WAMC Lab Template

Math Concept(s): Right Triangle Trigonometry

Source / Text:

Developed by: Colleen Kost E-Mail:ckost@sheltonschools.org

Date: _____

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 build a mini trebuchet to hit a target a reasonable distance away. The goal is for them to find the best angle to launch the eraser in order to accurately hit their target. This lab should be done after they learn basic trigonometry to find the side lengths of a triangle and as an introduction to using the inverse trig functions.

Lab Plan

Lab Title: Mini Trebuchet

Prerequisite skills: Write equations and solve for a variable, Use Pythagorean Theorem to find the missing side of a triangle, find the missing side of a triangle using right angle trig

Lab objective: Use the inverse trig functions to find the best angle to hit a target

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

Mathematics K–12 Learning Standards:

- CCSS.MATH.CONTENT.HSG.SRT.C.8
  Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Standards for Mathematical Practice:

- http://www.corestandards.org/Math/Practice/MP1/ - Make sense of problems and persevere in solving them
- http://www.corestandards.org/Math/Practice/MP2/ - Reason abstractly and quantitatively.
- http://www.corestandards.org/Math/Practice/MP4/ - Model with mathematics.
- http://www.corestandards.org/Math/Practice/MP5/ - Use appropriate tools strategically.
- http://www.corestandards.org/Math/Practice/MP6/ - 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.9-10.4Determine meaning of symbols, key terms, or other domain specific words and phrases as they are used in specific technical context.

- SL.9-10.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners building on others' ideas and expressing their own clearly and persuasively.

- SL.9-10.4 Present information, findings, and supportive 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.
- W.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

K-12 Science Standards

- HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

Technology

- 1.1.D Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

- 5.5.C Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

- 6.6.A Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

Engineering

- HS-TS1-2. 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:

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

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

Materials

-

Set-Up Required:

-

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

-

Cooperative Learning:

-

Expectations:

-

Timeline:

-

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

-

Career Applications

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Optional or Extension Activities

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WAMC Lesson Plan

Name(s): Colleen Kost
Email Address: ckost@sheltonschools.org
Lesson Title: Will it topple? (adapted from NTN lessons Geometry: Right Triangle Trigonometry)
Date: 06/21/2022
Text: STEM Correlation: Architecture and Engineering Lesson Length:3-5 days

Big Idea (Cluster): Right Triangle Trigonometry	
Mathematics K–12 Learning Standards: HSG-SRT.C.8	
Mathematical Practice(s):MP 4 – Model with Mathematics MP 6 – Attend to Precision	
Content Objectives: At the end of this lesson students will be able to use inverse trig functions and solve all parts of a right triangle.	Language Objectives (ELL): • Students will be able to name each part of the triangle. • Students will be able to describe which trig function is necessary to solve the parts of a right triangle.
Vocabulary: • Slope Ratio • Hypotenuse • Pythagorean Theorem • Sine • Cosine • Tangent • Ratio • Inverse Sine • Inverse Cosine • Inverse Tangent • Right Angle	Connections to Prior Learning • Write equations in one variable • Solve linear equations in one variable • Use multistep equations to solve applied problems • Rewrite a formula • Use Pythagorean Theorem and its converse • Find side lengths of a right triangle
Questions to Develop Mathematical Thinking: • How is a right triangle used to find the sine and cosine of an acute angle?	Common Misconceptions: • Assuming the opposite and adjacent sides are fixed legs of the triangle

Assessment (Formative and Summative):

- Formative Assessment – Exit Ticket
- Summative Assessment – Unit Test (Big Ideas Unit 9)

Materials:

- Calculators
- Trig Table worksheet
- “Will it topple” worksheet

Instruction Plan:

Introduction: Students will be given a picture of the Leaning Tower of Pisa with measurements on it for the two legs of the right triangle formed by the tower’s lean. Their task is to determine the current slant angle for the Leaning Tower of Pisa to determine how close the structure is to collapsing.
Explore: Collaborative exploring – Students will work in pairs and develop the slope ratios for different right triangles and fill in the “Trig Table”.

When I observe students:
Look for students who haven't made a connection between the graph and the slope of a line. Remind them of what slope ratios are and guide them on how to find it. Students are working together, talking to each other and developing ideas.

Questions to Develop Mathematical Thinking as you observe:
How do you find the missing side of right triangle when you have two other side lengths?
How do you find a slant angle without measuring it?
How do you use the sides of a right triangle to help find the angles?

Answers:
Use Pythagorean Theorem
Depending on what you're looking for use sine, cosine or tangent or the inverses as necessary.

Summarize: Students will explore how to use sine, cosine and tangent and their inverses by answering questions and filling in a trig table. At the end of the lesson, they will be given an exit ticket (formative assessment) to check for understanding.

Career Application(s):

- Archeologists use trig to divide up a dig site equally
- Criminologists use it to determine the path of a projectile
- Surveyors use trigonometry in various aspects of their job

Leadership/21st Century Skills:

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

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Entry Task:

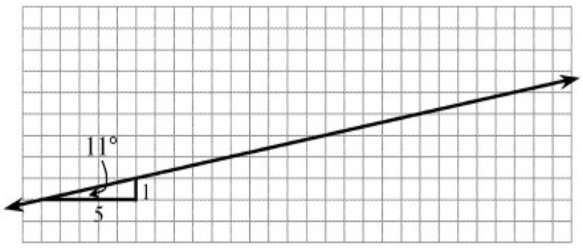
Will it Topple?

