INITIATE Lesson Plan: *Right Triangle Mathematics*

Lesson plan at a glance...

Name:	Sine Waves and Bloxter Programming
Course:	Engineering and Science Technologies Career Field - Robotics
Grade Level:	10 to 12
Prerequisites:	The participants have basic knowledge of creating simple equations associated with Sine, Cosine and Tangent; Right Triangles and Pythagoras. The participant should also have basic knowledge of Bloxter programming to run the smart car.
Time:	**Preparation: 15 minutes** **Instruction:** 215 minutes (Three Days)
Standard(s):	**Strand 2. Electrical/Electronics** Learners apply principles of electricity and electronics related to electronic theory, alternating and direct current, electronic components, electronic skills, digital electronics and power supplies. Knowledge and skills may be applied to fundamentals of electricity, analyzing and evaluating circuits, assembling components into electrical circuits, creating circuits to perform tasks and operations, wiring components to construct a communications system and providing power to an electrical system.

Competencies

Outcome: 2.1 **Electronic Theory:** Explain electrical principles and theories.

2.1.10 Evaluate frequency and phase.

Outcome: 2.2. **Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits.

2.2.10 Analyze wiring schematics and Diagrams for accuracy and function

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Outcome: 2.6 **Digital Electronics:** Create circuits to perform tasks and operations.

2.6.10. Identify the numbering systems, codes, arithmetic operations, Boolean operations, and simplification methods used in Digital electronics.

In this lesson plan…

Lesson Overview

This is an introductory lesson about sine, cosine and tangent, three important trigonometric functions, for grades 10-12. We start out by studying several similar right triangles and the ratio of certain two sides in them.

Sine, cosine and tangent are simply a RATIO of certain two sides in a right triangle. The triangles below all have the same shape, which means they are SIMILAR figures. That means they have the SAME ANGLE MEASURES but the lengths of the sides are different.

Students will be able to create equations using SOHCAHTOA to solve a problem. The smart car implements mathematical models developed during runtime. It helps in charting the path followed by the smart car and take decisions for subsequesnt actions. If mathematical models are not developed accurately, the result will be inaccurate. The equations demonstrated by the smart-car will enhance understanding of the relationship between Pythagoras, right triangles and sine waves.

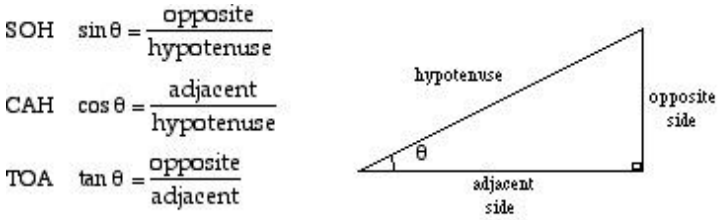


Diagram 1.

Driving Questions

Overarching Driving Questions for Bowsher Wide Project:

- How can we make smart cars safer and more convenient?
- How can we protect them from cyberattacks?

Lesson Specific Question:

- What are the relationships between Right Triangles, SOHCAHTOA and Pythagoras?
- How are Sine waves derived from Right Triangles?
- How can we calculate the hypotenuse of a Right Triangle and then program the smart car to avoid crashing into blocks before completing the Right Triangle in the fastest time? (Problem Statement)

Materials and Equipment

- Smart Cars
- Tablets
- Scrap Sheets
- Graph Sheets
- Pencil
- Mega Blocks
- Measuring Tape
- Timer (Stop Watch)
- One inch graph paper

Preparation Tasks

	• Teacher has given student teams different Right Triangles to complete. • The teacher must check whether all tablets are working, connected to the smart car, and have sufficient battery life. • To check whether the smart car is working, run it using a single command to make the car move forward for 2 seconds.	*Time: 10 to 15 minutes*

The Lesson

Warm-up Activity: ***What's your angle?***	*Time: 20 minutes*
Activity 1: ***What is SOHCAHTOA***	30 minutes
Activity 2: ***Who Was Pythagoras?***	20 minutes
Activity 3: ***How are Sine Waves, Right Triangles, SOHCAHTOA, and Pythagoras related?***	45 minutes
Activity 4: How can we program our smart car to stop it from crashing into an object or to intentionally make contact with an object?	45 minutes
Activity 5: Develop Algorithm's and program the Smart car to complete the Right Triangle in the least amount of time.	45 minutes
Wrap-up Activity: ***Discussion***	10 minutes

Warm-up Activity: What's your Angle? (10-15 minutes)

Activity Overview: In this activity, the objective of this lesson is introduced. How can you determine the Hypotenuse of a Right Triangle from only two pieces of Right Triangle information? For the later activities, a warm-up activity is performed here to revise the basic concepts required for the higher-level activities. Show Youtube Video to spark discussion.

