



# Pythagor-eatin' Theorem

## Constructing Pythagorean Theorem



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<b>Grade Level</b>	7th – 8th Grade	<b>Time Frame</b>	2-3 class period(s)
<b>Subject</b>	Mathematics	<b>Duration</b>	120 minutes
<b>Course</b>	Middle School Mathematics		

### Essential Question

What is the Pythagorean theorem and does it work for all right triangles?

### Summary

This lesson engages students in constructing the Pythagorean theorem using Cheez-It® crackers. Students will not only be able to visually see the theorem, but they will also subsequently prove why the Pythagorean theorem works for all right triangles.

### Snapshot

#### Engage

Students write a "preflection" about facts they know regarding triangle perimeters.

#### Explore

Students use Cheez-It® crackers to construct the Pythagorean theorem.

#### Explain

Students share their understanding and clarify misconceptions about what they explored.

#### Extend

Students test their newly constructed theorem on multiple right triangles for additional proof.

#### Evaluate

Students compare and contrast their preflection with their learning experiences.

## Standards

*Oklahoma Academic Standards for Mathematics (Grade 8)*

**PA.GM.1.1:** Informally justify the Pythagorean Theorem using measurements, diagrams, or dynamic software and use the Pythagorean Theorem to solve problems in two and three dimensions involving right triangles.

## Attachments

- [Pythagor-eatin-Theorem-Trifold - Spanish.docx](#)
- [Pythagor-eatin-Theorem-Trifold - Spanish.pdf](#)
- [Pythagor-eatin-Theorem-Trifold.docx](#)
- [Pythagor-eatin-Theorem-Trifold.pdf](#)
- [Right-Triangle-Cutouts.pdf](#)

## Materials

- Standard size Cheez-It® (or similar brand) crackers (at least 50 unbroken crackers per student)
- Paper
- Envelopes
- Card stock or construction paper

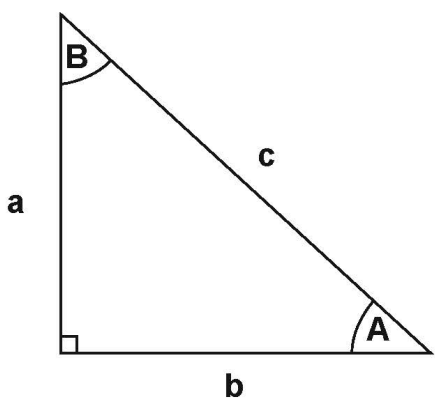
# Engage

Instruct each student to take out a blank sheet of paper.

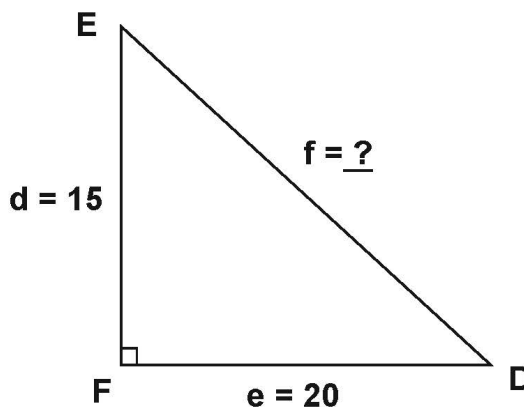
On their paper, instruct students to engage in writing a [Preflections](#) strategy using the following prompts:

- How can you tell if a triangle is a "right" triangle?
- What are the legs and what is the hypotenuse in a right triangle?
- If Triangle ABC has angles of  $A=20$  degrees and  $C=90$  degrees, how can you determine the measure of angle B?
- If Triangle DEF is a right triangle, with angle F being the right angle, and side  $d=15$  and side  $e=20$ , how do you think you could figure out the length of side  $f$ ?

Feel free to use or recreate the images below to help add context to the prompts:



$$A = 20^\circ \quad B = \underline{\quad} \quad C = 90^\circ$$



*Preflections strategy prompts.*

Give students approximately five minutes to write (this will feel like a long time). While they are writing, pass out an envelope to each student. If students are struggling, remind them that these are just educated guesses and they will be able to come back to their answers later.

Ask students to ensure their name is on their paper and on their envelope.

Have students fold their paper so that it fits within the envelope, place it in the envelope, and seal it shut.

Tell students that they will revisit these at the end of the lesson and collect all envelopes.

