

## Focus

*Hypsography* is the scientific study of Earth's topologic configuration above sea level, concentrating on the measurement and mapping of land elevations. An instrument used to measure these elevations is called a *hypsometer*. In this Chapter Project, students use a washer, string, and protractor to build a simple hypsometer. Then they measure angles of elevation and depression and use their results to make indirect measurements of height.

## Motivate

Work with students to brainstorm a list of nearby objects whose heights are already known or can be measured directly with some ease. Then make a second list of objects whose heights are not known and cannot be measured directly. Ask students if they know of any techniques for measuring unknown heights. Tell them that in this Chapter Project, they will learn how to make a simple device that can be used to measure heights indirectly by applying the mathematics they learned in this chapter.

# CHAPTER PROJECT TWELVE

## Working the Angles

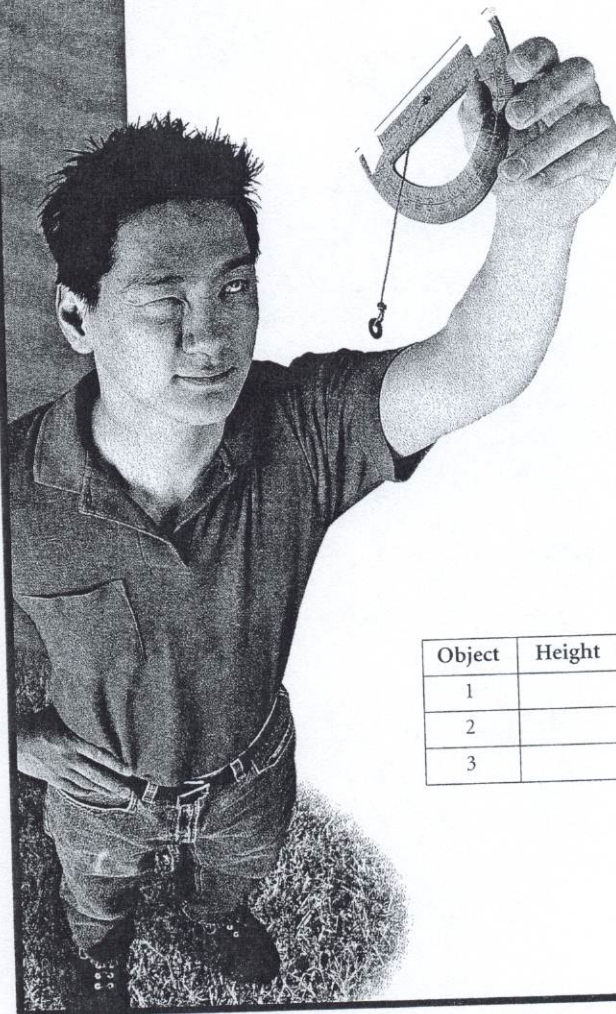
## Activity 1

## Building a Hypsometer

You will need: a protractor, a straw, tape, string, a metal washer (or other weight), and a tape measure (or other measuring device)

- Attach a straw to the edge of a protractor.
- Suspend a string tied to a washer from the hole in the protractor. This will give you the angle formed when you sight objects through the straw.
- Find three objects with known heights, and use the hypsometer to measure the angle from your position to the top of each object. Record your measurements in a table, including your horizontal distance from the object when you measured the angle.
- Compare the ratio of height to distance with the tangent of the angle created by the line of sight to each object.

Object	Height	Distance	Ratio (height/distance)	Angle	Tangent
1					
2					
3					



## Activity 1

- Students should gather the materials listed and construct a hypsometer as described.
- Students should choose three objects and use their hypsometers to take measurements. Data should be collected in the table given.
- Students should observe that the ratio height to distance is equal to the tangent of the angle.

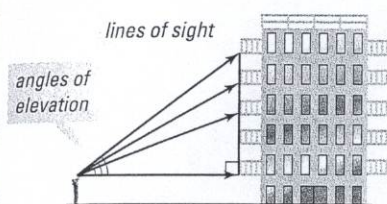


2

**Measuring Up**

- Use your hypsometer to measure the *angle of elevation* of three objects with unknown heights.
- Measure the horizontal distance between the hypsometer and the objects.
- Record your measurements in a table. Use the  $\tan^{-1}$  function on your calculator to compute the height.

Object	Distance	Angle	Height
1	?	?	?
2	?	?	?
3	?	?	?

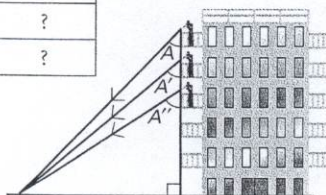


3

**Measuring Down**

- Use your hypsometer to measure the angle between the building and your line of sight from three unknown heights to a specific object on the ground. Call these angles  $A$ ,  $A'$ , and  $A''$ . (The unknown heights can be different floors of a building.)
- Measure the horizontal distance on the ground between the object and a point beneath the unknown heights.
- Use the  $\tan^{-1}$  function on your calculator and the formula  $\tan A = \frac{d}{h}$ , where  $d$  is distance and  $h$  is height, to compute the heights.