Activity: **Section 1: Analyzing the right triangle and devising an algorithm (5 minutes)**

https://www.youtube.com/watch?v=Tr-oF7J0cBw

The problem statement will be given to the students. They will carefully analyze the data given in the problem. After analyzing the problem, they will devise the algorithm to solve. Seek multiple answers from the class. Summarize their thought and encourage the class to reach consensus.

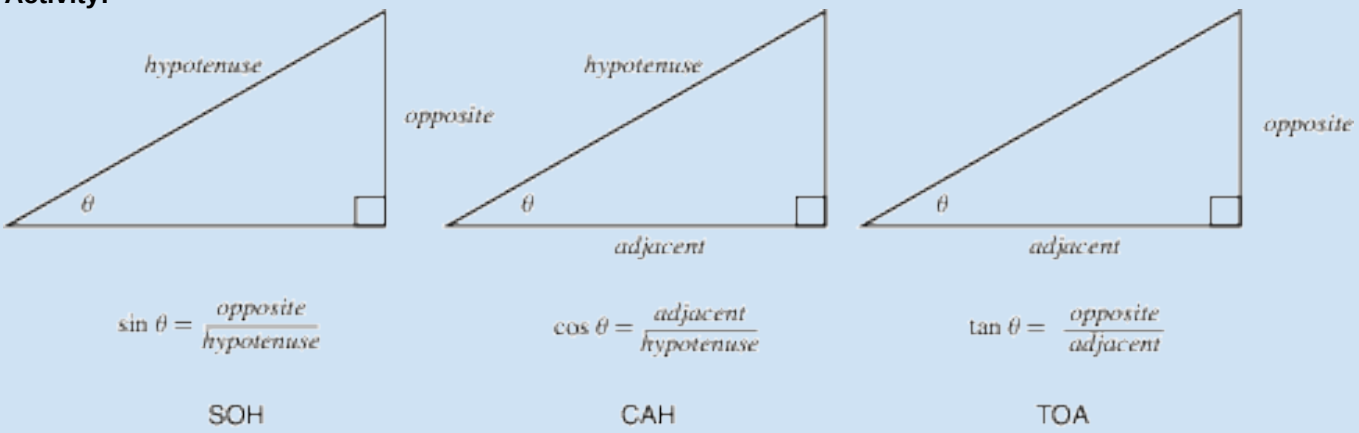
1. Give Students graph paper and competition objectives. Have them write out the algorithm steps to assist in programming the smart car. All members of the team need to participate if the team is going to be successful.

Activity 1: What is SOHCAHTOA? https://youtu.be/HnDvUaVjQ1I

(30 minutes)

Activity Overview: In this activity, students will use Sine Law, SOHCAHTOA and Angle Theta to solve Right Triangles.

Activity:



$$\sin\theta = \frac{opposite}{hypotenuse} \qquad \cos\theta = \frac{adjacent}{hypotenuse} \qquad \tan\theta = \frac{opposite}{adjacent}$$

SOH CAH TOA

What is angle Theta?
What is Sine Law?

https://sciencing.com/angle-theta-trigonometry-5075365.html
https://www.youtube.com/watch?v=ckx8V6tfaOk

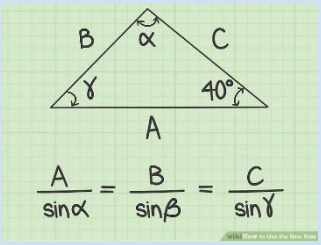


Diagram 2. SINE LAW

Teaching Tips:

- *List any suggestions you would have for someone else who might teach this lesson.*
- *Make sure students have pencil and paper and calculators.*

Activity 2: Who was Pythagoras? (20 minutes)

Activity Overview: In this activity, students will develop a thinking cluster associated with the seven questions to find out as much information as possible on Pythagoras.

