The Pythagorean Theorem Diamond in the Rough

SUGGESTED LEARNING STRATEGIES: Shared Reading, Activating Prior Knowledge, Visualization, Interactive Word Wall

Cameron is a catcher trying out for the school baseball team. He has played baseball in the community and is able to easily throw the ball from home plate to second base to throw out a runner trying to steal second base. However, the school baseball diamond is a regulation size field and larger than the field he is accustomed to. Will he be able to consistently throw out runners trying to steal second if he is able to throw the baseball 130 feet?

The distance between each consecutive base on a regulation baseball diamond is 90 feet and the baselines are perpendicular. The imaginary line from home plate to second base divides the baseball diamond into two right triangles. There is a relationship between the lengths of the three sides of any right triangle that might be helpful for determining if Cameron can throw across a regulation baseball diamond.



1. Use the terms **hypotenuse** and **leg** to identify and label the parts of the right triangle below.



a.

b. Explain the differences between the hypotenuse and the legs of a right triangle.

CONNECT TO AP

In AP Calculus, the Pythagorean theorem is useful when solving related rates problems.



My Notes

continued

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My Notes

MATH TERMS

The Pythagorean theorem

states that: The square of the length of the hypotenuse of a right triangle is equal to the sum of the squares of the lengths of the legs of the triangle.



SUGGESTED LEARNING STRATEGIES: Questioning the Text, Create Representations, Think/Pair/Share, Group Presentation, Work Backwards

The **Pythagorean theorem** describes triangles containing a right angle.

- **2.** In a right triangle, let *c* be the length of the hypotenuse and let *a* and *b* be the lengths of the legs of the triangle.
 - **a.** Draw and label a right triangle using *a*, *b*, and *c*.

- **b.** Write an equation using *a*, *b* and *c* to represent the Pythagorean theorem.
- **3.** Use the Pythagorean theorem to find the length of the hypotenuse in each of the following triangles.



4. Use the Pythagorean theorem to find the length of the missing leg in each of the following triangles.



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SUGGESTED LEARNING STRATEGIES: Create Representations, Think/Pair/Share, Group Presentation, Group Discussion

5. Use the Pythagorean theorem to find *p* in terms of *r* and *t*.



- 6. Sketch a diagram of a regulation baseball diamond showing the baselines and the imaginary line from home plate to second base. Identify and label the hypotenuse and legs of any right triangles. What are the lengths of the legs of the triangles?
- **7.** Write an equation that can be used to find the distance from home plate to second base.
- **8.** Can the distance from home plate to second base be found without a calculator? Why or why not?

Because it may be difficult to find some distances without a calculator, estimation is often a useful problem solving tool.

9. Use the Pythagorean theorem to find the exact length of the hypotenuse for each of the right triangles described in the table below. Then estimate the value of the square root to find the estimated length of the hypotenuse.

	Length of	Length of	Exact Length	Estimated Length	
Triangle	Leg 1	Leg 2	of Hypotenuse	of Hypotenuse	
1	1 unit	2 units			
2	1 unit	3 units			
3	2 units	2 units			
4	2 units	3 units			
5	9 units	9 units			

My Notes

ACTIVITY 6.1

continued

If you take the square root of a number that is not a perfect square, the result is a decimal number that does not terminate or repeat and is called an irrational number. The exact value of an irrational number must be written using a radical sign. Decimal approximations of irrational numbers are found using technology such as a calculator.

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M	y Notes	SUGGESTED LEARNING STRATEGIES: Simplify the Problem, Think/Pair/Share, Group Presentation, Activating Prior Knowledge
		10. Which of the triangles in the table in Item 9 could be used to help Cameron estimate the distance from home plate to second base? Justify your choice.
		11. Use the Pythagorean theorem and the information in the table in Item 9 to find the distance from home plate to second base. Show all your work.
		12. If Cameron can throw the baseball 130 feet, will he be able to consistently throw out a runner trying to steal second base? Explain your reasoning.
		13. On a regulation softball diamond, the distance between consecutive bases is 60 feet and the baselines are perpendicular.
		a. Sketch and label a scale drawing of a softball diamond.
		b. Use the Pythagorean theorem and your sketch to estimate the distance from home plate to second base on a softball field. Show all your work.

