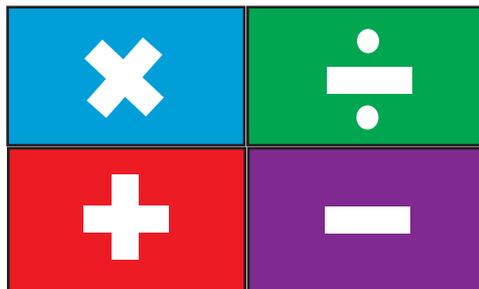


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When a Ruler Isn't Enough

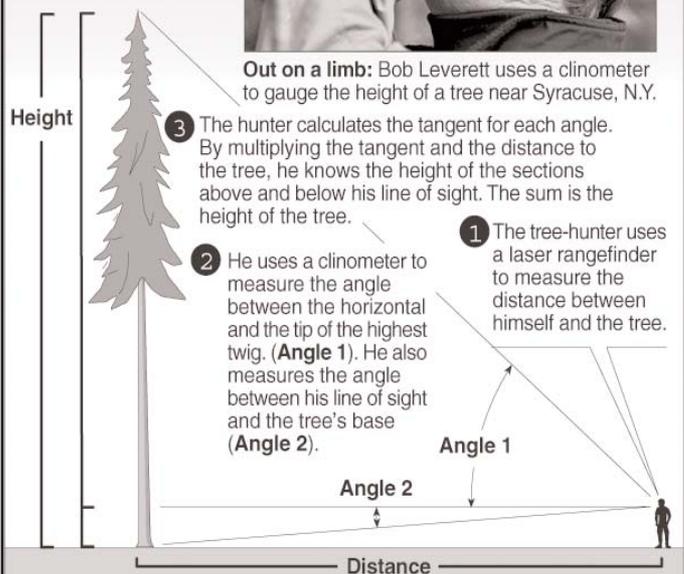
By: Bob Tower

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.

Source: *Stalking the Forest Monarchs: A Guide to Measuring Champion Trees*

By Grant Jerding, USA TODAY

Activity Overview:

This activity will show students a real-life problem that uses trigonometry to solve for an unknown. The USA TODAY Snapshot® "When a ruler isn't enough" explains how a tree hunter uses a clinometer and trigonometry to determine the height of a tree. The student will be asked to determine the angle that would be recorded on the clinometer when they measure the two included sides of the triangle. Students will use inverse trigonometric functions to determine this angle.

Activity at a Glance:

- Grade level: 9-12
- Subject: Geometry
- Estimated time required: 5-10 minutes

Materials:

- TI-83 Plus or TI-83 Plus Silver Edition
- Overhead view screen handheld for instruction/demonstration
- Student handout
- Transparency

Prerequisites:

Students should:

- be familiar with trigonometric ratios for a right triangle.
- be familiar with inverse trigonometric functions to find the angle.
- know how to change the mode on their handhelds from radians to degrees.
- know how to identify angle of elevation and angle of depression.

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Texas Instruments handheld technology.

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When a Ruler Isn't Enough

Concepts:

- Using right triangle trigonometry to solve for a side of the triangle
- Using inverse trigonometric functions to solve for an angle in a right triangle
- Reading and interpreting graphs

Objectives:

Students will:

- use right triangle trigonometry to determine the measure of a side of the triangle given one side and an angle.
- use inverse trigonometric functions to determine the angle between two given sides.

Background:

This activity will show students a real-life application of trigonometry. Students will use trigonometric ratios and inverse trigonometric relationships to determine the side of a triangle and the measure of the included angle. Students can research how to make a clinometer (see Activity Extension, page 3). Arrange for the students to go outside on campus to use their clinometers to determine the height of the building, goal posts or any object that they can't directly measure.

Preparation:

- Provide one graphing handheld for each student.
- Each student should have a copy of the corresponding student activity sheet.

Classroom Management Tips:

- Students will have a better understanding of how to read the graphic and retrieve data if you use the transparency for a class discussion before the students start working.
- Use the transparency with the class to clarify what represents the horizontal line of sight from the tree hunter to the tree, line of sight up to the top of the tree and line of sight down to the ground (base of the tree).
- Remind students to carefully read all parts of the graphic before they start collecting data.
- Remind students to have the handheld in degree mode or convert the degrees to radians before starting the activity.

Data Source:

Stalking the Forest Monarchs: A Guide to Measuring Champion Trees

National Council of Teachers of Mathematics (NCTM) Standards*:

Geometry Standard

- 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.

*Standards are listed with the permission of the National Council of Teachers of Mathematics (NCTM), www.nctm.org. NCTM does not endorse the content or validity of these alignments.

Additional Resources:

Student Handout

Transparency

TI Technology Guide, for information on the following:

- TI-83 Plus

When a Ruler Isn't Enough

Classroom Management Tips (continued):

- Suggest that the students label where the horizontal line of sight meets the tree for later use in this activity.
- Students can work individually or in small groups on this activity.
- Students can work individually or in groups to assist each other as they learn the various features of the handheld.
- Allow students to talk about the "how" and "why" approach they used to find the solution.
- This activity can be used as a review of concepts or a culminating activity with the class.

Activity Extension:

- As a class project have the students make their own clinometers. The following site will show you how to do this. Then have students go outside and try them.
www.rondexter.com/professional/sun/home-made_clinometer.htm
- Have the students visit the site listed below and write a report on how to use a clinometer.
www.forestry-suppliers.com/t01_pages/tt_pdf/1201_Clinometer.pdf

Activity: Goal posts in the NFL are 30 feet tall with a crossbar 10 feet from the ground. The two posts are 18 feet, 6 inches apart. Ask students to use the Pythagorean Theorem ($a^2 + b^2 = c^2$) to determine the distance from the top of the left goal post down to the corner where the right goal post meets the crossbar. Then, calculate the perimeter and the area (in yards) of a football field that is 160' wide, 100 yards long and has two end zones that are each 10 yards deep. Finally, using today's USA TODAY Sports section, have students create two of their own football-related math questions. Then, trade with a partner and solve.

Curriculum Connections:

- Environmental Science
- Earth Science

Teacher Notes:

When a Ruler Isn't Enough

Assessment and Evaluation:

According to the USA TODAY Snapshot "When a ruler isn't enough" the clinometer can be used to measure angle one (the angle of elevation) and angle two (the angle of depression) from the horizontal.

Q. The measure of angle one is 54° . A tree hunter is standing 30 feet from the tree. How far from the horizontal line of sight is the top of the tree?

A. It is approximately 41 feet to the top of the tree.

Q. The tree hunter is standing at the same position and the clinometer measures angle two as 10° . What is the distance from the horizontal line of sight to the ground? How tall is the tree?

A. It is approximately five feet to the ground. The tree is approximately 46 feet.

Q. The tree hunter is standing 60 feet from a tree on a flat surface and the distance from the ground to the horizontal line between angle one and angle two is six feet. The distance to the top of the tree from the horizontal is 87 feet. Estimate the angles of elevation and depression.

A. Angle one (angle of elevation) is approximately 55° and angle two (angle of depression) is approximately 6° .