Activity: https://youtu.be/YompsDlEdtc

In mathematics, the Pythagorean theorem, also known as Pythagoras' theorem, is a fundamental relation in Euclidean geometry among the three sides of a right triangle. It states that the square of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the other two sides.

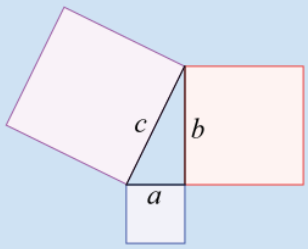


Diagram 3. $a^2 + b^2 = C^2$

Teaching Tips:

- *List any suggestions you would have for someone else who might teach this lesson.*

Activity 3: ***How are Sine Waves, Right Triangles, SOHCAHTOA, and Pythagoras related?*** (45 minutes)

Activity Overview: In this activity, students will answer the seven questions: Intuitive Understanding of Sine Waves

Activity:

https://betterexplained.com/articles/intuitive-understanding-of-sine-waves/

Teaching Tips:

- *List any suggestions you would have for someone else who might teach this lesson.*

Activity 4: How can we program our smart car to stop from crashing into an object and/or intentionally make contact with an object? (45 minutes)

Activity Overview: In this activity, students will learn the basic commands to avoid and then gently touch the Mega Blocks. First, diagram problem on graph paper and compare with team.

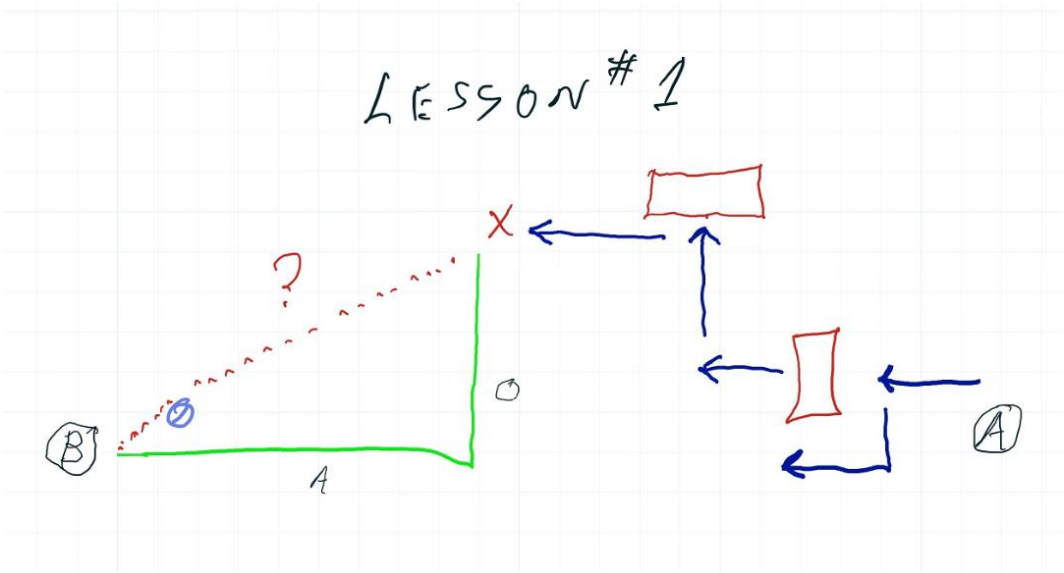


Diagram 4. Competition Diagram
(Not drawn to scale)

Activity: Program the Smart Car to avoid the Mega Blocks.

