

WAMC Lab Template

Math Concept(s): **Right Triangle Trigonometry**

Source / Text:

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Date: **Summer**

Conference 2021

Attach the following documents:

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

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

Students will utilize a measuring wheel, clinometer, and scientific calculator to determine the height of various tall objects such as flagpoles and trees. Students will apply trigonometric ratios and special triangle rules to calculate heights. Students will analyze differences in calculated values and attribute differences to measurement error, mathematical error, inaccurate assumptions, device limitations, or other environmental factors. This lab will occur after lesson 8.4 – Application of Trigonometric Ratios.

Lab Plan

Lab Title: **Clinometer Activity**

Prerequisite skills: **Students must know basic trigonometry ratios and how to apply them to find missing side lengths of right triangles.**

Lab objective: **Use properties of sine, cosine, and tangents to solve real-world problems.**

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

Mathematics K–12 Learning Standards:

- **G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.**

Standards for Mathematical Practice:

- **MP.1 Makes sense of problems and persevere in solving them**
- **MP.2 Reason abstractly and quantitatively**
- **MP.3 Construct viable arguments and critique reasoning of others**
- **MP.4 Model with mathematics**
- **MP.5 Use appropriate tools strategically**
- **MP.6 Attend to precision**

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

- **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.**

- 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.
- RST: 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

K-12 Science Standards

Technology

Engineering

Leadership/21st Century Skills:

- 3B.1 Demonstrate ability to work effectively and respectfully with diverse teams
- 4A.2 Evaluate information critically and competently
- 11A.1 Use interpersonal and problem-solving skills to influence and guide others toward a goal

<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</p> <p><u>Creativity and Innovation</u></p> <input type="checkbox"/> Think Creatively <input 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</p> <p><u>Information Literacy</u></p> <input type="checkbox"/> Access and Evaluate Information <input 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</p> <p><u>Flexibility and Adaptability</u></p> <input type="checkbox"/> Adapt to Change <input type="checkbox"/> Be Flexible <p><u>Initiative and Self-Direction</u></p> <input type="checkbox"/> Manage Goals and Time <input type="checkbox"/> Work Independently <input 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</p> <input checked="" type="checkbox"/> Manage Projects <input checked="" type="checkbox"/> Produce Results <p>Leadership and Responsibility</p> <input type="checkbox"/> Guide and Lead Others <input checked="" type="checkbox"/> Be Responsible to Others

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

Materials

- Clipboards for each group.
- Tall Outdoor Objects
- Clinometers
- Measuring Device - Tape Measure, Measuring Wheel, Free Easy Measure App, or other Cell Phone App.
- Desmos Calculator (or other scientific calculator with trigonometric functions).
- Cell Phone Camera
- With large classes this lab works best with a Teacher Assistant so that groups can be in multiple locations at the same time.

Set-Up Required:

- Assembled Clinometers – 1 per group. Students may pre-assemble.
- Clipboards for each group. Student Job Title Descriptions. Clinometer. Calculator. Measuring Wheel. Worksheet. Pencil.
- Assign students to groups of 4.
 - MANAGER: Location: Position your team where they belong at all times.
 - ARCHITECT: Angles: Measure angle of elevation to object with teammates. Hold the line steady for measurements. Remind teammates to subtract from 90°
 - ENGINEER: Calculations: Calculate height of object with teammates. Do NOT set calculator down. Return calculator to classroom.
 - ASSISTANT MANAGER: Records: Record horizontal distance and angle measures with team. Discuss differences and record team answer after discussion. Hold clipboards as needed.
- With large classes, measure 4 distances from the base of the flagpole to be used as the base of the triangle. With small classes, allow students to measure their own distances.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will solve problems by working together as a team to develop and analyze their results.

Cooperative Learning:

- Students will assist each other with calculations and compare results.

Expectations:

- Student groups must calculate the height of the flagpole utilizing geometry tools and trigonometry. Each student in the group will complete the calculation from a different distance.

Timeline:

- This lab can be completed in two 55 minute class periods. The measurement can be completed in one day and the discussion and conclusions will be completed the 2nd day.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- How can I determine the height of a tree, building, or other tall object without measuring it?

Career Applications

- Forestry, Navigation, Construction, Criminology

Optional or Extension Activities

- Calculate the height of the space needle or other tall building that you see.

