) The map does not provide enough information to answer this question.

20. Where is the steepest cliff on the map located?
   (A) north side of the eastern hill
   (B) south side of the western hill
   (C) west side of the western hill
   (D) east side of the eastern hill
   (E) east side of the western hill
# Unit One
## Educator's Overview
### Mapping the Earth

#### Guiding Concept
The following guiding concept directed the design of this unit:

Scientists make maps and globes to model earth’s surface features in order to make them easier to visualize and study.

#### Fundamental Questions
- How do scientists make maps of earth?
- How do scientists use maps to learn about earth’s surface features?

#### Acquired Knowledge and Skills
At the end of this unit students will be able to demonstrate a variety of new skills. They will be able to …

- construct a balloon globe with latitude and longitude lines and plot the locations of famous places on their globe,
- find locations the latitude and longitude of locations on a world map and globe,
- identify the different kinds of maps used by scientists and discuss the limitations of each,
- use a compass to identify and record the positions of landmarks around the horizon,
- use their hand as a sundial to tell time,
- interpret a contour map,
- design and construct a contour model and draw how it looks from a “bird’s eye view.”
THE GLO ACADEMY® EARTH SCIENCE PROGRAM

OBJECTIVES

The objective of the GLO® MIDDLE GRADES EARTH SCIENCE PROGRAM is to give every student an enduring understanding of what scientists know about the earth. At the successful completion of this seven unit program students will have a meaningful grasp of the following fundamental ideas:

(1) All scientific disciplines progress by asking meaningful questions, making accurate observations, and conducting carefully designed experiments.

(2) The features of the Earth’s surface are affected by the transfer of heat through radiation, conduction, and convection currents. Heat energy flows from warmer objects to cooler objects until all objects have the same temperature.

(3) Movements of the earth’s tectonic plates accounts for major geologic events and the most prominent features of earth’s surface such as mountain ranges and ocean ridges.

(4) The shape of the earth’s surface, its topography, is formed and reformed by mechanical and chemical weathering, erosion of rocks and soils, and the transportation and deposition of sediment.

(5) The energy sources and materials made available to earth’s plant and animal inhabitants take time to form and vary in amount and distribution.

(6) Plant and animal organisms inhabiting earth’s ecosystems exchange energy and nutrients with each other and the environment.

(7) The properties of rocks and minerals reflect the processes that formed them.

HOW TO USE THE GLO ACADEMY® EARTH SCIENCE PROGRAM

By completing the LESSON WORKSHEETS provided in each UNIT of the STUDENT WORKBOOK, students will develop an enduring understanding of what scientists know about the earth. Each UNIT begins with the following: (1) an OVERVIEW GUIDE that addresses the GUIDING CONCEPTS that directed the design of each unit, (2) a brief set of FUNDAMENTAL QUESTIONS that the pupil will be able to answer at the end of the unit, as well as (3) a list of the ACQUIRED KNOWLEDGE AND SKILLS they will have acquired by the end of each unit.

Each lesson begins with an introductory article, titled GLO ACADEMY® NEWS, which contains the essential background knowledge students should use as a reference in completing the vocabulary and hands-on activities in LESSON WORKSHEETS.

This EDUCATOR GUIDE provides instructors with the ancillary information they need to present lesson content, assist students in completing LESSON WORKSHEETS, and assess student acquisition of content. Each lesson in the EDUCATOR’S GUIDE includes (1) a Lesson Objective, (2) tips on Lesson Preparation and Execution, (3) a List of Materials needed to complete the lesson, (4) a summary of the Background Knowledge presented in the GLO ACADEMY® NEWS article appearing at the beginning of each lesson, and (5) Worksheet Answers that give examples of the most appropriate responses to the questions that appear in LESSON WORKSHEETS.
GUIDELINES FOR ASSESSING WORKSHEET RESPONSES

Upon completing individual LESSON WORKSHEETS in the STUDENT WORKBOOK, student performance can be rated using the following rubric:

ADVANCED (a score of 4): Pupils are able to define the vocabulary words introduced in the lesson. They can draw a simple illustration to convey their understanding of each term. They are able to successfully complete the worksheet questions by giving answers similar to those on the WORKSHEET ANSWERS section. They are able to answer and defend their response to the FINAL QUESTION with confidence.

