

SPIRIT 2.0 Lesson:
Pythagorean Theorem...Easy as ABC!

===== **Lesson Header** =====

Lesson Title: Pythagorean Theorem...Easy as ABC!

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1st Author (Writer): Lynn Spady

2nd Author (Editor/Resource Finder):

Algebra Topic: Pythagorean Theorem

Grade Level: Middle School

Cartoon Illustration Idea: ?

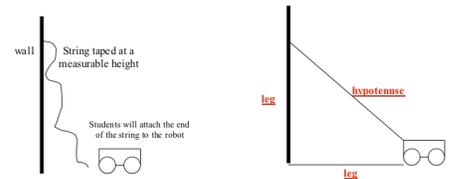
Outline of Lesson

Content (what is taught):

- Vocabulary associated with right triangles
- Pythagorean Theorem – calculating the length of the hypotenuse of a right triangle

Context (how it is taught):

- The robot is attached to a string, which is attached to the wall. The robot drives until the string is pulled tight, thus creating a right triangle.
- The legs of the triangle are measured and recorded.
- The hypotenuse is calculated using the Pythagorean Theorem.



Activity Description:

Pieces of string (various lengths) will be taped to the wall. The height at which these strings are taped will vary. The bottom of the string will hang freely so that students can attach the string to their robot. Students will drive the robot as far as it can, stretching the string and creating a right triangle. Students will measure the 2 legs and use the Pythagorean Theorem ($a^2 + b^2 = c^2$) to calculate the hypotenuse (string length).

Standards: (At least one standard each for Math, Science, and Technology - use standards provided)

Math: A3, D2

Science: A1, A2

Technology: B4, C4

Materials List:

Classroom Robot

String

Notebook

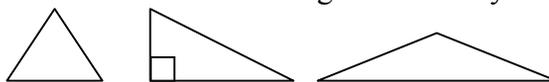
Meter Sticks

ASKING Questions (Pythagorean Theorem...Easy as ABC!)

Summary: Students are asked to identify different types of triangles and where they are located and how they are used in the world.

Outline:

- Draw different types of triangles on the board and/or write triangle vocabulary on the board.
 - Right, acute, obtuse
 - Isosceles, scalene, equilateral
- Ask students where triangles are found and how they are used in the world.



Questions	Possible Answers
1. Where do you see triangles in the world?	Sailboats, bridges, instruments, chips, quilts, floor tiles, etc.
2. What words are used to describe triangles?	Sides: equilateral means all sides are equal, isosceles means that 2 sides are equal, and scalene means that all sides are different. Angles: right means that there is a 90 degree angle, acute means that all angles are between 0 and 90 degrees, and obtuse means that there is one angle that measures between 90 and 180 degrees. Right Triangles: legs and hypotenuse 30-60-90 45-45-90
3. What types of triangles do you see in these images? Are some more common than others? Why?	<ul style="list-style-type: none"> ○ triangle0.jpg: right triangle in window, isosceles triangle on bars ○ triangle1.jpg: equilateral triangle, right triangle ○ triangle2.jpg: isosceles triangle ○ triangle3.jpg: scalene right triangle ○ triangle4.jpg: isosceles triangle, obtuse triangle ○ triangle 5.jpg: scalene right triangle ○ triangle6.jpg: obtuse isosceles triangle ○ triangle7.jpg: right triangle ○ triangle8.jpg: obtuse isosceles triangle ○ triangle9.jpg: equilateral triangle ○ triangle10.jpg: right triangle

11 Triangle Images (triangle0-10.jpg)

EXPLORING Concepts (Pythagorean Theorem...Easy as ABC!)

Summary: Students will connect their robot to the string and drive it until the string is pulled tight creating a right triangle.

