

WAMC Lab Template

Math Concept(s): Indirect Measurement

Source / Text:

Developed by: Sergio Fernandez E-Mail: Fernandez.Sergio@ysd7.org

Date: 06/25/24 – Summer Conference 2024

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):

- Students will use indirect measurement to calculate the height of various tall objects using an angle measuring tool (clinometer) and a tape measure. Students will use one measurement of distance and one angle of elevation to calculate the height of any tall object.

Lab Plan

Lab Title: How tall is that?

Prerequisite skills:

Understanding of trigonometry functions

Measurement with a tape measure

Measurement with a clinometer

Lab objective: To find the height of tall objects using the indirect measurement method.

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

Mathematics K–12 Learning Standards:

- **HSG-SRT.C**
Define trigonometric ratios and solve problems involving right triangles.

Standards for Mathematical Practice:

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Use appropriate tools strategically.
- Attend to measurements with precision.

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

- CCSS.ELA-Literacy.RST.9-10.3 - Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

<https://wa-appliedmath.org/>

- CCSS.ELA-Literacy.RST.9-10.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.
- CCSS.ELA-Literacy.RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words.
- SL. 9-10.4. Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
- L.9-10.6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

K-12 Science Standards

-

Technology

- 1.2.1 Communicate and collaborate to learn with others.

Engineering

- HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

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 type="checkbox"/> Health/Safety Literacy <input 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> <input type="checkbox"/> Think Creatively <input type="checkbox"/> Work Creatively with Others <input checked="" type="checkbox"/> Implement Innovations <u>Critical Thinking and Problem Solving</u> <input type="checkbox"/> Reason Effectively <input type="checkbox"/> Use Systems Thinking <input type="checkbox"/> Make Judgments and Decisions <input checked="" type="checkbox"/> Solve Problems <u>Communication and Collaboration</u> <input type="checkbox"/> Communicate Clearly <input checked="" type="checkbox"/> Collaborate with Others</p>	<p>INFORMATION, MEDIA & TECHNOLOGY SKILLS <u>Information Literacy</u> <input checked="" type="checkbox"/> Access and Evaluate Information <input checked="" type="checkbox"/> Use and manage Information <u>Media Literacy</u> <input type="checkbox"/> Analyze Media <input type="checkbox"/> Create Media Products <u>Information, Communications and Technology (ICT Literacy)</u> <input type="checkbox"/> Apply Technology Effectively</p>	<p>LIFE & CAREER SKILLS <u>Flexibility and Adaptability</u> <input type="checkbox"/> Adapt to Change <input type="checkbox"/> Be Flexible <u>Initiative and Self-Direction</u> <input type="checkbox"/> Manage Goals and Time <input type="checkbox"/> Work Independently <input type="checkbox"/> Be Self-Directed Learners <u>Social and Cross-Cultural</u> <input checked="" type="checkbox"/> Interact Effectively with Others <input checked="" type="checkbox"/> Work Effectively in Diverse Teams</p>	<p>Productivity and Accountability <input type="checkbox"/> Manage Projects <input checked="" type="checkbox"/> Produce Results <u>Leadership and Responsibility</u> <input checked="" type="checkbox"/> Guide and Lead Others <input checked="" type="checkbox"/> Be Responsible to Others</p>

<https://wa-appliedmath.org/>

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

Materials

- Each lab team (of 3-4 students) needs the following:
 - One tape measure (at least 25 ft.)
 - Clinometer (consisting of a protractor, string, and washer)
 - One clipboard or writing surface

Set-Up Required:

- Identify 3-5 tall objects for students to measure

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Lab teams of 3-4 students will be formed to complete the task. Each student will be assigned a specific role. One person on the lab team will be designated the team leader. It will be their responsibility to guide and lead others by ensuring the correct measurements are taken accurately.
- Other roles include someone to take measurements, someone to record measurements, and someone to stand and look for the top of the tall object. Each one of these roles is critical to the success of the project, requiring each student to be responsible to others.

Cooperative Learning:

- The process of taking measurements cannot easily be done alone. Students need to collaborate with others in their group to be successful with this project. Specific roles will be assigned to students ahead of time.

Expectations:

- Students will use the measurements they've taken and apply their knowledge of special right triangles to calculate the height of the tall objects.
- Students will confirm their calculations produced reasonable results by comparing their calculated results with their estimated results.

Timeline:

- All students will complete the data collection within a 50-minute class period.
- Most students will complete the calculations and answer all the lab prompts by the end of the class period. Students needing additional time will be given until the next day to answer the prompts.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- It is often not practical to measure the height of tall objects. Here are a few specific examples of why measuring the height of something might be important:
 - When replacing the rope of a flagpole, the height is needed to determine the length of the rope.

<https://wa-appliedmath.org/>

o When cutting down a tree, the height of the tree is important to ensure that the tree doesn't damage buildings or other objects as it falls.

o Near an airport, it would be important to know that power poles, trees, or other tall objects won't interfere with a flight path during takeoff and landing.

Career Applications

- Surveying
- Construction
- Tree Service

Optional or Extension Activities

- Try different observers (of varying heights) and compare results.
- The measurements could be used to calculate the measures of the angles in the special right triangles using the inverse trigonometric functions.

Washington Applied Math Council

<https://wa-appliedmath.org/>