# Explore

## Teacher's Note: Prep

Distribute to each student (or student pairs/small groups) about 50 whole Cheez-Its® (no broken pieces), a piece of construction paper, adhesive, and one of the Right Triangle Cutouts (attached).

Guide students to:

1. Glue or tape the right triangle onto a large piece of construction paper.
2. Label the two sides forming the right angle as ***a*** (shortest side) and ***b***. Label the longest side opposite the right angle ***c***.
3. Using Cheez-Its®, line the perimeter (outside edge) of the right triangle. *(Note: the crackers should fit almost perfectly along the outside edges. See Fig. 1 below.)*
4. Using the rest of the Cheez-Its, build perfect squares outward from each side of the triangle. The perimeter will be one side of each perfect square. *(See Fig. 2 below.) (Note: If needed, provide students an example: "If a side is 7 Cheez-Its® long, then build a 7 by 7 square along that edge of the triangle. Cheez-Its® will be touching but not overlapping.")*
5. Once the perfect squares are built on all sides of the right triangle, take the Cheez-Its® from the two sides forming the right angle (sides *a* and *b*) and begin stacking these on top of the Cheez-Its® that form the square on the longest side, opposite the right angle (side *c*). *(Note: Stack only one Cheez-It® on top of each of the existing Cheez-Its® on side c. See Fig. 3 and Fig. 4 below.)*

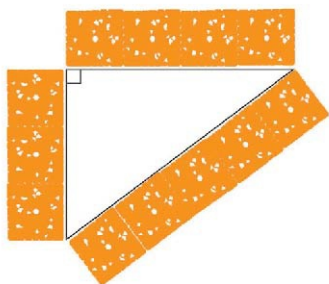


Fig. 1  
Outline perimeter

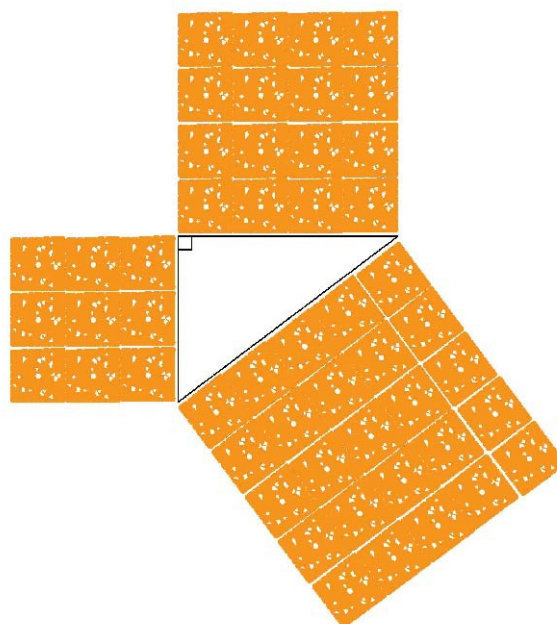


Fig. 2  
Build squares

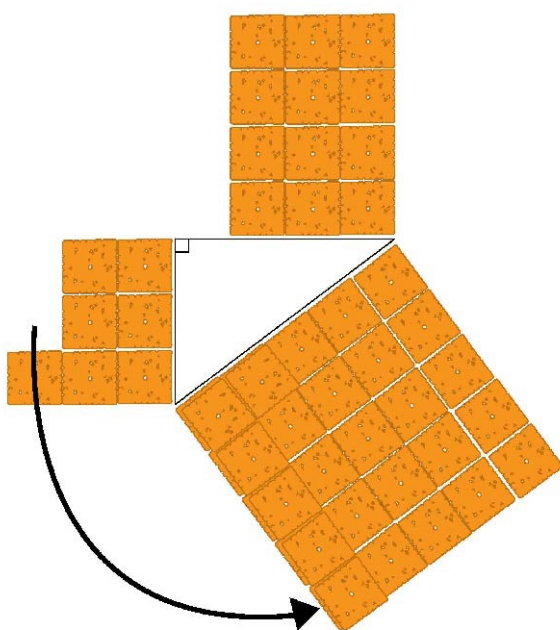


Fig. 3  
Stack Cheez-Its® that form right angle

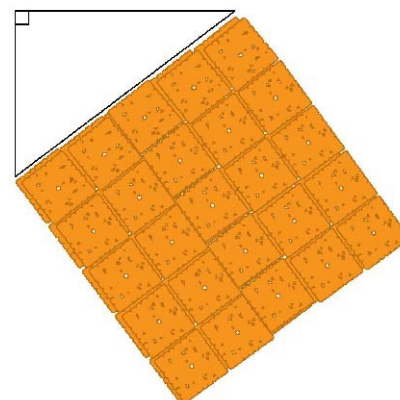


Fig. 4  
Stacking complete ( $a^2 + b^2 = c^2$ )

**Step 1:** Outline perimeter. **Step 2:** Build squares. **Step 3:** Stack Cheez-Its® using those that form the right angle onto the perfect square of side  $c$ . **Step 4:** Stacking complete ( $a^2 + b^2 = c^2$ ).