Object	Distance	Angle	Height
1	?	?	?
2	?	?	?
3	?	?	?

**Cooperative Learning**

Have students work in groups of three. In **Activity 1**, the group can work together to make the hypsometer and prepare a table for recording results. Then each student can use the hypsometer to take one of the three sets of measurements. Each student should record his or her results in the table. The group can then work together to complete the table and discuss the results.

**Activities 2 and 3** can be conducted in a similar fashion, with each group member taking and recording one set of measurements. The group can then complete the table together.

**Discuss**

After all groups have completed the three activities, bring the class together for a discussion of the results. If two or more groups calculated the height of the same object, have them compare results to see if they agree. If their results differ, discuss possible reasons for the differences. Have students assess the accuracy of their hypsometers. Ask them to suggest real-world situations in which it might be useful to have a hypsometer available for measuring a height.

**Activity 2**

- Students should choose 3 objects above them and use their hypsometers to take measurements.
- Students should calculate the height of the three objects by using the table given.

**Activity 3**

- a-b. Students should choose an object below them and use their hypsometer to take measurements from 3 different heights.
- c. Students should calculate the height of the viewing position by using the inverse tangent function and record data in the table given.

Unit 2



## Unit #2

Literacy Strategies (Check all that apply.)	Habits of Success (Check one per unit.)	Multiple Intelligence Areas
<input type="checkbox"/> Admit/Exit slips <input type="checkbox"/> Graphic organizer <input type="checkbox"/> Know/Want to Know/Learn chart (KWL) <input type="checkbox"/> Open-response questions <input type="checkbox"/> Double-entry/Two-column notes <input type="checkbox"/> Retelling <input type="checkbox"/> Reflection <input type="checkbox"/> Jigsaw reading <input type="checkbox"/> Anticipation guide <input type="checkbox"/> RAFT (Role/Audience/Format/Topic) <input type="checkbox"/> Interactive reading guide <input type="checkbox"/> Concept definition maps <input type="checkbox"/> Frayer model <input type="checkbox"/> Visual prediction guide <input type="checkbox"/> Other: _____	<input type="checkbox"/> Create relationships <input type="checkbox"/> Teamwork, responsibility, effective communication) <input type="checkbox"/> Study, manage time, organize <input type="checkbox"/> (Organization, time management, study skills) <input type="checkbox"/> Improve reading/writing skills <input type="checkbox"/> (Use reading and writing to learn strategies) <input type="checkbox"/> Improve mathematics skills <input type="checkbox"/> (Estimate, compute, solve, synthesize) <input type="checkbox"/> Set goals/plan <input type="checkbox"/> (Set goals, plan, monitor progress) <input type="checkbox"/> Access resources <input type="checkbox"/> (Research, analyze, utilize) <input type="checkbox"/> USE OF TECHNOLOGY	<input type="checkbox"/> Logical/Mathematical <input type="checkbox"/> Spatial <input type="checkbox"/> Musical <input type="checkbox"/> Bodily—Kinesthetic <input type="checkbox"/> Interpersonal <input type="checkbox"/> Intrapersonal <input type="checkbox"/> Naturalist <input type="checkbox"/> Linguistic

## UNIT Assessments:

Pre-Assessment:
Daily/Weekly: (Included on daily activities plans)
Post-Assessment:

## State Standards and Benchmarks:

**9-12.G.1.3** Draw three-dimensional objects and calculate the surface areas and volumes of these figures (e.g. prisms, cylinders, pyramids, cones, spheres) as well as figures constructed from unions of prisms with faces in common, given the formulas for these figures.

**9-12.G.2.3** Use basic geometric ideas (e.g., the Pythagorean theorem, area and perimeter) in the context of the Cartesian coordinate plane (e.g., calculate the perimeter of a rectangle with integer coordinates and with sides parallel to the coordinate axes, and of a rectangle with sides not parallel).

**-12.G.4.1** Solve contextual problems using congruence and similarity relationships of triangles (e.g., find the height of a pole given the length of its shadow).

**9-12.G.4.3** Know that the effect of a scale factor  $k$  on length, area and volume is to multiply each by  $k$ ,  $k^2$  and  $k^3$ , respectively.

**9-12.G.4.6** Apply basic trigonometric functions to solve right-triangle problems.

**9-12.G.4.7** Use angle and side relationships in problems with special right triangles (e.g., 30-, 60-, 90-, and 45-, 45-, 90- degree triangles).

**9-12.G.4.5** Understand how similarity of right triangles allows the trigonometric functions sine, cosine and tangent to be defined as ratios of sides and be able to use these functions to solve problems.

## Project:

**Day 1**

Benchmark: N/A

Learning Objective: ATjhe student will be able to demonstrate previous concepts necessary to completion of this unit

Assessment: Pre test

Accommodations:

Tier 2:

Tier 3:

Materials:

Strategy	Time	Activity
Bell work		
Introduction/Engage		
Explore/Review		
Assessment		
Closure		Create a foldable of formulas for surface areas of shapes and one for volumes.

Reflection:

**Day 2**