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SUGGESTED LEARNING STRATEGIES: Shared Reading, Visualization, Create Representations, Think/Pair/Share Identify a Subtask

During summer vacation, Cameron's parents take him to see his favorite baseball team, the Anglers, play. On their last day of vacation, he discovers that he will not be able to carry the autographed bat he won home on the plane. His dad suggests that he speak to the concierge at the hotel about options for shipping the bat home. The concierge only has one box that he thinks might be long enough. After measuring the dimensions of the box to be $16'' \times 16'' \times 27''$, the concierge apologizes for not having a box long enough for the 34'' bat. Cameron thinks he might still be able to use the box. His idea is to put the bat in the box at an angle as shown in the diagram below. He wonders if the bat will fit in the box.



- **14.** The diagonal of the box is the hypotenuse of a right triangle. Outline this triangle in the diagram above.
- **15.** What are the lengths of the legs of this right triangle? Show any work needed to find these lengths.
- **16.** Find the length of the diagonal of the box. Show any necessary calculations.

My Notes

CONNECT TO TRAVEL

In a hotel, a concierge is a person who helps guests with various tasks ranging from restaurant reservations to travel plans.

ACTIVITY 6.1 continued



continued

Diamond in the Rough



SUGGESTED LEARNING STRATEGIES: Think/Pair/Share, Group Presentation, Create Representations

- **17.** Will Cameron be able to use the box to ship his bat? Justify your response.
- **18.** When Cameron returns to school, he tells his math teacher how he applied the Pythagorean Theorem while on vacation. She is excited and tells him they will do some investigation into why the Pythagorean Theorem works.
 - **a.** On centimeter grid paper or graph paper, draw right triangles having legs with each of the following lengths. Use one piece of paper for each triangle.

Triangle 1:	3 units and 4 units
Triangle 2:	5 units and 12 units
Triangle 3:	8 units and 15 units

b. Use the Pythagorean Theorem to find the length of the hypotenuse in each of the triangles.

Hypotenuse of Triangle 1: Hypotenuse of Triangle 2: Hypotenuse of Triangle 3:

c. On each leg of each of the right triangles, draw a square with sides the same length as the leg of the triangle. Find the area of each of these squares and complete the table below.

Triangle	Length of Leg 1	Area of Square on Leg 1	Length of Leg 2	Area of Square on Leg 2

d. How does the area of each square relate to the length of a leg of the triangle?

SUGGESTED LEARNING STRATEGIES: Group Presentation, Create Representations

- **e.** Cut out each of the triangles and the squares drawn on each of the legs.
- f. Use the small squares drawn on the legs of each right triangle to build a large square on the hypotenuse of that triangle. You may cut and rearrange the small squares any way necessary to create one larger square having side length equal to the length of the hypotenuse of the triangle.
- **g.** Find the area of the square created on the hypotenuse of each triangle.

Area of square on the hypotenuse of Triangle 1: Area of square on the hypotenuse of Triangle 2: Area of square on the hypotenuse of Triangle 3:

- **h.** What is the relationship between the areas of the squares drawn on each of the legs of the triangle and the large square built on the hypotenuse? Explain your reasoning.
- i. How does this relationship illustrate the Pythagorean Theorem in the form $c^2 = a^2 + b^2$?



My Notes

The Pythagorean Theorem Diamond in the Rough

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You can also use the Pythagorean theorem to find the distance between two points on a coordinate plane. Just think of the two points as the endpoints of the hypotenuse of a right triangle. Then draw the legs and use their lengths in the formula.



- **19.** Find the distance from point (1, 2) to point (7, 6) to the nearest tenth of a unit.
- **20.** Find the distance from point (3, 1) to point (5, 5) to the nearest tenth of a unit.

CHECK YOUR UNDERSTANDING

Write your answers on notebook paper. Show your work.

Find *x* in each of the following.







- **4.** A painter uses a ladder to reach a secondstory window on the house she is painting. The bottom of the window is 20 feet above the ground. The foot of the ladder is 15 feet from the house. How long is the ladder?
- **5.** Estimate the square roots of each of the following:
 - **a.** 12
 - **b.** 17
 - **c.** 40
 - **d.** 99
- **6.** Find the distance from point (2, 6) to point (8, 3) to the nearest tenth of a unit.
- **7.** MATHEMATICAL REFLECTION Is $c^2 > a^2 + b^2$? In what type of triangle is $c^2 < a^2 + b^2$? Explain your answers.