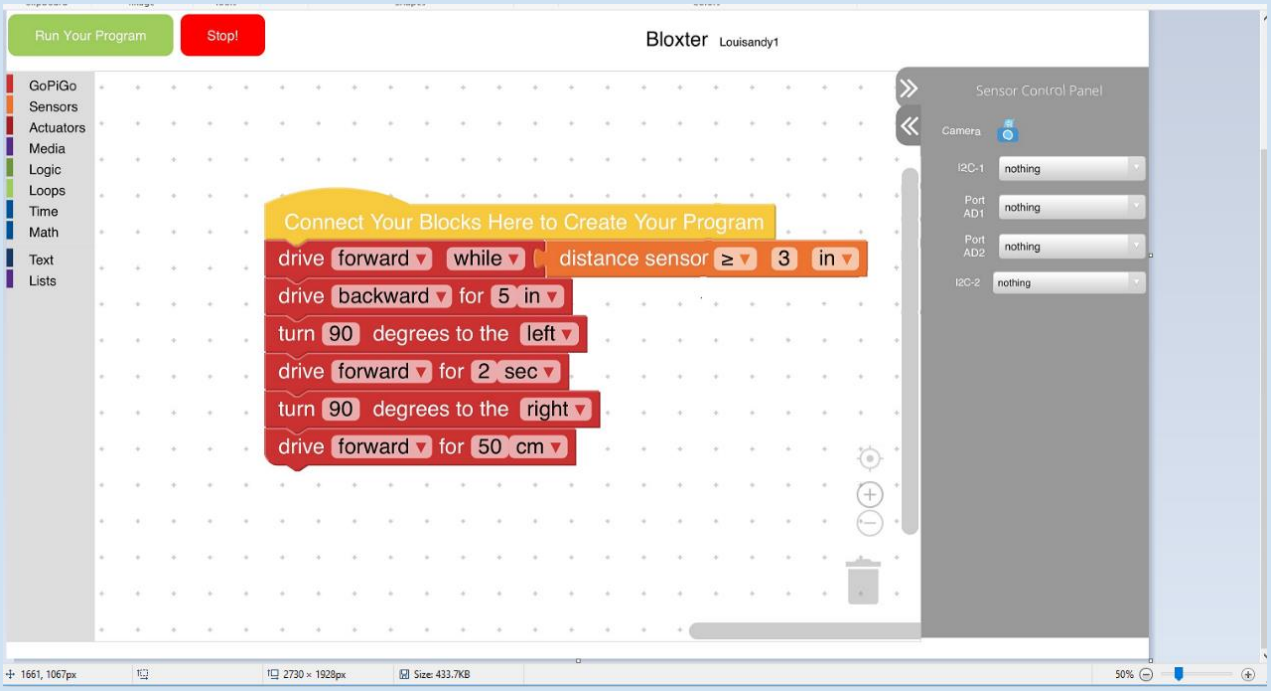


Diagram 5. Bloxter example

Teaching Tips:

- *List any suggestions you would have for someone else who might teach this lesson.*

Activity 5: ***Develop Algorithm's and program the Smart car to complete the Right Tri-Angle in the least amount of time.*** **COMPETITION** (45 minutes)

Activity Overview: In this activity, students will design and develop an algorithm to solve the problem.

Activity:

This further illustrates why it is important to properly program a smart car to perform specific tasks such as detecting an object and deciding to suitably avoid potential collision. This discussion would set the stage for the problems that each group will be given to solve using the smart cars. They will be asked to program their car to solve their problem. Instructional strategy:

Watch the YouTube video https://betterexplained.com/articles/intuitive-understanding-of-sine-waves/

1. to begin to understand the relationship between, Sine Law, SOH, CAH, TOA, Right Triangles and Pythagoras. Let them collaborate with each other and reach consensus.

The teacher should have students accomplish the assigned task and solve the problem by programming their car. The students must decide how to write their equation and decide how using inequalities would allow them to solve the problem (>, <, =).

- Problem: Prevent a smart car from crashing into an object. How can we program our smart vehicle to stop it from crashing into an object? For instance, if a smart car on the road senses that the car in front of it has come to a halt, then it needs to stop as well at a safe distance of say, 8-10ft from that car. For the GoPiGo smart car used in the classroom, let the safe distance be scaled down to 5 inches.

- Once the mathematical model is designed, the teachers are asked to develop the program using computational thinking for the smart car using Bloxter. Up until this point, we have used only the basic features of Bloxter programming. Note that there are few additional features available in Advanced Bloxter that will provide more flexibility to your program.

