Math TODAY™
Student Edition

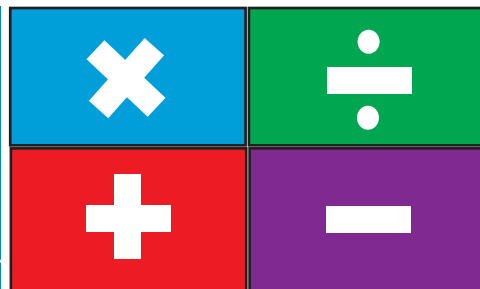**USA TODAY**
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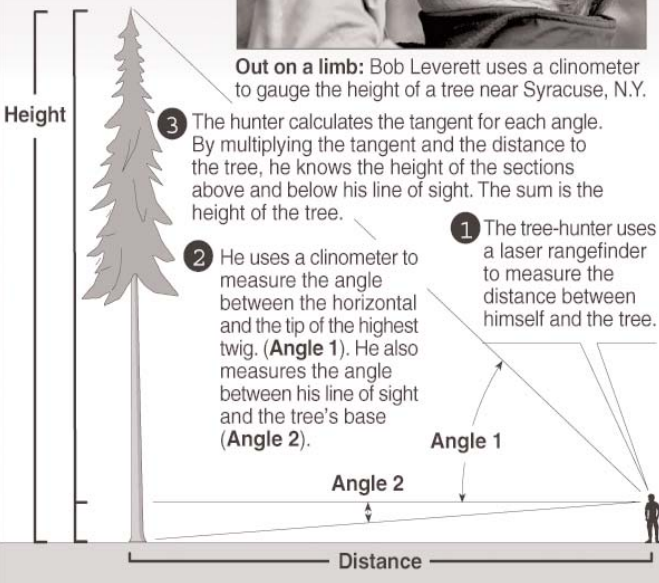
When a Ruler Isn't Enough

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.

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.

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**).

1 The tree-hunter uses a laser rangefinder to measure the distance between himself and the tree.

Height

Angle 1

Angle 2

Distance

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

Activity Overview:

There are times when you can't take a measurement directly and must rely on mathematical relations to help determine the measurement. A tree hunter uses a clinometer to measure the angle of a line of sight above and below horizontal. Once these angle measurements are known you can use them to calculate the height of the tree. You will also be given the tree height and distance that the tree hunter is from the tree and will be asked to determine the measure of angle one and angle two.

Focus Questions:

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.

- 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?

- 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?

- 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 line is 87 feet. Estimate the angles of elevation and depression.

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

When a Ruler Isn't Enough

Procedure:

Step 1

According to the USA TODAY Snapshot "When a ruler isn't enough," the clinometer will measure angle one and angle two from the horizontal. The measure of angle one, the angle of elevation, 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. Set up a ratio using right triangle trigonometry to find the height of the section of the tree above the horizontal line of sight.
B. Change the mode of your handheld to degree.
C. Use your handheld to determine the height of the tree above the horizontal and record the measurement below. Include the appropriate units with your answer.

_____

Step 2

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

A. Use right triangle trigonometry to find the distance of the section of the tree below the horizontal line of sight to the ground and record your measurement below. Include the appropriate units with your answer.

_____

B. How tall is the tree? _____

Step 3

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 angle of elevation (angle one) and angle of depression (angle two).

A. Again use right triangle trigonometry to write an equation that would represent the problem situation described.
B. Solve for the unknown and use your handheld to estimate each angle.

Angle One = _____

Angle Two = _____

Data Source:

Stalking the Forest Monarchs: A Guide to Measuring Champion Trees

Materials:

- TI-83 Plus or
  TI-83 Plus Silver Edition

Additional Information:

- Forestry Suppliers, Inc. -
  How to use a clinometer
  www.forestrysuppliers.com/
  t01_pages/tt_pdf/1201_
  Clinometer.pdf