Outline:

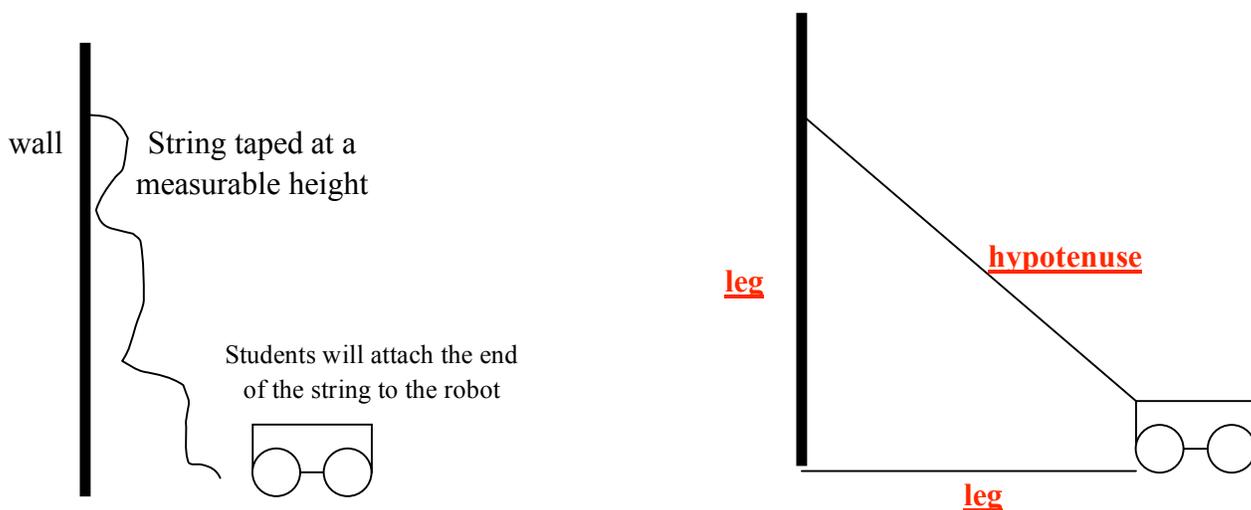
- The robot is attached to a free-hanging string attached to the wall
- Students drive the robot until the string is pulled tight, thus creating a right triangle
- Students measure the 2 legs of the right triangle
- Students predict/estimate the length of the string.
- Students connect a different robot to another string (different length and height) and create another right triangle by driving the robot until the string is pulled tight. Students predict/estimate the length of the string.
- Students compare/contrast the triangles created.

Activity:

Two pieces of string (different lengths) will be taped to the wall. The height at which these strings are taped will be different. The bottom of the string will hang freely so that students can attach the string to their robot. Students will drive the robot as far as it can, stretching the string and creating a right triangle. Students will repeat this process with a different string and another robot.

Students will have a discussion about the triangles created. As a formative assessment, you can note whether students are using triangle vocabulary (right, acute, isosceles, scalene, etc.) to describe the triangles. If students do not come up with it on their own, it should be pointed out that the string is the hypotenuse of the right triangle and the hypotenuse is always the longest side in a right triangle. Also, point out the legs of the triangle, which students might want to measure and record. Students can also measure the angles using a protractor.

Video Clip Idea: Video clip of procedure

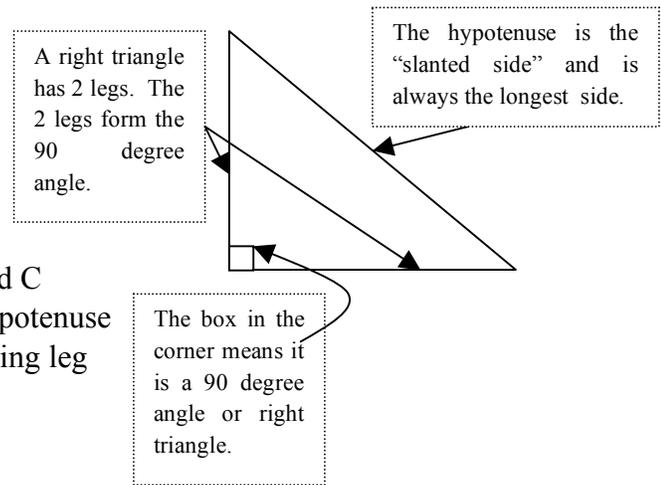


INSTRUCTING Concepts (Pythagorean Theorem...Easy as ABC!)