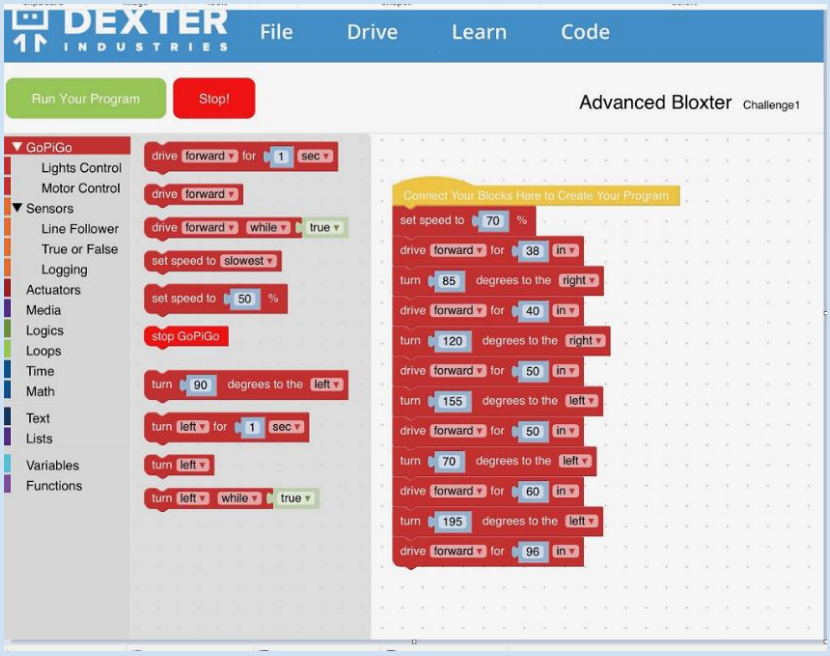


Diagram 6. Advanced Bloxter example

Teaching Tips:

- *List any suggestions you would have for someone else who might teach this lesson.*

Wrap-up Activity: Analysis and reflection (20 minutes)

Activity Overview: In this activity, students will …

Activity: Once the students have had time to work through their solutions, and once the teacher is satisfied that they have answered the seven questions, or at least tried to answer them, then the teacher can bring the whole group together to present their problems, questions and how they decided to solve it to the entire class. The end goal is to solve the problems using Sine Law, Pythagoras and Right Triangles; but some students may choose to represent the problem numerically, graphically, or even verbally at this point. It may be nice to allow this as a way to differentiate. Some students may not be thinking Sine Wave quite yet. Allowing different representations and then connecting them will help them to develop this conceptually leading to procedural fluency in this area.

It would also be useful to sequence the students' presentations from least sophisticated to most sophisticated. The more basic solution strategies can then connected to more sophisticated ones. By allowing even the failures to present, students can problem solve together and be more efficient and effective in future lessons.

In other words, allowing students the flexibility to choose how they present answers to the following questions could provide rich presentations and discussions. What equations and formulas did they use and what happened when they used those to develop an algorithm to program the car? What happened to the car? How far did it travel? Why do you think the car traveled that way when you used specific Bloxter commands? Make sure to cover the seven questions. This will allow time for students to discuss failures; what caused them and possible solutions.

The teacher would then ask the students how these problems relate to the larger question of; How can we program our smart car to complete the right triangle the fastest? The facilitator should use Google Classroom and have students post their problems and what solutions they used, to evaluate them later after the session is over.

Could you break down the problem and write the sequence of steps (an **algorithm**) that describes the process?
For the last part of the wrap-up activity, these are the set of questions to be discussed, involve the class and discuss to connect the mathematical modeling they have done in the class with the algorithm of the smart car. Moreover, what would be its repercussions if the faulty model implemented in the smart car, remember the article that we have read at the starting of the class. Summarize the session by discussing the following questions:

a) Do you think the smart cars have mathematical model implemented in the software?
b) How could you connect the Tesla car crash with Mathematical Modeling?
    a. Answer: The algorithm implemented might not be able to figure out the safe distance, or there could be a failure from sensors which feeds the data to the software.
c) What factors have you considered while designing the mathematical model
d) Which standard do you think are more appropriate for this lesson plan.

Assessment: Students will learn how Math can be used to create the algorithm for a car to automatically perform what is required to complete the Right Triangle. Also, student will learn how to not only avoid but move around an object.