PROFICIENT (a score of 3): Pupils are able to define the vocabulary words introduced in the lesson. They can draw a simple illustration to convey their understanding of each term. They are able to successfully complete the worksheet questions by giving answers similar to those on the WORKSHEET ANSWERS section.

BASIC (a score of 2): Pupils are able to define the vocabulary words introduced in the lesson. They have difficulty conveying their understanding of terms in an illustration. They fail to complete the answer the worksheet questions with responses similar to those on the WORKSHEET ANSWERS section.

BELOW BASIC (a score of 1): Pupils have difficulty defining the vocabulary terms. They have trouble drawing an illustration that conveys their understanding of the term. They fail to give answers similar to those on the WORKSHEET ANSWERS section.

OBJECTIVE ASSESSMENTS

In addition to the EDUCATOR GUIDE and STUDENT WORKBOOK, a series of unit OBJECTIVE ASSESSMENTS are provided to test the acquisition of unit content. These assessments are short multiple-choice exams that test student acquisition of each unit’s key vocabulary and concepts. These exams are designed to prepare students to achieve success on state and national proficiency exams. The final section of the EDUCATOR GUIDE contains answers to each unit assessment exam.
LESSON #1
How Do Scientists Find Locations On A Globe?

Lesson Objective
Pupils will construct a balloon globe with latitude and longitude lines and plot the locations of famous places on their globe. They will use the following vocabulary to discuss what they have learned: **globe**, **reference lines**, **equator**, **prime meridian**, **equidistant**, **North Pole**, **South Pole**, **Greenwich (England)**, **latitude** (parallel), **longitude** (meridian).

Lesson Preparation and Execution
A globe of the earth would help the student to complete this lesson. If a globe is not available, then a world map will do just as well. Let the student study the map before the lesson begins and find where they live on the globe or map.

List of Materials
Make sure each pupil has a balloon and permanent marker.

Background Knowledge
A **globe** is a model of a planetary object. Like other models, it is a smaller version of a real object. A globe can be constructed to represent earth or any other planet in our solar system. A globe of earth shows our planet’s continents and their positions relative to one another. It can show earth’s natural surface features, such as mountain ranges and deep ocean trenches, or other features such as time zones and national boundaries.

To make it easy to find locations on a globe, mapmakers created two **reference lines** from which all points on earth can be plotted. The two reference lines are the **equator** and the **prime meridian**. Refer to the illustration on the **Lesson #1 Worksheet**. The equator is an imaginary line drawn around the circumference of the earth. It is **equidistant** from the **North** and **South Poles**. The prime meridian is an imaginary line extending from the North to the South Pole through the township of **Greenwich (England)**. Scientist chose the town of Greenwich because the meeting where this mapping system was invented was held there. Other lines drawn parallel to the equator are called **latitudes** or **parallels**. Latitudes measure distances north and south of the equator. Lines drawn, like the prime meridian, from the North to South Poles are called **longitudes** or **meridians**. Longitudes measure locations east and west of the prime meridian.

Worksheet Answers

**globe**: a three-dimensional model of a planet or other celestial object.

**reference lines**: a line used as a basis for comparing other line such as the equator from which we measure other latitudes.

**equator**: the reference line encircling the middle circumference of the earth, equal to 0° latitude, from which all other latitude lines are measured.

**prime meridian**: the reference line encircling the earth from the North to South Pole, equal to 0° longitude, from which all other longitude lines are measured.

**equidistant**: Equidistant means “of equal distance.”

**North Pole**: the pole at the top of the earth is located where all longitude lines cross.

**South Pole**: the pole at the bottom of the earth is located where all longitude lines cross.

**Greenwich (England)**: The reference line known as the prime meridian runs through Greenwich, England.

**latitude (parallel)**: lines drawn parallel to the equator to measure distances north and south of the equator.
longitude (meridian): lines drawn through the North an South Pole to measure distances east and west across the globe.

There are two (2) unlabelled latitude lines in the left-hand diagram. Can you label them: yes or no? Yes. If you can, then do it.

The two lines above the equator that are not labeled should be labeled 15° and 45°.