Summary: The teacher explains the Pythagorean Theorem and how it can be used to calculate the length of a leg or the hypotenuse of a right triangle.

Outline:

- Define right triangle, leg, and hypotenuse
- State the Pythagorean Theorem and identify A, B, and C
- Apply the Pythagorean Theorem and solve for the hypotenuse
- Apply the Pythagorean Theorem and solve for a missing leg



Activity:

We can find the length of the hypotenuse in a right triangle by using the measurements of the 2 legs. For example, if the lengths of the legs were 3 feet and 4 feet, we can use the Pythagorean Theorem to solve for C (or the hypotenuse).

$$\begin{aligned}a^2 + b^2 &= c^2 \\3^2 + 4^2 &= c^2 \\9 + 16 &= c^2 \\25 &= c^2 \\5 &= c\end{aligned}$$

Note that it doesn't matter if 3 is A or B because the commutative property of addition says that $A + B = B + A$.

Once students feel comfortable with finding the hypotenuse length, try solving for one of the legs. Make sure to point out that the lengths are not always perfect squares. Sometimes it is appropriate to estimate while other times it is necessary to use a calculator.

ORGANIZING Learning (Pythagorean Theorem...Easy as ABC!)

Summary: Students will use their notebook to draw the triangles created and record measurements. Students will use the Pythagorean Theorem to calculate the length of the string.

Outline:

- Connect the end of the string to the robot
- Drive the robot so that the string is pulled tight, thus creating a right triangle
- Measure the 2 legs and record
- Use the Pythagorean Theorem to calculate the hypotenuse (string) length

Activity:

Two pieces of string (different lengths) will be taped to the wall. The height at which these strings are taped will be different. The bottom of the string will hang freely so that students can attach the string to their robot. Students will drive the robot as far as it can, stretching the string and creating a right triangle.

Students will draw the triangle in their notebook and record the measurements of the 2 legs. Next, students will calculate the length of the string by applying the Pythagorean Theorem.

Worksheet Idea: A sample student sheet

UNDERSTANDING Learning (Pythagorean Theorem...Easy as ABC!)

Summary: Students will use the Pythagorean Theorem to solve for missing lengths of a right triangle.

Outline:

- Formative assessment of right triangle vocabulary (leg, hypotenuse, 90 degree angle, Pythagorean Theorem)
- Summative assessment of Pythagorean Theorem ($a^2 + b^2 = c^2$)

Activity:

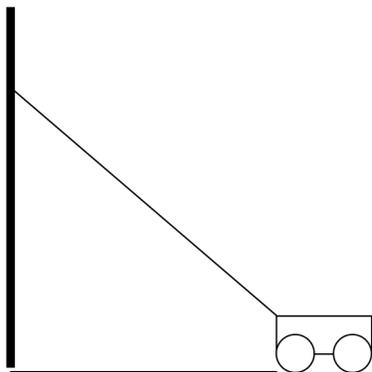
Formative Assessment

As students are engaged in learning activities, ask yourself or your students these types of questions:

1. Can students identify the legs and hypotenuse in a right triangle?
2. Do students understand that the hypotenuse is the longest side of the triangle?
3. Were the students able to apply the Pythagorean Theorem and solve for the hypotenuse?

Summative Assessment

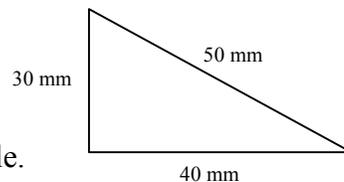
1. A set-up can be created as illustrated below. The 2 legs can be measured and given to the students. Students will solve for the hypotenuse using the Pythagorean Theorem. Students can do a write-up of the problem and the solution. A rubric can be used to assess understanding.



2. Students could answer these quiz questions:

Answer the following questions using the triangle given.

1. The square in the corner tells you this is a _____ triangle.
2. The sides that measure 40 mm and 30 mm are called the _____ of the triangle.
3. The side that measures 50 mm is called the _____ of the triangle.
4. How do you know which side is the hypotenuse?



Find the length of the hypotenuse if the legs measure 8 cm and 15 cm.