

WAMC Lab Template

Math Concept(s): Calculating Tree Heights

Source / Text: <https://bigtrees.forestry.ubc.ca/measuring-trees/> and other internet sources

Developed by: Michael Brenner

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Date: Summer Conference 2022

Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Lab Plan

Lab Title: Calculating Tree Heights

Prerequisite skills: Students will need to know...

1. Pythagorean theory
2. Relationship between, sine, cosine, tangent in a right triangle
3. Familiarity with a construction square

Lab objective: At the end of the lesson, the student will be able to use a construction square or a triangle they fabricated from a piece of paper, to determine the height of a tree

Standards: (Note SPECIFIC relationship to Science, Technology, and/or Engineering)

Mathematics K–12 Learning Standards:

- HS.G.CO.D12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.)
- HS.G.SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

-

K-12 Science Standards

-

Technology

-

Engineering

-

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

- Global Awareness Financial/Economic/Business/Entrepreneurial Literacy Civic Literacy
 Health/Safety Literacy Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION

Creativity and Innovation

- Think Creatively
 Work Creatively with Others
 Implement Innovations

Critical Thinking and Problem Solving

- Reason Effectively
 Use Systems Thinking
 Make Judgments and Decisions
 Solve Problems

Communication and Collaboration

- Communicate Clearly
 Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy

- Access and Evaluate Information
 Use and manage Information

Media Literacy

- Analyze Media
 Create Media Products
Information, Communications and

Technology (ICT Literacy)

- Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability

- Adapt to Change
 Be Flexible

Initiative and Self-Direction

- Manage Goals and Time
 Work Independently
 Be Self-Directed Learners

Social and Cross-Cultural

- Interact Effectively with Others

- Work Effectively in Diverse Teams

Productivity and Accountability

- Manage Projects
 Produce Results
Leadership and Responsibility

- Guide and Lead Others

- Be Responsible to Others

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Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Tape measure
- Construction square
- Level
- Piece of plain paper
- trees

Set-Up Required:

- non rainy day. We will be measuring and taking data outside

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- See above

Cooperative Learning:

- Work in groups of two. One person measuring angle with square or student generated triangle, one person spotting first person for accuracy

Expectations:

- Students in groups of two to obtain data and calculate distance

Timeline:

- 1-2 class periods depending on size and length of class

LAB

Once outside you will find three trees that are marked '1' '2' '3'. I need you to

1. Find the height of each tree
2. Determine if the tree fell, will it hit the side of the CTE building?
3. Determine if the tree fell, will it hit any other items of importance (cars, power lines, light poles, etc.....) Assume the parking lot is empty but I have my car parked outside the roll up door.
4. Is there a tree not previously identified that can hit the side of the building? Take a picture of it and mark it accordingly and turn it in

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- Finding the height of any object

Career Applications

- Surveyor, Civil Engineer, tree trimmer

Optional or Extension Activities

- Height of eye (HOE) relationship to base can be used to determine whether to add or subtract indicated altitude to true altitude

Materials needed:

- Piece of plain paper
- scissors
- Construction square

Use this method to find the height of a tree without doing any math.

All you need for this method is a piece of paper and a tape measure. No calculations are necessary. However, if you're interested in how this works, you will soon love to trust the magic of trigonometry.

Fold a piece of paper in half so that it forms a triangle. If the paper is rectangular (not square), you'll have to

Fold one corner of the paper to meet the opposite edge. This brings the short side of the paper over to one of the long sides. Line up these two edges and crease the fold. You should now have a right triangle made from the folded sheet, plus an extra rectangle of single-sheet paper.

Cut off the extra paper. Cut along the edge of the triangle to separate it from the extra paper.