**Final Question**

Write an A, B, C, D, and E at the following locations on the diagram to the right: (A) 30° north latitude (n.lat.)/60° west longitude (w.long.); (B) 30° south latitude (s.lat.)/30° east longitude (e.long.); (C) 60° n. lat./30° w.long.; (D) 0° lat./30° w.long.; (E) 90° n.lat./30° e.long.

Note that the latitude and longitude lines shown in the diagram are each at 30° intervals. This is because the poles are 90° from the equator (and 90 ÷ 3 sections = 30); and, the side of the globe facing us is one-half of a complete circle, or 180° (and 180 ÷ 6 sections = 30).

Why isn't it necessary to identify a north or south direction when you use 0° latitude?

0° latitude is the equator. Only latitude lines that are north or south of the equator need to be labeled either north or south.

What did you discover when you plotted 90° n. lat./30° e. long?

All longitude lines cross at 90° north and south latitude (at the North and South Poles).

**LESSON #2**

**How Do Scientists Use Maps to Find Locations on Earth's Surface?**

**Lesson Objective**

Pupils will find the latitude and longitude of locations on a world map and globe. They will use the following vocabulary to discuss what they have learned: equator, prime meridian.

**Lesson Preparation and Execution**

Instruct students on the safest way to use scissors to cut the balloon and handle the push-pins. Assist them in stretching the cut balloon should they need help.

**List of Materials**

Make sure each pupil has a pair of scissors, a thick piece of square or rectangular cardboard, push-pins, a map of the world (or a real globe), and the globe they constructed in Lesson #1.
Background Knowledge

All maps are labeled with latitudes and longitudes. Refer to the illustration on the Lesson #2 Worksheet. The distance from the equator to either the North or South Pole is only one quarter of a circle. Since all circles are 360° in circumference, both the North and South Pole are one-quarter of 360°, or 90° latitude, from the equator. The farthest points east or west of the prime meridian can be half of 360°, or 180°, longitude. Half way around the world the imaginary line at 180° longitude is called the International Dateline. When the International Dateline passes midnight during earth’s rotation, when the line is directly opposite the position of the sun, a new calendar day begins on earth. The new day always begins at the International Dateline.

Worksheet Answers

equator: the reference line encircling the middle circumference of the earth, equal to 0° latitude, from which all other latitude lines are measured.

prime meridian: the reference line encircling the earth from the North to South Pole, equal to 0° longitude, from which all other longitude lines are measured.

International Dateline: an imaginary line is located along 180° longitude half-way around the world from the prime meridian; the line that marks the beginning of the new day by passing midnight during earth’s rotation

Most maps are accurate in latitude and longitude to the nearest 5° or 10°. Do your best to estimate the correct latitude and longitude of the major world capitals listed below. Then plot the positions of these cities on your balloon globe.

(B) London, England: 51° n. lat. / 0° long.
(C) Paris, France: 49° n. lat. / 2° e. long.
(D) Moscow, Russia: 56° n. lat. / 37° e. long.
(E) Beijing, China: 40° n. lat. / 116° e. long.
(F) Melbourne, Australia: 39° s. lat. / 145° e. long.
(G) Bombay, India: 20° n. lat. / 73° e. long.
(H) Cairo, Egypt: 30° n. lat. / 31° e. long.
(I) Buenos Aires, Argentina: 35° s. lat. / 59° w. long.
(J) Ottawa, Canada: 45° n. lat. / 75° w. long.

Think of five places you would like to visit in the future. Find those places on your map of the world and plot them on your balloon globe?

Answers will vary to this question. Be sure students have plotted their chosen locations correctly.

Final Question

Deflate your balloon globe when you are completely done with this worksheet. Then, carefully use scissors to cut it open along the prime meridian. Try to stretch and flatten the cut balloon so that it will cover the surface of a thick piece of cardboard. With caution, use push-pins to secure the balloon to the cardboard. Try and get the longitude lines to run parallel to one another. Make additional cuts as needed along other longitude lines to make the stretching, flattening, and pinning easier.

Describe the difficulties you had trying to secure the balloon to the cardboard when you tried to get the longitude lines to run parallel to one another.

Student should notice that stretching the balloon is difficult and that doing it distorts the appearance of the map.
Describe the problems a mapmaker might have trying to make a flat map drawing that has all of the information you put on your balloon globe.

Allow students to express their ideas. They would be correct in concluding that attempting to transfer information from a three-dimensional globe to a flat two-dimensional surface creates a host of distortion problems.

**LESSON #3**

**What Are the Different Kinds of Maps Used By Scientists?**

**Lesson Objective**

Students will identify the different kinds of maps used by scientists and discuss the limitations of each. They will discuss the difficulties that arise in trying to put the information on a globe on a flat map. They will be able to use the following vocabulary to discuss what they have learned: distortion, projection, landmasses, map projection, Mercator (cylindrical) projection, Robinson projection, Polar (conical) projection.

**Lesson Preparation and Execution**

Obtain maps of your community at a local merchant and keep a globe and map of the world (if available) ready for handy use. You can challenge the student to compare these maps to those described in this lesson.

**List of Materials**

Make sure each pupil has a flashlight and ruler.

**Background Knowledge**

For centuries mapmakers have encountered problems transferring the information on globes accurately onto flat maps. In Lesson #2 you tried to cut, stretch, and flatten your balloon globe to make it fit on a flat piece of cardboard. You might have noticed that the cut balloon had to be stretched in odd ways to make it fill the whole cardboard. You discovered that stretching the balloon to pin it to the cardboard created distortions in the map.

One of the world’s first great mapmakers, Gerhard Kremer Mercator (b. 1512; d. 1594), drew longitude lines parallel to one another on a flat map. But on a globe, longitude lines come together and cross at the North and South Poles. Drawing them parallel to one another causes landmasses to become distorted. The continent of Greenland is much smaller than the continental United States and looks that way on a globe, but on a Mercator projection it appears to be just as large. The Robinson and Polar (or conical) projections lessen these distortion problems. The Robinson projection was created by the American mapmaker Arthur Robinson (b. 1916; d. 2005).

**Worksheet Answers**

distortion: a twisted or misrepresented version of an original
projection: to throw or cast out something such as a light source “projected” on a wall
landmass: a body of land
map projection: the transfer of information from a globe to a flat map
Mercator (cylindrical) projection: a map projections drawn so that all longitude line parallel to one another
Robinson projection: a map projection where curved longitude lines come closer together at the poles to create less distortion than a Mercator map
polar (conical) projection: a map projections showing the earth as viewed from above either pole

Shine a flashlight onto a ruler so that you can see the ruler’s shadow on a wall. Observe how the shadow changes as you tilt the flashlight so that the light hits the ruler at different angles. Record your observations.
Students will observe that the shadow changes shape, becoming shorter or longer as the flashlight is tilted at different angles toward the ruler.

Imagine placing a bright light at the center of the earth. If we surrounded the planet with a cylinder of photographic film, then we can imagine capturing the shadows cast by the landmasses. Just as the shadow of the ruler changed shape when you held the flashlight at different angles, the landmasses would cast distorted shadows on the film. The continents would appear to spread and grow, the shadows appearing larger than they really are. This is what happens in a Mercator (or cylindrical) projection when we draw longitude lines parallel to one another instead of letting them cross at the poles as they do on a globe.

A Robinson projection draws longitude lines on a flat map so that they come closer together at the poles. This helps to decrease the distortion of the landmasses.

Imagine wrapping a cone of photographic film around the North Pole instead of a cylinder as we imagined above. Cutting and flattening the cone would give us a view of the earth from above the pole. All the longitude lines would cross as they do on a globe.

**Final Question**

Write a short paragraph describing the drawback of flat maps.

Allow students to express their ideas. They would be correct to conclude that flat maps distort the appearance of landmasses on the earth’s curved surface because they are attempts to draw three-dimensional objects on a flat, two-dimensional surface.

**LESSON #4**

**How Do Scientists Use A Compass to Record the Positions of Landmarks on the Horizon?**

**Lesson Objective**

Pupils will identify landmarks on the horizon and use a compass to plot their positions on a chart. They will be able to use the following vocabulary to discuss what they have learned: compass, Shen Kua, horizon, azimuth chart, north, south, east, west.

**Lesson Preparation and Execution**

Familiarize yourself with the use of a hand-help compass. The compass needle points toward magnetic north (in the general direction of geographic north). Align the underlying letter symbol, N, with the tip of the compass needle pointing north to easily identify the other map directions.

**List of Materials**

Make sure each pupil has a compass (or bar magnet and string).

