# What’s square?

Students explore how to find and verify Pythagorean triads. These are then used to justify whether a shape is a square.

## Visible learning

Learning intentions and success criteria should be shared with students later in the learning episode.

### Learning intention

* To know when a shape has a right angle.

### Success criteria

* I can define a Pythagorean triad.
* I can verify if 3 numbers are a Pythagorean triad.
* I can use Pythagorean triads to determine if a shape has a right angle.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* applies Pythagoras’ theorem to solve problems in various contexts **MA4-PYT-C-01**

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Table 1 – lesson summary

|  |  |  |  |
| --- | --- | --- | --- |
| Section | Summary of activity | Teaching strategy | Teaching points  |
| Launch | Students draw a square using only a ruler and discuss how they can prove it is a square.Display slides 2–3 from PowerPoint *What’s square?* to show a shape that looks like a square but is not a square. | Think-Pair-Share | We cannot assume geometrical properties unless they are marked. |
| Explore  | Watch the video ‘How To Use The 3-4-5 Rule To Make A Square - DIY At Bunnings (0:21)’ ([bit.ly/345rulesquare](https://bit.ly/345rulesquare)) and then check to see if the square they drew in the launch is a square.Students test that 3, 4, 5 satisfies Pythagoras’ Theorem.Define Pythagorean triads and ask students to find as many triads as they can with values less than 100. | Mini whiteboardsVisibly random groups of 3Vertical non-permanent surfaceGallery walkPose-Pause-Pounce-Bounce | Pythagorean triads can be used to measure right-angles. |
| Summarise | Discuss:* Why do builders use 3, 4, 5 and not another Pythagorean triad?
* What was your favourite Pythagorean triad you found? Why?
* Did you find any patterns to create more Pythagorean triads?
 | Pose-Pause-Pounce-BounceNotes to future forgetful self | The 3, 4, 5 triad is used to measure triangles because the lengths are the smallest.Additional triads can be found by using multiples of a known triad. |
| Apply | Students create a square outside using 4 pegs and string.Students discuss challenges in creating a square and how they verified it was a square. | Groups of 3Pose-Pause-Pounce-Bounce |  |

## Activity structure

Please use the associated PowerPoint *What’s square?* to display images in this lesson.

### Launch

1. Distribute a ruler to each student and ask them to draw a square.
2. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), ask students how they can prove they have created a square.

Students may suggest that all the sides are equal but remind them that this is also a property of a rhombus.

1. Use slides 2–3 from the PowerPoint *What’s square,* to show the ‘squares’ in Figure 1. Show students the left ‘square’ and then reveal its angles to show it is in fact, not a square.

Figure 1: a 'square' and 'square' with angles revealed



### Explore

1. Reveal the learning intention and the success criteria.
2. Watch the video ‘How To Use The 3-4-5 Rule To Make A Square - DIY At Bunnings (0:21)’ ([bit.ly/345rulesquare](https://bit.ly/345rulesquare)). This explains how to check if something is square.

When builders are checking if something is ‘square’, they are checking if the sides meet at a right angle, not necessarily checking if the whole frame is the shape of a square.

Students should note that the units builders use to check this do not matter if they are all the same.

1. Students should return to the square they drew in the Launch to check if they did draw a square.
2. In a Think-Pair-Share, ask students why using the numbers 3, 4 and 5 can be used to check we have constructed a right angle.

Students should suggest substituting the values into Pythagoras’ theorem to check if it is true. If students haven’t made the connection to Pythagoras’ theorem, then draw a square showing its diagonal as a hint.

1. On mini whiteboards ([bit.ly/miniwhiteboards](https://bit.ly/miniwhiteboards)), ask students to verify that a right angle is formed by substituting the values into Pythagoras’ theorem and displaying their working to the teacher.
2. Ask random students, who correctly substituted the values, what number they substituted in for c and why.
3. Tell students that 3, 4 and 5 are considered a Pythagorean triad. Ask students why they think the 3 numbers would be called that.
4. Define a Pythagorean triad and state to students that they are going to find more Pythagorean triads.

A Pythagorean triad consists of 3 positive integers $a$, $b$ and $c$, that satisfy Pythagoras’ theorem ($a^{2}+b^{2}=c^{2}$).

1. Assign students to visibly random groups of 3 ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) on vertical non-permanent surfaces ([bit.ly/VNPSstrategy](https://bit.ly/VNPSstrategy)), and ask them to try and find more Pythagorean triads with values less than 100.

