Lesson #1: The Pythagorean Theorem (2 days)

Objectives

Students will be able to...

- Determine the distance between two points on a coordinate plane using the Pythagorean theorem.

Common Core Standards

LS 11-12.6
RSIT 11-12.2
RLST 11-12.2
Writing 9-10.5
Problem Solving/Critical Thinking 5.4
Health and Safety 6.2, 6.3, 6.6, 6.12
Responsibility and Leadership 7.4, 9.3
CCSS.MATH.PRACTICE.MP6
CCSS.MATH.PRACTICE.MP2
CCSS.MATH.PRACTICE.MP1
Residential and Commercial Construction Pathway D2.1, D2.2, D3.1, D3.7

Materials

Pythagorean Theorem: Finding the Hypotenuse of a Right Triangle Worksheet
Pythagorean Theorem in Real Life Worksheet
Pythagorean Theorem Ramp Project Practice
The Pythagorean Theorem-Rubric for Ramps

Lesson Sequence

- Pass out ***Pythagorean Theorem: Finding the Hypotenuse of a Right Triangle Worksheet*** and review with the class. Answer any questions as needed (30 minutes).
- Pass out ***Pythagorean Theorem in Real Life Worksheet*** and have students work on this independently (20 minutes). Answer any questions as needed.
- Review the ***Pythagorean Theorem in Real Life Worksheet*** as a class (10-15 minutes).
- Pass out the ***Pythagorean Theorem Ramp Project Practice*** and have students practice creating a ramp (35-40 minutes).

© **BITA:** A program promoted by California Homebuilding Foundation

Assessment

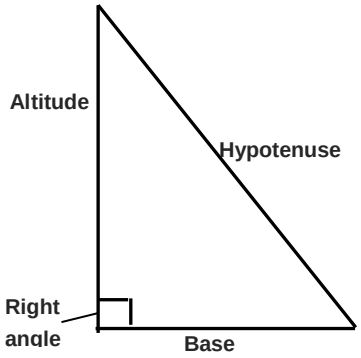
Check for understanding through questioning and calling on random students.

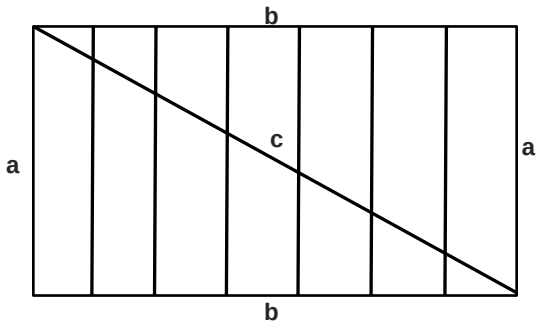
Collect worksheets and grade worksheets to check for understanding of concept. Provide additional assistance to students who may need it.

Accommodations/Modifications

Check for Understanding
One on One Support
Calculators
Scaffolded Instructions as Needed
Peer Support As Needed

Pythagorean Theorem: Finding the Hypotenuse of a Right Triangle Worksheet





Woodworkers must make sure that the sides, tops, and bottoms of casework are square to each other during assembly. In this sense, square means that the parts are at right angles to each other.

As shown in the figure, a diagonal line drawn on a rectangular surface divides the surface into two triangles. If the sides of the rectangle are truly at right angles to each other, then both triangles will be right triangles. The Pythagorean theorem can be used to determine whether the triangles are right triangles.

The Pythagorean theorem states that in a right triangle, the hypotenuse squared equals the sum of the squares of the two remaining sides. The hypotenuse is the side opposite the right angle. The formula is $a^2 + b^2 = c^2$, where 'a' is the altitude, 'b' is the base, and 'c' is the hypotenuse.

A simplified equation is c = $\sqrt{a^2 + b^2}$

e.g. a triangle with sides 5, 12, 13

$5^2+12^2 = 13^2$

25+ 44 = 169

5, 12 13 is a perfect combination and the triangle is a right-angled triangle

e.g. a triangle with sides 7,7,10

$7^2 + 7^2 = 10^2$

49 + 49 = 98

7, 7, 10 is not a perfect combination and the triangle is not a right-angled triangle because $10^2 = 100$.