**Background Knowledge**

A compass is a “floating” magnetized needle that always points north. One of the first compasses was invented by the Chinese astronomer Shen Kua (b. 1031; d. 1095) in the 11th Century.

The fact that a compass always points north allows us to find due north and plot the position of landmarks around the horizon. The horizon is the outer boundary of the earth, as far as the eye can see, where the level surface of the earth meets the sky. Refer to the illustration on the Lesson #4 Worksheet.

Since the horizon surrounds us in a full 360° circle, we can create a chart to draw objects on the horizon. This kind of record is called an azimuth chart. Azimuth is defined as degrees around the horizon. On an azimuth chart, we pick north, or 0° azimuth, as our starting point. One quarter of the way, or 90° azimuth, around the horizon is due east. Half way, or 180° azimuth, around the horizon is due south. Three quarters of the way, or
270° azimuth, around the horizon is due west.

Worksheet Answers

compass: a tool that uses a magnet to tell direction
Shen Kua: a Chinese astronomer and one of the first scientists to tell direction using a compass
horizon: the farthest horizontal boundary from an observer on earth’s surface
azimuth chart: a diagram used to record positions of objects around the 360° horizon
north: the up direction on a good map that shows the direction to the North Pole
south: the down direction on a good map that shows the direction to the South Pole
east: the right side on a good map that shows the direction to the Eastern Hemisphere
west: the left side on a good map that shows the direction to the Western Hemisphere.

Imagine you are standing at the center of the circle shown in the illustration to see how you can use a compass to
find positions along the horizon.

Use a compass to find due north. If you do not have a compass you can suspend a bar magnet horizontally from a
string. After a few moments the pole of the bar magnet marked “N” will point north. This direction is 0° azimuth.
Label the remaining directions using degrees azimuth on the AZIMUTH CHART below. Identify some familiar
landmarks (such as houses, light poles, trees, and mountains) and use the compass to find and record their
locations on the chart.

Azimuth chart recordings will vary with the surroundings. However, pupils should be able to draw objects on the
chart and indicate the location in degrees azimuth using their worksheet chart and compass.

Final Question

Write a short paragraph describing how a compass and an azimuth chart can help you to find your way home if you
ever got lost.

Allow students to express their ideas. They would be correct to conclude, if they ever got lost, that they could
compare the locations of objects around them to the azimuth chart of the area surrounding their home. After
using their compass to determine which way is north, so that they can position their azimuth chart correctly,
they could travel in the general direction that continues to put objects in a more familiar arrangement.

LESSON #5

How Did Ancient Scientists Use a Sundial to Tell Time?

Lesson Objective

Pupils will use the hand and a pencil to make a sundial and a compass to tell time. They will be able to use the
following vocabulary to discuss what they have learned: sundial, calendar, celestial object.

Lesson Preparation and Execution

Have the student examine a furniture shadow cast by a nearby lamp. Discuss what would happen to the shadow if
the lamp were moved in a clockwise circle around the piece of furniture. The shadow would move around the
furniture like the hands on a clock.

List of Materials

Make sure each pupil has a clock, a world map, and a compass (or a bar magnet and string).
**Background Knowledge**

The ability to tell time was just as important to our ancestors as it is to us. Knowing the time of day allowed early hunters to get to their camps before nightfall. Knowing the cycle of the seasons was critical to their ability to sow and harvest healthy crops.

The first tools used to measure time tracked the motion of the sun across the sky. The first clocks were **sundials** that helped people to measure the length and time of day. A sundial is simply a stick in the ground placed at a specific angle (using a protractor to measure angles) in order to cast a shadow that moves along the ground as the sun moves across the sky. The angle of the stick depends on the latitude where you live.

**Calendars** were used later to track of the motions of other **celestial objects**, such as the moon and stars, across the sky for days, weeks, and months.

**Worksheet Answers**

- **sundial**: A sundial is a tool used to tell the time of day by tracking shadows created by the sun as it moves across the sky.
- **calendar**: A calendar is a tool used to tell the time of week, month, and year. All calendars are based on the movements of the sun, moon, and stars.
- **celestial object**: A celestial object is any natural object located in outer space.
- **protractor**: A protractor is a tool used to measure angles.

Find where you live on a world map. Record the latitude where you live: answers will vary.

