

Angles of Elevation and Depression

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Audience: Geometry or Trigonometry Students

Objectives:

- Students will be able to apply sine, cosine and tangent ratios to find angles of elevation and depression.
- Students will be able to measure lengths and use measurements to determine angle measures.

Standards:

North Carolina Standard Course of Study:

- Geometry – Goal 1.01 – Use trigonometric ratios to model and solve problems involving right triangles.
- Advanced Functions and Modeling – Goal 2.04 – Use trigonometric (sine, cosine) functions to model and solve problems.
- Pre-Calculus – Goal 2.02 – Use trigonometric and inverse trigonometric functions to model and solve problems.

National Council for Teachers of Mathematics:

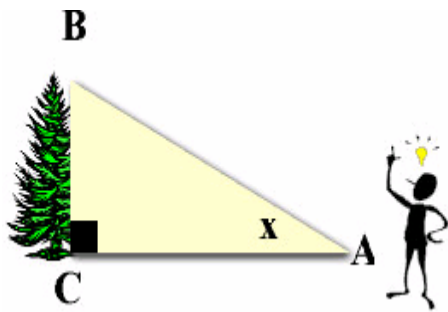
- Standard 2: Understand functions.
- Standard 4: Apply proper formulas to find measures.

Process Standards:

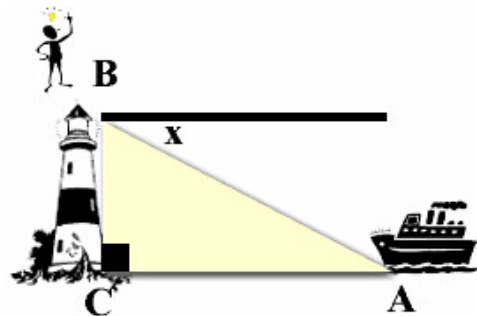
- Problem Solving, Connections, Representations

Explanation:

Trigonometric ratios have many practical real-world examples. Angles of elevation and depression are formed by the horizontal lines that a person's lines of sight to an object form. If a person is looking up, the angle is an elevation angle. If a person is looking down, the angle is a depression angle.



x = angle of elevation from ground to top of tree



x = angle of depression from lighthouse to boat

(Pictures taken from <http://regentsprep.org/regents/Math/rtritrig/LtrigW.htm>)

In this activity, students will use trigonometric ratios to determine the angle of elevation to the sun and the height of an unknown object. Student groups will use the height of a person and the length of his or her shadow to find the angle of elevation to the sun. Then, the students will use that angle of elevation and length of an unknown object's shadow to find the height of that object. *This activity gives the students two different applications of trig ratios.* In my example, I will use a football goalpost as the unknown object.

Preparation:

- Students should be comfortable with trig ratios and inverse trig ratios.
- Make sure you do this activity on a sunny day. Without shadows, the activity will not work.
- Students will need tape measurers to determine necessary lengths. If the school does not have tape measurers, ask the students to bring them from home (potentially for bonus points).
- Depending on the class size, the teacher may need to have more than one unknown object for the students to find the heights of. A sports field should have lots of options – goalpost, goal, flag pole, etc.
- It is not necessary that students have any formal definition of angle of elevation and depression. This activity could be used as an introduction to the concept (discovery) or as a supplement to previous instruction.

Activity: (students should be in groups of up to four people)

1. Measure the height of one person in the group.
2. Measure that person's shadow.
3. Using what you know about trig ratios, determine the angle of elevation from the ground to the sun.
(Students should sketch a picture of the situation to help make sense of the computation.)
4. Measure the shadow of the object.
5. Using the angle of elevation and the measure of the shadow, use what you know about trig ratios to determine the height of the object.
(Students should sketch a picture of the situation to help make sense of the computation.)
6. Fill in all of the information in your picture (you should now have two right triangles with 2 sides and an angle measure).
*** Depending on what measuring devices you have, tell your students what units to measure in ***

Assessment Possibilities:

- Ask the following question and have the students journal:
Can the sine or cosine of an angle ever be greater than 1? If so, when? If not, why?
- Have the students draw and describe their own application of angles of elevation and depression, complete with a solution.
- Give the students a few word problems with scenarios similar to the outside experience they did in class. The students should draw a picture and solve.

SHADOW?

What can I learn from my

Name: John Doe Date: 12-12-2012

Group Members: Mark, Roberto, Tasha

Objective: Students will apply trigonometric ratios and other things they know about right triangles to determine the height of an object outdoors.

Trig Ratios: $\sin = \frac{\text{opp}}{\text{hyp}}$ $\cos = \frac{\text{adj}}{\text{hyp}}$ $\tan = \frac{\text{opp}}{\text{adj}}$

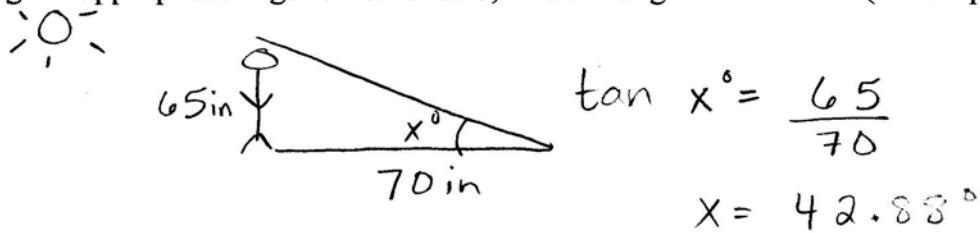
We have used right triangles to determine some important relationships that you have listed above. Today, you and your group members will use these ratios to determine the height of an object outside. Follow the following steps:

1. Pick one person in the group and measure height: 65 in

Name of person you are measuring: Tasha

2. Measure the length of that person's shadow: 72 in

3. Using the appropriate trigonometric ratio, find the angle of elevation (sketch picture):



4. Find the length of the shadow of the object your group has chosen: 126 in

5. Using the angle of elevation and the shadow length, find the height of the object:
 $\tan 42.88 = \frac{x}{126}$ $x = 117.004$ in

6. Sketch a picture of the object, its shadow, and the angle of elevation.