© **BITA:** A program promoted by California Homebuilding Foundation

Terms

Right Triangle - a triangle with one right (90-degree) angle

Pythagorean Theorem - in a right triangle, the hypotenuse squared = sum of squares of other sides

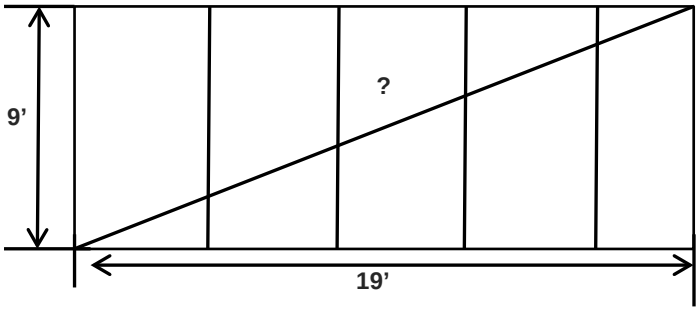
Hypotenuse - the side of a right triangle that is opposite the right angle

Altitude or Leg - the vertical side of a triangle

Base or Leg - the bottom of a triangle

Find the diagonal of a wall that is 9' high and 19' long.

Step 1	The formula is $c = \sqrt{a^2 + b^2}$
Step 2	Insert he known values. $c = \sqrt{9^2 + 19^2}$
Step 3	$c = \sqrt{81 + 361}$
Step 4	$c = \sqrt{442}$
Step 5	c = 21.0238'



Use a calculator to complete the following problems.

1. Find the diagonal of a floor that is 12' long and 14' wide.

   A) 9.2195'

   B) 18.4391'

   C) 27.6586'

   D) 36.8781'

2. Find the diagonal of a wall that is 8' high and 11' long.

   A) 13.6015'

   B) 27.2029''

   C) 40.8044'

   D) 54.4058'

3. If a floor is 15' × 22', then the diagonal is

   A) 13.3135'.

   B) 19.9703'.

   C) 26.6271'.

   D) 53.2540'.

You can use the same formula to find the length of a right triangle's leg if you are given measurements for the lengths of the hypotenuse and the other leg. Consider the example below.

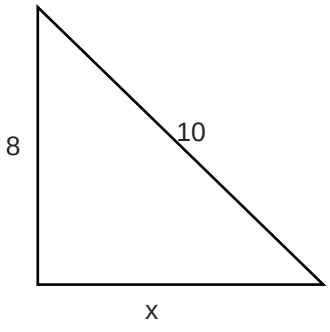
a =? b = 6 c = 7	In this right triangle, you are given the measurements for the hypotenuse, *c*, and one leg, *b*. The hypotenuse is always opposite the right angle and it is always the longest side of the triangle.
$a^2 + b^2 = c^2$ $a^2 + 6^2 = 7^2$	To find the length of leg *a*, substitute the known values into the Pythagorean Theorem.
$a^2 + 36 = 49$ $49 – 36 = 13$ $a^2 = 13$ $a \approx 3.6$	Solve for a^2. Think: what number, when added to 36, gives you 49? Use a calculator to find the square root of 13. The calculator gives an answer of 3.6055, which you can round to 3.6. (Since you are approximating, you use the symbol ≅ .)

Which of the following correctly uses the Pythagorean Theorem to find the missing side, *x?*

A. $8^2 + 10^2 = x^2$

B. $x + 8 = 10$

C. $x^2 = 8^2 = 10^2$



Pythagorean Theorem in Real Life Worksheet

Uses of Pythagoras' Theorem

You may have heard about Pythagoras's theorem (or the Pythagorean Theorem) in your math class, but what you may fail to realize is that Pythagoras's theorem is used often in real life situations. According to Pythagoras's theorem the sum of the squares of two sides of a right triangle is equal to the square of the hypotenuse. Let one side of the right triangle be a, the other side be b and hypotenuse are given by c. According to Pythagoras's theorem $a^2 + b^2 = c^2$. This is taught in every classroom throughout the world, but what isn't taught is how it can be applied outside of the classroom.