If you do not have scissors, fold the small rectangle over the triangle and crease well. Unfold the paper. Press down hard on the small rectangle with one hand, and on the rest of the paper with the other. Slowly move your hands apart to tear along the crease

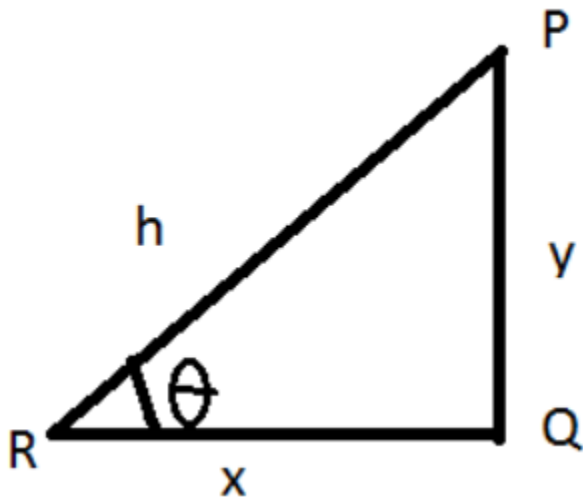
Unfold the triangle. You now have a perfect square with a diagonal crease in it.

So now fold one corner over so it forms a triangle again with the opposite side, then cut off the extra paper above the triangle. You should be left with the triangle you need.

NOTE: The triangle you made will have one right (90 degree) angle and two 45 degree angles.

Move back from the tree until you can sight the top of the tree at the top tip of the triangle. Close one eye and use the other to look directly along the longest side of the triangle, until you see the exact top of the tree. You want to find the point where your line of sight follows the longest side of the triangle to the very top of the tree

Mark this spot and measure the distance from it to the base of the tree. This distance is *almost* the full height of the tree. Add your own height to this, since you were looking at the tree from the height of your eyes off the ground. Now you have the full answer!



In the above figure, let

P be the top most point of the tree.

Q be the bottom point of the tree

R be the position of the observer's eye.

Then

PQ be the maximum height of the tree in feet;

QR be the distance between the tree and the observer's eye in feet.

PR be the line of sight or the line along which observer is observing the top of the tree.

The angle 'θ' is the angle of elevation.

Here are the relationships we know about 'θ' using the following formulae:

$$\sin \theta = y/h$$

$$\cos \theta = x/h$$

$$\tan \theta = y/x$$

We don't need to do any calculations in this method, because there's a little trick: the tangent of a 45° angle (which you used) equals 1. The equation can be simplified to this: (Height of tree) / (distance from tree) = 1. Multiple each side by (distance from tree) and you get: Height of tree = distance from tree.

Now, I am showing you what a construction square is, notice it is very similar to the paper square you made. This is what I use when I am in the woods and need to figure out how tall a tree is. Notice that is impervious to water and doesn't bend or warp.

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WAMC Lesson Plan

Name(s): Michael Brenner
Email Address: mikeb@ckschoola.org
Lesson Title: Calculating Tree Height
Date: 6/22/22
Text: handouts
STEM Correlation: Math
Lesson Length: 1 class period

Big Idea (Cluster): using simple tools to determine height of a tree	
Mathematics K–12 Learning Standards:	
HS.G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.)	
HS.G.SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*	
Mathematical Practice(s): right angle trigonometry	
Content Objectives: At the end of this lesson, the student will be able to apply right angle geometry in applied problems	Language Objectives (ELL): SL 9-10.4-5 This topic will contain academic vocabulary such as adjacent, opposite, hypotenuse, tangent. Ensure that ALL students are asking questions about unfamiliar words.
Vocabulary: adjacent, opposite, hypotenuse, tangent	Connections to Prior Learning: Fun with Stomp Rockets 1&2- measurement, Precision and Accuracy lesson
Questions to Develop Mathematical Thinking: <ul style="list-style-type: none">• Is it important to keep the device level?• How will you factor in the fact that the base of the tree is above or below your height of eye	Common Misconceptions: <ul style="list-style-type: none">• I'll just eyeball this• It's too close to the house, I 'll just hire someone to do it

Assessment (Formative and Summative):

<ul style="list-style-type: none">• Engage and connect with students as they take data. Check for understanding (formative)• Unit test using calculations (summative)
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Materials:

<ul style="list-style-type: none">•

WAMC Lesson Plan

Instruction Plan:

Introduction: discussion and review of Pythagorean theorem
When I observe students: Check for understanding as they discuss and work on the calculations
Questions to Develop Mathematical Thinking as you observe: is there anything else you need to worry about other than the object you want to protect?
Answers: Yes, that tree can fall in any direction, despite your best intentions
Summarize: class engagement in discussions

Career Application(s):

- | |
|--|
| <ul style="list-style-type: none"> • Tree trimming services, Civil Engineer |
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Leadership/21st Century Skills:

<p><u>21st Century Interdisciplinary themes</u> (Check those that apply to the above activity.)</p> <input type="checkbox"/> Global Awareness <input type="checkbox"/> Financial/Economic/Business/Entrepreneurial Literacy <input type="checkbox"/> Civic Literacy <input checked="" type="checkbox"/> Health/Safety Literacy <input checked="" type="checkbox"/> Environmental Literacy			
<p><u>21st Century Skills</u> (Check those that students will demonstrate in the above activity.)</p>			
<p>LEARNING AND INNOVATION <u>Creativity and Innovation</u></p> <input checked="" type="checkbox"/> Think Creatively <input checked="" type="checkbox"/> Work Creatively with Others <input type="checkbox"/> Implement Innovations <p><u>Critical Thinking and Problem Solving</u></p> <input type="checkbox"/> Reason Effectively <input type="checkbox"/> Use Systems Thinking <input checked="" type="checkbox"/> Make Judgments and Decisions <input checked="" type="checkbox"/> Solve Problems <p><u>Communication and Collaboration</u></p> <input checked="" type="checkbox"/> Communicate Clearly <input checked="" type="checkbox"/> Collaborate with Others	<p>INFORMATION, MEDIA & TECHNOLOGY SKILLS <u>Information Literacy</u></p> <input checked="" type="checkbox"/> Access and Evaluate Information <input checked="" type="checkbox"/> Use and manage Information <p><u>Media Literacy</u></p> <input type="checkbox"/> Analyze Media <input type="checkbox"/> Create Media Products <p><u>Information, Communications and Technology (ICT Literacy)</u></p> <input type="checkbox"/> Apply Technology Effectively	<p>LIFE & CAREER SKILLS <u>Flexibility and Adaptability</u></p> <input checked="" type="checkbox"/> Adapt to Change <input checked="" type="checkbox"/> Be Flexible <p><u>Initiative and Self-Direction</u></p> <input type="checkbox"/> Manage Goals and Time <input checked="" type="checkbox"/> Work Independently <input checked="" type="checkbox"/> Be Self-Directed Learners <p><u>Social and Cross-Cultural</u></p> <input checked="" type="checkbox"/> Interact Effectively with Others <input checked="" type="checkbox"/> Work Effectively in Diverse Teams	<p>Productivity and Accountability <u>Productivity and Accountability</u></p> <input type="checkbox"/> Manage Projects <input type="checkbox"/> Produce Results <p><u>Leadership and Responsibility</u></p> <input checked="" type="checkbox"/> Guide and Lead Others <input checked="" type="checkbox"/> Be Responsible to Others

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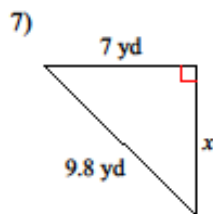
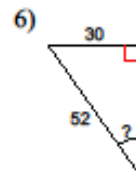
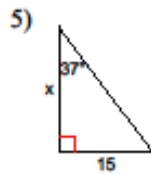
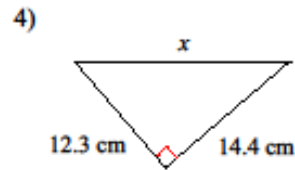
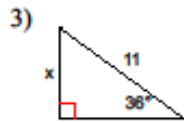
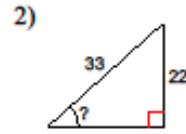
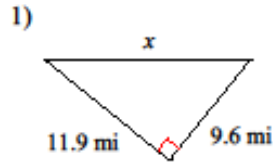
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9-4 Trig & Pythagorean Theorem mix up

Date _____ Period _____

Use Trig or the Pythagorean theorem to find the missing side or angle of each triangle.
Round angles to the nearest degree and to the nearest tenth for sides.



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