

Math Challenge® Student Edition

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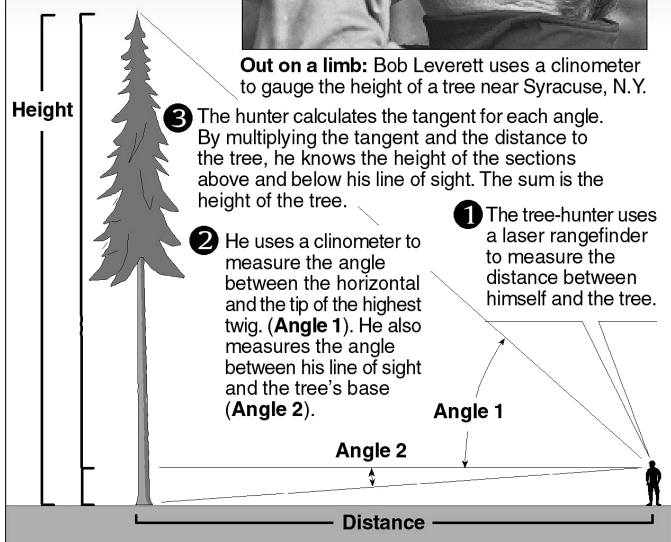
When a ruler isn't enough – Geometry

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

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.

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?

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

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.

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

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Procedure:

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

Step 1. Press \square , select Cabri Jr. and press \square .

Step 2. Press \perp (Y= button), select *Open...*, and press \square . Highlight **GEOMEAN** and press \square . A right triangle, ABC, with altitude BD will be manipulated to explore geometric properties. The measures of the angles in the opening screen are as follows, $m\angle ABD = 31^\circ$, $m\angle CBD = 59^\circ$, $m\angle A = 59^\circ$, $m\angle BDC = 90^\circ$, $m\angle ABC = 90^\circ$, $m\angle C = 31^\circ$, and $m\angle BDC = 90^\circ$. What can you conclude about $\triangle ADB$, $\triangle BDC$, and $\triangle ABC$?

Step 3. Look at the ratios AD/BD and BD/CD. What can you conclude about these ratios?

Step 4. Move the pointer to A and press \square . 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?

Step 5. Press \square and move the pointer to C. Press \square 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?

Step 6. Summary: In a right triangle, the altitude from the right angle to the hypotenuse divides the hypotenuse into two segments. The length of the altitude is called the geometric mean of the lengths of the two segments. And we now know, using the ratios from above, that $AD/BD = BD/CD$.

Data Source:

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

Materials:

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

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Procedure:

Activity 2: Answer the Focus Questions using the information from Activity 1.

Step 1. 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 to 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.

Step 2. 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?

Step 3. What is Nate's eye level if he is 8 meters from a 34 meter tree?

Student Notes: