

Math TODAY®

Teacher Edition




When a ruler isn't enough – Geometry

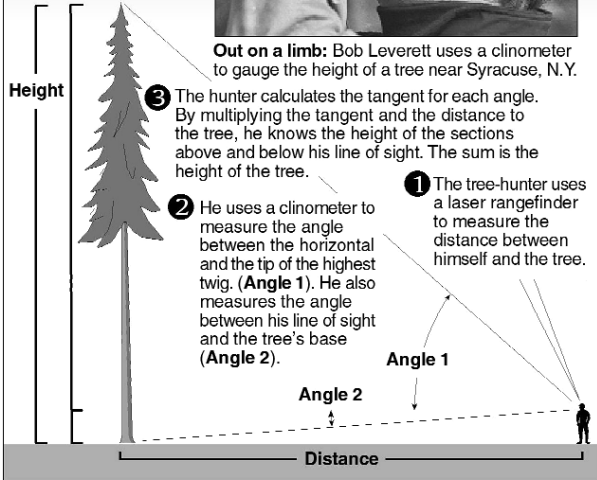
by: Bob Tower

When a ruler isn't enough

Tree hunters combine simple math and sophisticated instruments to measure tree height accurately. The method doesn't work for crooked trees or trees on uneven ground.



Out on a limb: Bob Leverett uses a clinometer to gauge the height of a tree near Syracuse, N.Y.



- 1 The tree-hunter uses a laser rangefinder to measure the distance between himself and the tree.
- 2 He uses a clinometer to measure the angle between the horizontal and the tip of the highest twig. (**Angle 1**). He also measures the angle between his line of sight and the tree's base (**Angle 2**).
- 3 The hunter calculates the tangent for each angle. By multiplying the tangent and the distance to the tree, he knows the height of the sections above and below his line of sight. The sum is the height of the tree.

Source: *Stalking the Forest Monarchs: A Guide to Measuring Champion Trees* By Grant Jerding, USA TODAY

Activity Overview:

Using the USA TODAY Infograph, "When a ruler isn't enough," you will explore the geometric relationships in similar right triangles. The altitude to the hypotenuse will create two right triangles that are similar to each other and to the original. You will determine measurements indirectly by using properties of similar triangles. You will apply the relationships to find solutions to a real-world problem.

Activity at a Glance:

- Grade level: 8-10
- Subject: Geometry
- Estimated time required: 30 minutes

Materials:

- TI-83 Plus family or TI-84 Plus family
- Cabri® Jr. Application
- TI-ViewScreen™ calculator for instruction/demonstration
- Student handout
- Transparency
- USA TODAY newspapers (recommended)

Prerequisites:

Students should:

- know how to use Cabri Jr.
- have prior knowledge about similar triangles.
- have prior knowledge about solving proportions.



© Copyright 2006 USA TODAY, a division of Gannett Co., Inc.

This activity was created for use with Texas Instruments handheld technology.

Copyright © 2000 by the National Council of Teachers of Mathematics, Inc. www.nctm.org. All rights reserved.

When a ruler isn't enough

Concepts:

- Similar right triangles
- Find measurement indirectly
- Solving proportions

Objectives:

Students will:

- explore the relationship between triangles formed by an altitude to the hypotenuse.
- use the geometric mean to solve for an unknown.

Background:

The purpose of this lesson is to help students to develop a better understanding of the mean proportional of a right triangle. In this activity, students will use concepts from their study of similar right triangles and the relationship between the triangles formed by the altitude from the right angle to the hypotenuse. Using the knowledge about the mean proportional, students will solve real-world problems using indirect measurements.

Preparation:

- Provide one graphing calculator for each student.
- Each student should have a copy of the corresponding student activity sheet.
- Provide each student with the following calculator file (AppVar) *GEOMEAN*.

Classroom Management Tips:

- Have the students link their calculator and share the AppVar as part of the class period on the previous day or during the beginning of the class period when you are going to use this activity. (Insure that graphing calculators have been updated with the latest version of operating system and Cabri Jr.)
- Review opening an AppVars using Cabri Jr. with your class before starting the activity.
- Students can work individually or in groups to assist each other during the activity.
- Have students discuss their discoveries while they work to better understand the relationships.
- Before starting the AppVars, remind students to carefully read the opening screen and the activity pages.
- Have students illustrate the geometric mean property with a diagram and summarize by using a proportion and a similarity statement.

Data Source:

Stalking the Forest Monarchs: A Guide to Measuring Champion Trees.

National Council of Teachers of Mathematics (NCTM)

Standards:

Geometry Standard

- Use visualization, spatial reasoning, and geometric modeling to solve problems.
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

Problem Solving Standard

- Solve problems that arise in mathematics and in other contexts.

Connections Standard

- Recognize and apply mathematics in contexts outside of mathematics.

Additional Resources:

TI Technology Guide, for information on the following:

- TI-83 Plus family or TI-84 Plus family
- Cabri Jr.

When a ruler isn't enough

Activity Extension:

- Challenge students to find and bring in other examples of this type of graph from USA TODAY. Use these as additional problems for students to continue working on this topic or use as a review for an exam.
- Have students work in pairs to go around campus and test the indirect procedure to determine the height of objects. Then compare the measurements for the groups and go through the procedures used.

Curriculum Connection:

- Algebra—solving proportions
- Art—proportional drawing
- Drafting—proportional drawing
- Environmental Science

Assessment and Evaluation:

Activity 1: You will explore proportional relationships formed by altitudes to the hypotenuse in right triangles. Complete Activity 1 before answering the Focus Questions.

Q. What can you conclude about $\triangle ADB$, $\triangle BDC$ and $\triangle ABC$?

A. They are similar.

Q. Move the pointer to A and press Alpha. Move A up or down but the $m\angle ABC$ must remain equal to 90° . Watch the parts of the triangle that are changing. Look at the ratios, AD/BD and BD/CD . What can you conclude about the ratios as you move A?

A. They remain equal as A is moved.

Q. Press CLEAR and move the pointer to C. Press Alpha and move C left or right. Again, the measure of $\angle ABC$ must remain equal to 90° . As you move C, what can you conclude about the ratios AD/BD and BD/CD as you move C?

A. They remain equal as C is moved.

Activity 2: Use the information from Activity 1 and the USA TODAY Infograph “When a ruler isn't enough” to answer the focus questions.

Q. To estimate the height of a tree, Nate uses a small square of plastic. He holds the square up to his eyes and walks away from the tree. He stops when the bottom of the tree lines up with the bottom edge of the square. Nate's eye level is about five feet from the ground. He is about 15 feet from the tree. Estimate the height of the tree.

A. The height of the tree is approximately 50 feet.

Q. If Nate's eye level is the same as above, how far has he walked away from the tree if the tree height is 55 feet?

A. He has walked about 16 feet.

Teacher Notes:

When a ruler isn't enough

Q. What is Nate's eye level if he is 8 meters from a 34-meter tree?

- A. His eye level is about 2 meters from the ground. The other solution using the Quadratic Formula would make Nate's eye level 32 meters from the ground, which should be rejected.

Teacher Notes:



If you are using the TI-Navigator Classroom Learning System, send the provided LearningCheck assessment to your class to gauge student understanding of the concepts presented in the activity. See the TI-Navigator Basic Skills Guide for additional information on how this classroom learning system may be integrated into the activity.