Learning Objectives and Standards

Learning Objectives	Standards
Students will learn the relationships between Right Triangles, SOHCAHTOA and Pythagoras.	**Outcome: 2.1 Electronic Theory:** Explain electrical principles and theories. 2.1.11 Evaluate frequency and phase. **Outcome: 2.2. Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits. 2.2.10 Analyze wiring schematics and Diagrams for accuracy and function
Students will learn how Sine waves derived from Right Triangles	**Outcome: 2.1 Electronic Theory:** Explain electrical principles and theories. 2.1.12 Evaluate frequency and phase. **Outcome: 2.2. Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits. 2.2.10 Analyze wiring schematics and Diagrams for accuracy and function

Students will learn how to calculate the hypotenuse of a Right Triangle and then program the smart car to avoid crashing into blocks before completing the Right Triangle in the fastest time.	**Outcome: 2.1 Electronic Theory:** Explain electrical principles and theories. 2.1.13 Evaluate frequency and phase. **Outcome: 2.2. Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits. 2.2.10 Analyze wiring schematics and Diagrams for accuracy and function

Additional Information and Resources

Lesson Vocabulary

Term	Definition	For Additional Information
Algorithm	A step-by-step set of operations performed to solve a problem	http://en.wikipedia.org/wiki/Algorithm

Project-based Learning Features

Feature	Where does this occur in the lesson?
Driving Question	*At the beginning of this lesson. The question was how to* calculate the hypotenuse of a Right Triangle and then program the smart car to avoid crashing into blocks before completing the Right Triangle in the fastest time. *In this lesson plan, the students have learned that mathematical calculations can be programmed into a smart car to teach and reinforce concepts of* SOHCAHTOA, Right Triangles, Sine Law and Pythagoras*.*
Making Sense of Data	In Activity's 1 thru 3, students learned how to come up with the idea of how can they translate the path taken by a smart car using the mathematical model. Students will be able to create equations using SOHCAHTOA and Right Triangles to solve a problem. The smart car implements mathematical models developed during runtime. It helps in charting the path followed by the smart car and take decisions for subsequesnt actions. If mathematical models are not developed accurately, the result will be inaccurate. These mathematical model program equations demonstrated by the smart-car will enhance understanding of the relationship between Pythagoras, right triangles and sine waves. *In Activities 4 & 5, students had to understand the constraints provided in the problem statement.*
Investigation and Problem Solving	Students learned how to come up with the idea of how can they translate the path taken by a smart car using the mathematical model. Students will be able to create algorithm equations using SOHCAHTOA and Right Triangles to solve a problem.
Technology Incorporation	In every activity, the students had to use their tablet calculators to calculate values. Additionally, students had to use their smart cars and tablets to program the cars. Tablets were used to research data and work with Bloxter GoPiGo (programming language).
Collaborative Opportunities	After doing the calculations on the paper, students will share their answer with their team to check if they have the same answers or not. This will allow students to evaluate their team's design of algorithm. If a student feels that another student's approach is wrong, they will discuss the problem and try to come up with a collaborative answer.

Assessment Techniques	Students will learn how Math can be used to create the algorithm for a car to automatically perform what is required to complete the Right Triangle. Also, student will learn how to not only avoid but move around an object.

Computational Thinking Concepts

Concept	Where does this occur in the lesson?
Decomposition:	In Activity's 1 & 2, students learned how to come up with the idea of how can they translate the path taken by a smart car using the mathematical model. Students will be able to create equations using SOHCAHTOA and Right Triangles to solve a problem. The smart car implements mathematical models developed during runtime. It helps in charting the path followed by the smart car and take decisions for subsequesnt actions.
Data Representation:	In *Activity's 1* thru *5,* students are creating, representing and organizing data in appropriate graphs, charts, words, or images.
Pattern Generalization:	In *Activity's 4* and *Activity 5,* students were creating models and theories of observed patterns to test predicted outcomes.
Algorithm Design:	In *Activity 4 & 5*, students are creating an ordered series of instructions using advanced Bloxter programming for translating the mathematical model in a code understood by the smart car to win the competition.

Administrative Details

Contact info: Louis Jimenez,
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Sources:
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https://www.homeschoolmath.net/teaching/understanding_sine.php
Kuta Software – Infinite Algebra 2 – Sine Law – Worksheet #1
Pmath 10 – Mr. Duncan – SOHCAHTOA – Worksheet #2
Seven Questions – Pythagoras – Worksheet #3

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Template adapted from: https://edu.google.com/resources/programs/exploring-computational-thinking/