The Leaning Tower of Pisa, a free-standing bell town in the Italian city of Pisa, is expected to collapse once its angle of slant is less than 83°. Currently, the top of the seventh story (point A in the diagram at right) is 50 meters above the ground. In addition, when a weight is dropped from point A, it lands 5 meters from the base of the tower, as shown in the diagram. Your task is to determine the current slant angle for the Leaning Tower of Pisa, and thus how close this structure is to collapse.

Will it Topple?

Today we will begin to see how a table of slope angles and slope ratios can be used with right triangles.

1. a. Draw three new slope triangles on the line. Each should be a different size. Label each triangle with as much information as you can, such as its horizontal and vertical lengths and its angle measures.



b. What do these triangles have in common? How are these triangles related to each other?

c. Write the slope ratio for each triangle as a fraction, such as $\Delta y/\Delta x$. (Note: Δy represents the vertical change or "rise", while Δx represents the horizontal change or "run.") Then change the slope ratio into decimal form.

d. What do you notice about the slope ratios written in fraction form? What do you notice about the decimals?

2. Makala thinks she sees a pattern in these slope triangles, so she decides to make some changes in order to investigate whether or not the patterns remain true.

a. She asks, "What if I draw a slope triangle on this line with $\Delta y = 6$? What would be the Δx of my triangle?" Answer her questions and explain how you figured it out.

b. "What if Δx is 40?" she wonders. "Then what is Δy?" Find Δy, and explain your reasoning.

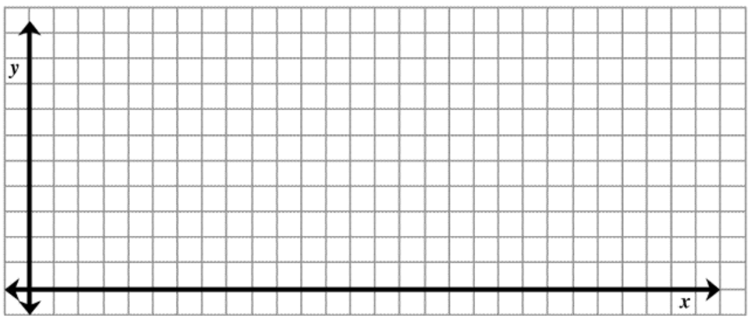
c. Makala wonders, "What if I draw a slope triangle on a different line? Can I still use the same ratio to find a missing Δx or Δy value?" Discuss this question with your team and explain to Makala what she could expect.

Will it Topple?

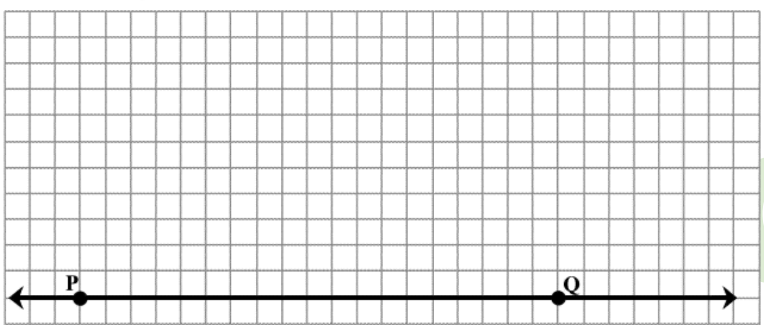
Changing Lines: Helping Makala Investigate

3. In part (c) of Problem #2 yesterday, **Makala asked, "What if I draw my triangle on a different line?"** With your team, investigate what happens to the slope ratio and slope angle when the line is different. Use the graph grids provided to graph the lines described below. Use the graphs and your answers to the questions below to respond to Makala's question.

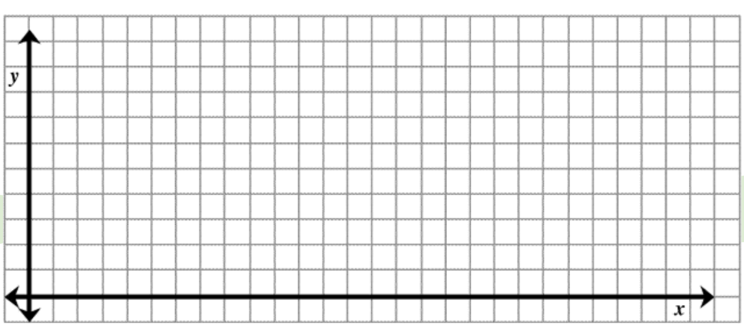
a. On graph A, graph the line $y = \frac{2}{5}x$. What is the slope ratio for this line? What does the slope angle appear to be? Does this information about this line support or change your conclusion from part (c) of problem #2 yesterday? Explain.



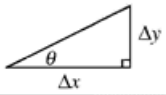
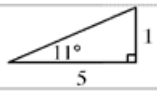
b. On graph B, you are going to create $\angle QPR$ so that it measures 18°. First, place your protractor so that point P is the vertex. Then find 18° and mark and label a new point, R. Draw ray $\overrightarrow{PR}$ to form $\angle QPR$. Find an approximate slope ratio for this line.



c. Graph the line $y = x + 4$ on graph C. Draw a slope triangle and label its horizontal and vertical lengths. What is $\frac{\Delta y}{\Delta x}$ (the slope ratio)? What is the slope angle?



Trig Table

Angle	Slope triangle	Approximate slope ratio as a fraction and a decimal
$\theta°$		$\frac{\Delta y}{\Delta x}$
0°		
8°		
11°		$\frac{1}{5} = 0.2$
18°		
22°		
45°		
55°		
68°		
70°		
72°		
79°		
83°		
84°		
89°		

Note: Angle measures are rounded to the nearest degree