# Explain

**Trifold Instructions:** Once all students have completed this activity, pass out the trifold (attached). Students may now begin to complete the first page of the trifold and reflect on the two questions below the right triangle diagram. Facilitate a whole class or small group discussion regarding what students notice and wonder about the Pythagorean theorem.

## Possible Response To The Relationship Between The Triangle's Sides:

*"When you combine the perfect squares for sides a and b (add  $a^2$  and  $b^2$ ), they equal the perfect square for side c ( $c^2$ )."*

**Vocabulary and Symbols:** This section of the trifold may be done before, during, or after the Cheez-It® activity. It can be used to engage prior knowledge and support students' thinking and understanding.

**Am I Right?:** This section of the trifold should follow the class/small group discussion and answer students' inquiries such as, "Does this work with any triangle or only triangles with side lengths of 3, 4, 5?" Students then begin using the Pythagorean theorem to prove and disprove if the given side lengths form a right triangle.

## Possible Responses To This Write, Pair, Share:

*"When  $a^2$  and  $b^2$  do not equal  $c^2$ , then the triangle is not a right triangle." (Note: Students may need to use a manipulative like centimeter cubes, square tiles, or grid paper to visualize how these side lengths do not construct a right triangle.)*

Reengage the whole class to discuss their findings about right triangles. Then ask students to complete the "TURN & TALK."

After a few minutes of students discussing, ask a few students to share responses to what they noticed about the relationship between the sides of the Cheez-Its® triangle, and problems one and four from the trifold.

## Possible Responses To This Turn & Talk:

*"Problems 1 and 4 have a proportional relationship to the side lengths from the Cheez-It triangle," "Side a is  $3 \times 2 = 6$ ; side b is  $4 \times 2 = 8$ ; side c is  $5 \times 2 = 10$ ," "The sides of problem 4 are three times larger than each side of the 3, 4, 5 triangle," and "Does the proportional relationship work with all right triangles?"*

The following "What's My Hypotenuse?" and "What's My Leg Length?" sections of the trifold serve as the EXTEND and might be completed during a different class.

## Extend

**What's My Hypotenuse?:** Instruct students to work individually or in small groups to complete problems five and six. They will also complete the WRITE, PAIR, SHARE.

### Possible Responses To This Write, Pair, Share:

*"I think you can have a decimal, but what place value do you round it?" and "Maybe if it is a rational number."*

Students share responses with the whole class. Through student understanding, the teacher can clear up any misunderstandings and help bridge knowledge from what students have constructed on their own exploration and experience.

**What's My Leg Length:** Students complete the last section of the trifold. Allow students time to complete the WRITE, PAIR, SHARE and the remaining problems below. Students can share responses and solutions with other students or groups. The teacher might opt to facilitate another whole class discussion and share out.

### Possible Responses To The Final Write, Pair, Share:

*"I think that we will use our steps or the process to solve multi-step equations to find the missing leg length." I am not sure how we find the letter a since the equation uses  $a^2$ ," and "I know that the answer for the missing leg length will be less than 28 and 35." (Note: If you receive a response similar to the latter, clarify that models are not always to scale. Do not rely on that to justify your answer.)*

Using the blank backside of this trifold, students can glue or tape the resource into their student notebooks.

# Evaluate

To complete this section, distribute students' Reflection envelopes that they completed during the Engage.

Ask students to individually open their envelopes and read through their writing.

Ask students to take out a separate sheet of paper to answer the following prompts:

1. What are the main differences you noticed between what you learned during the lesson compared to what you initially wrote down in your reflection?
2. What is the Pythagorean theorem and what is it used for?
3. What are two major takeaways from today's lesson that you will remember?



## Resources

- K20 Center. (n.d.). Preflections. Strategies. Retrieved from <https://learn.k20center.ou.edu/strategy/fc74060730ea745c8c4f356aa203f86a>