Washington Applied Math Council

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Name: _____ Period: _____ Date: _____

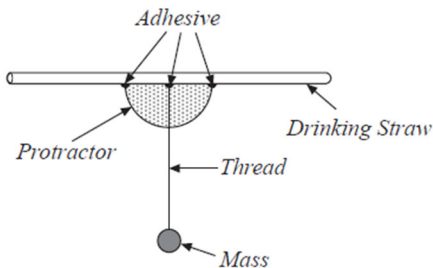
ACTIVITY 8.4 Angles of Elevation - *Clinometers*

MATERIALS NEEDED:

- 1) Tall Object Outside (Tree, Telephone Pole, Flag Pole, Other)



- 2) Clinometer – Provided with Math Binder Materials. This device will measure angles of elevation.



- 3) Measuring Device - Tape Measure, Measuring Wheel, Free Easy Measure App, or other Cell Phone App.



- 4) Desmos Calculator (or other scientific calculator with trigonometric functions).



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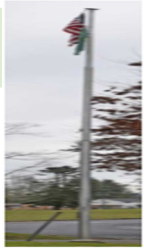
- 5) Cell Phone Camera – Optional. Draw image if no cellphone camera is available

Name: _____ Period: _____ Date: _____

ACTIVITY 8.4 Angles of Elevation - *Clinometers*

You can now use your clinometer to determine the height of the CHS FLAGPOLE

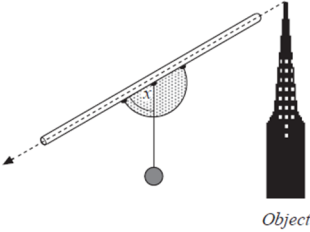
1. Choose your object.

<p>MY OBJECT IS</p> <p><u>CHS Flagpole</u></p>	<p>PICTURE OR DRAWING OF IMAGE</p> <p>Upload attachment to google classroom</p> 
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2. Measure and record your distance from the object. Each group member must be a different distance from the object.

<p>DISTANCE FROM OBJECT</p> <p>d = _____</p>
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3. View the top of it through the drinking straw. Read and record the value of angle x . Keep chin from tilting upward.

<p>MEASURE OF ANGLE OF ELEVATION</p> <p>$X =$ _____</p>	
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4. SKETCH YOUR SCENARIO. USE A TRIGONOMETRY TO SOLVE FOR THE HEIGHT OF YOUR OBJECT

<p>SHOW CALCULATION HERE</p> <p>HEIGHT = _____</p>	<p>DRAWING WITH MEASUREMENTS</p>
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Name: _____ Period: _____ Date: _____

ACTIVITY 8.4 Angles of Elevation - *Clinometers*

5. COMPARE YOUR MEASUREMENT TO YOUR PARTNERS/GROUPS – EXPLAIN POSSIBLE REASON FOR DIFFERENCES

HEIGHT MEASUREMENTS	POSSIBLE EXPLANATIONS
1) PERSON _____	
2) PERSON _____	
3) PERSON _____	
4) PERSON _____	

Name: _____ Period: _____ Date: _____

ACTIVITY 8.4 Angles of Elevation - Clinometers

You can now use your clinometer to determine the height of another object such as a building or a tree.

1. Choose your object.

MY OBJECT IS _____	PICTURE OR DRAWING OF IMAGE <p style="text-align: center; color: orange;">Upload attachment to google classroom</p>
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2. Measure and record your distance from the object. Each group member must be a different distance from the object.

DISTANCE FROM OBJECT d = _____

3. View the top of it through the drinking straw. Read and record the value of angle x . Keep chin from tilting upward.

MEASURE OF ANGLE OF ELEVATION $X =$ _____	
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4. SKETCH YOUR SCENARIO. USE A TRIGONOMETRY TO SOLVE FOR THE HEIGHT OF YOUR OBJECT

SHOW CALCULATION HERE HEIGHT = _____	DRAWING WITH MEASUREMENTS
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Name: _____ Period: _____ Date: _____

ACTIVITY 8.4 Angles of Elevation - *Clinometers*

5. COMPARE YOUR MEASUREMENT TO YOUR PARTNERS/GROUPS – EXPLAIN POSSIBLE REASON FOR DIFFERENCES

HEIGHT MEASUREMENTS	POSSIBLE EXPLANATIONS
1) PERSON _____	
2) PERSON _____	
3) PERSON _____	
4) PERSON _____	

MANAGER

Location: Position your team where they belong at all times.

Location: Measure horizontal distance from object with teammates.

ARCHITECT

Angles: Measure angle of elevation to object with teammates. Hold the line steady for measurements. Remind teamates to subtract from 90°

ENGINEER

Calculations: Calculate height of object with teammates. Do NOT set calculator down. Return calculator to classroom.

ASSISTANT MANAGER

Records: Record horizontal distance and angle measures with team.

Discuss differences and record team answer after discussion. Hold clipboards as needed.