Examine the illustration below and follow the directions to make your palm-sundial. Use your palm-sundial to record the time of day a few times in the morning and a few times in the afternoon. Compare the time of day indicated by your sundial to a clock.

Trace and cut out the tracing of the protractor on the back of the worksheet. Insert a pencil between your thumb and forefinger. Hold your palm facing up and horizontal to the ground. Use the protractor to angle your pencil at the same angle as the latitude where you live. Use a compass to find due north. When you face in direction indicated in the illustration the pencil will cast a shadow on your hand. The shadow will point to the time of day as shown. Record the actual clock time of day at the same time you read your palm-sundial.

Answers ill vary depending on the time of day. However, the sundial and clock times should be within half-an-hour of one another. If they are not, then pupils needs to make sure they are facing in the right direction and that the angle of the pencil in their hand is the same as the latitude where they live.

**Final Question**

Why do you think the angle of the pencil must be just right when reading your sundial? Give your honest opinion.

Allow students to express their ideas. They would be correct to conclude that the angle is important because the surface of the earth is curved. The farther one moves away from the equator toward the poles the closer the sun gets to the horizon. The sun is nearly or directly above one’s head when they are standing at the equator an noon. The sun is near or on the horizon when they are standing at the either pole an noon. The shadow cast by the pencil of a palm-sundial depends on the time of day and the position of the sun at a particular latitude.

**LESSON #6**

**How Do Contour Maps Describe Elevations Above Sea Level?**

**Lesson Objective**

Pupils will examine and interpret a contour map. They will be able to use the following vocabulary to discuss what they have learned: topography, contour map, contour lines, elevation, sea level.
Lesson Preparation and Execution

Compare any handy local or global map to the contour map on the LESSON WORKSHEET. Discuss the obvious difference between the maps.

List of Materials

Students will need any handy local or global map.

Background Knowledge

As you have probably observed, the surface of the earth is not flat. There are hills and valleys, mountains and canyons, river basins and sloping coastlines. The drawing of the surface features of the earth is called topography. A map that shows the earth’s topography is called a topographic or contour map.

Topographic maps use contour lines to indicate the elevation of features above sea level. All points on a contour line are the same elevation above sea level. Sea level is the starting elevation from which all other elevations are compared. Sea level is at an elevation of zero feet (or meters).

Refer to the illustration on the Lesson #6 Worksheet to see how mapmakers draw earth’s surface features using contour lines.

Worksheet Answers

topography: the drawing of an object’s surface features
contour map: a map using contour lines to show elevations above and below sea level
sea level: the reference or starting elevation used to determine the elevation of objects
contour line: a line drawn on a map to show surface features at the same elevation above or below sea level
elevation: the distance above or below something

Examine the contour map below. Then, answer the questions on the back of the worksheet. Each line represents the same elevation above sea level. Any point on the line labeled “100,” for example, is 100 feet above sea level. The dotted lines show features that are sloping down.

Describe the hill on the left. Your description should answer these questions: How high is the hill? Which side of the hill is the steepest? Which side has the gentlest slope? Add any other conclusions you can draw from the map.

The hill on the left reaches an elevation of 400 feet above sea level. The left or west side of the hill is the steepest because the contour lines are closer together. This shows a rapid drop or rise in elevation. The right or east side of the hill has a gentler slope because the contour lines are farther apart.

Describe the hill on the right. Your description should answer the questions asked above. How does the hill on the right differ from the hill on the left? Add any other conclusions you can draw from the map.

The hill on the right reaches an elevation of 300 feet above sea level. The drops off in the center to 100 feet above sea level. The right or east side of the hill is a bit steeper than the left or west side of the hill.

Have students defend any other conclusions they draw from the map: such as “The right hill has a crater at the top. It might be a volcano or the site of a meteor impact.”

Final Question

Draw the contour map of a hill that rises to 500 feet above sea level. The western face of the hill is a steep cliff. The eastern side of the hill slopes gently from its top down to sea level.

Drawings will vary but should have the overall features of the diagram below.
Lesson Objective

Pupils will construct a model that shows the features of a earth's surface. They will be able to use the following vocabulary to discuss what they have learned: two-dimensional, three-dimensional, contour lines, contour map, topography.

Lesson Preparation and Execution

Instruct students in the safest way to use scissors to cut the cardboard.