Real Life Applications

1) **Road Trip:** Let's say two friends are meeting at a playground. Mary is already at the park, but her friend Bob needs to get there taking the shortest path possible. Bob has two way he can go - he can follow the roads getting to the park - first heading south 3 miles, then heading west four miles. The total distance covered following the roads will be 7 miles. The other way he can get there is by cutting through some open fields and walk directly to the park. If we apply Pythagoras's theorem to calculate the distance you will get:

2) **Buying a Suitcase:** Mr. Harry wants to purchase a suitcase. The shopkeeper tells Mr. Harry that he has a 30-inch of suitcase available at present and the height of the suitcase is 18 inches. Calculate the actual length of the suitcase for Mr. Harry using Pythagoras' theorem. It is calculated this way:

3) **What Size TV Should You Buy?** Mr. James saw an advertisement of a T.V.in the newspaper where it is mentioned that the T.V. is 16 inches high and 14 inches wide. Calculate the diagonal length of its screen for Mr. James. By using Pythagoras' theorem, it can be calculated as:

4) **Finding the Right Sized Computer:** Mary wants to get a computer monitor for her desk, which can hold a 22-inch monitor. She has found a monitor 16 inches wide and 10 inches high. Will the computer fit into Mary's cabin? Use Pythagoras' theorem to find out:

© **BITA:** A program promoted by California Homebuilding Foundation

Pythagorean Theorem Ramp Project Practice

Application of The Pythagorean Theorem

Handicap ramps, which is the application on which this lesson focuses, and skateboarding ramps are just a few examples of where the Pythagorean Theorem can be used. According to the Americans with Disabilities Act (ADA), every work place, private or public, must make their place of business handicap accessible. This activity focuses on the understanding of mathematical ideas and problem solving, in accordance with the NCTM standards.

Materials/Resources for Practice Ramp

- rubric
- tape measures
- construction paper or cardboard
- masking and scotch tape
- scissors
- some push pins
- calculators
- at least five objects in the classroom against which a ramp can be built

Procedure: (30 - 35 min.)

1. Divide the class into groups of three or four, depending on space. Groups should be organized before the activity starts. It saves critical time.
2. Give each group a copy of the rubric. Explain to the students that their grade depends on their performance on the task.
3. Explain to the students what they will be doing. Each group will have to measure the height of the object they have been assigned. (bookcase, table, desk, windowsill, file cabinet, etc.)
4. Then, to save some more time and to make the results more predictable, tell the students that the base of their ramp is already measured out for them. I did this with some masking tape before class. Each base was five feet.
5. Once the students have these two measurements, they can figure out the actual length of the ramp.
6. Once they have calculated the length of the ramp, they can begin construction. Part of the grade depends on accuracy and neatness of finished ramp. Encourage students to work cooperatively and independently. Assistance from the teacher will result in a lower the grade.

© **BITA:** A program promoted by California Homebuilding Foundation

7. When the students have the ramp put together, they can attach it to the object. This is where the accuracy of their measurements and calculations comes into play. If the ramp doesn't reach from the top of the object to the piece of masking tape on the floor, which measures five feet, their calculations or measurements must have been off. Accuracy and neatness are accounted for on the rubric.
8. When the students have finished with their construction and are satisfied with their results, they must sit down as a group and decide on their anticipated grade according to the rubric. Then they must mark the rubric with the appropriate grade and turn it in to the teacher.

The Pythagorean Theorem - Rubric for Ramps

Team Members:

_____

_____

Requirements to be Assessed	Pts.	Anticipated Mark	Actual Mark
Accuracy and Neatness -of product -of measurements -of calculations Teamwork -ability to work with others -everyone contributed			
Teamwork -divided task evenly -not just one person **Independent of teacher** **Tone and Volume** -talked in regular voices **Completion of Task** **Accuracy** -product is mostly accurate -measurements and calculations are within a 5 % -needed my help a couple of times	**4**		
Teamwork- -could have split up task better -one person doing a little more **Independent of teacher** -needed teachers help...? **Tone and Volume** -voices were a bit too loud **Completion of task-** -needed about 10 minutes to finish **Accuracy-** -product wasn't very accurate -calculations and measurements about 10% off	**3**		
Teamwork - task not divided up evenly -one person doing a majority **Independent of teacher** -needed teacher's help more than 5 times **Tone and Volume** -voices too loud for classroom **Completion of task-** -incomplete even after extra time was given **Accuracy-** -product wasn't very accurate	**2**		
None of the above, but some portion of the project was done.	**1**		

© **BITA:** A program promoted by California Homebuilding Foundation