Use the following [assessing and advancing questions (DOCX 327 KB)](https://education.nsw.gov.au/content/dam/main-education/documents/teaching-and-learning/curriculum/mathematics/mathematics-s4-supporting-strategies-assessing-and-advancing-questions.docx) to further student thinking.

Table 2: assessing and advancing questions

|  |  |
| --- | --- |
| Assessing questions | Advancing questions |
| How did we know that the numbers 3, 4 and 5 were a Pythagorean triad? | Could you try another set of numbers? |
| What strategy did you use to find these Pythagorean triads? | Is there a way that you could structure your working to find potential Pythagorean triads?  |
| Can you explain how you got this set of Pythagorean triads, from using the other sets you previously found? | Can you see any patterns that would help you to find more Pythagorean triads? |

As students work, walk around the room to observe the different approaches students have taken. This will allow teachers to highlight to other groups the problem-solving approaches that have helped students towards solutions.

1. Students are to do a gallery walk ([bit.ly/DLSgallerywalk](https://bit.ly/DLSgallerywalk)), noting the similarities and differences in approaches to the problem and which were more successful than others.
2. Using the Pose-Pause-Pounce-Bounce questioning strategy (PDF 557 KB) ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)) ask students to share the similarities and differences between the strategies different groups have used.
3. Students return to their vertical non-permanent surfaces to continue finding more Pythagorean triads.

A list of Pythagorean triads for values under 100 can be found on the BYJU’s website ‘Pythagorean Triples’ ([byjus.com/maths/pythagorean-triples/](https://byjus.com/maths/pythagorean-triples/)).

### Summarise

1. Using the Pose-Pause-Pounce-Bounce questioning strategy start a class discussion using the following questions:
* Why do builders use 3, 4, 5 and not another Pythagorean triad?
* What was your favourite Pythagorean triad that you found? Why?
* Did you find any patterns to create more Pythagorean triads?

Students may have found that multiples of the same number also create Pythagorean triads. For example, multiples of 3, 4 and 5, such as 6, 8 and 10 are also Pythagorean triads.

1. Students are to create notes to their future forgetful selves ([bit.ly/notestofutureself](https://bit.ly/notestofutureself)) on what a Pythagorean triad is and how to justify whether a set of numbers are a triad.

### Apply

#### Equipment per group

* Four pegs
* String
* Tape measure

Alternatively, if the equipment or a grassed area is not available, the activity can be done on a solid surface with masking tape.

#### Method

1. Inform students that they will be returning to their groups of 3 and will be challenged to create a square outside on the grass, using the string and pegs. Tell students that not only are they to create a square, but they are to verify, using a tape measure and calculations, that it is a square.
2. In their groups of 3, ask students to plan how they will create their square and verify they have created a square.

Teachers could check student plans before letting them go outside. Students should suggest using a Pythagorean triad to check that each corner is a right angle and making sure that each side is the same length.

1. Distribute the equipment to each group and take students to an oval or appropriate location.
2. When students believe they have created a square, have them swap with another group to verify each other’s solutions.
3. Bring the class together and use the Pose-Pause-Pounce-Bounce questioning strategy to ask the following questions:
* What challenges did you face when creating your square?
* How did you verify you had a square?
* How did you modify your shape to make it closer to a square?
* Do you think it would be easier to make a larger square or a smaller square? Why?

## Assessment and differentiation

### Suggested opportunities for differentiation

**Explore**

* To enable students, allow them to use a calculator to find the squares of numbers.
* Students can be provided with one or 2 numbers in a Pythagorean triad and have them find the third.
* To extend students, encourage them find patterns to create additional Pythagorean triads, such as triads in which c is between 100 and 200.

**Summarise**

* Students can write their notes to their future forgetful selves in pairs.

**Apply**

* To enable students, provide them with lengths of string or masking tape that are already cut to length.
* To extend students, have them visit their woodwork teacher to ask how to modify a building frame to ensure it is square.

### Suggested opportunities for assessment

**Launch**

* Students will demonstrate their knowledge of special quadrilaterals through class discussions during the launch.

**Explore**

* Mini whiteboards provide evidence that students know that the longest side, or highest value, should be substituted for c. If many students get this incorrect it provides an opportunity for teachers to address this concept before continuing the lesson.
* When placed in groups of 3, students provide and receive peer feedback on their understanding.
* Students working on vertical non-permanent surfaces show if they can verify Pythagorean triads.
* The gallery walk provides students time to reflect on their own approaches and solutions to find more Pythagorean triads.

**Summarise**

* Monitor responses in class discussions to check for student understanding of Pythagorean triads.
* Review student's notes to their forgetful future selves.

## References

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