List of materials

Make sure each pupil has glue, a scissor, a sheet of tracing paper, and piece of corrugated cardboard.

Background Knowledge

Modern scientists use satellites and computers to map the surface of the earth. From space, the surface of the earth appears flat even though we know that it has an extremely varied topography. With the information transmitted from orbiting satellites, mapmakers can program their computers to produce three-dimensional images of earth’s surface features. These images show the contour lines that you see on a flat two-dimensional, contour map so that scientists can visualize the topography of a region. The computer graphics you see in movies of spacecraft zooming over land formations are all designed using this type of technology.

Worksheet Answers

two-dimensional: A two-dimensional surface is like a flat piece of paper having length and width.

three-dimensional: A three-dimensional object has volume. It has length, width, and height.

contour lines: a line drawn on a map to show surface features at the same elevation above or below sea level

contour map: a map using contour lines to show elevations above and below sea level

topography: the drawing of surface features on a map

Use a pencil, a pen, or a felt tipped marker to draw shapes like the ones shown below on a piece of cardboard. You may draw more than the shapes shown. Carefully cut out the pieces with a scissor, and label each with a contour elevation (100 feet, 200 feet, and so on). Stack and glue the pieces together, with the largest one at the bottom, so that your model creates a hill. You can stack two piles to make two hills that reach different elevations like the one illustrated.
Assist students in designing and putting together their contour model.

Place your completed model on a table and view it from the north, south, east, and west. Draw each view.

Make sure students are viewing their model from the correct direction. Their drawings will vary but should match what they actually observe from each viewing direction.

**Final Question**

Before scientists sent roving robots to explore the surface of Mars they took thousands of the photographs of the planet from orbiting probes. The probes mapped the topography of the planet using radar to determine the elevations of hills, mountains, and valleys. Write a brief paragraph describing the kinds of problems they might have encountered had they not done this. In your paragraph explain how contour maps proved useful in avoiding these problems.

Answers will vary. Students would be correct to conclude that failing to know the topographic features of the surface of Mars could result in a collision between the landing spacecraft and a mountainside. Contour maps allow scientists to plan the route their probes can take to explore the planet's surface.

**OBJECTIVE ASSESSMENT GUIDELINES AND ANSWERS**

**MAPPING THE EARTH**

Each correct answer is worth 5 points. Students should go back and review the information in the BACKGROUND KNOWLEDGE sections and their LESSON WORKSHEETS to resolve questions they have about wrong answers. Performance can be rated as follows: ADVANCED = 90 points or above; PROFICIENT = 80 points or above; BASIC = 70 points or above; BELOW BASIC = 60 points or BELOW.

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Circle the letter of the best answer.

1. Which reference line lets us measure distances from north to south?
   (C) equator

2. Which reference line lets us measure distances from east to west?
   (A) prime meridian

Use the diagram below to match each letter to its proper latitude and longitude in questions #3 through #6.

3. Which of the following gives the correct latitude and longitude of Q?
   (A) 0° lat./60° w. long.

4. Which of the following gives the correct latitude and longitude of R?
   (C) 60° n.lat./30° w. long.

5. Which of the following gives the correct latitude and longitude of S?
   (D) 60° s.lat./30° e. long.

6. Which of the following gives the correct latitude and longitude of T?
   (E) 30° n.lat./60° e. long.
7. Which map creates the most distortion nearest the poles?
   (B) a Mercator projection

8. Which of the following tools helps to determine direction?
   (B) a suspended bar magnet

9. A compass always points ...
   (E) Both A and B are correct

10. What two things determine the time indicated on a sundial?
    (D) the sundial’s latitude and the sun’s position

Match the term to its word or phrase that best defines it.

11. latitude  (B) equator

12. longitude  (A) prime meridian

13. azimuth  (C) horizon

14. projection  (E) distortion

15. topography  (D) contour

16. What is azimuth?
    (A) degrees around the horizon

17. Which statement is TRUE?
    (D) Globes produce less distortion than flat maps.

18. What is the International Date Line?
    (D) the longitude line where the new day begins

Examine the contour map shown and answer questions #19 and 20. Elevation is shown in meters.

19. Which hill is higher?
    (B) The hill in the west is higher.

20. Where is the steepest cliff on the map located?
    (E) east side of the western hill