# Area of a circle

Students explore the relationship between the area of a circle and its radius. Students look at deals for different-sized pizzas and other real-life contexts.

## Visible learning

### Learning intention

* To understand how to find the area of a circle.

### Success criteria

* I can explain how the area of a circle formula is derived.
* I can calculate the area of a circle using the radius.
* I can calculate the area of a circle given the diameter.
* I can calculate the radius given the area of a circle.

### 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**
* solves linear equations of up to 2 steps and quadratic equations of the form   **MA4-EQU-C-01**
* applies knowledge of area and composite area involving triangles, quadrilaterals and circles to solve problems **MA4-ARE-C-01**

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Table 1: lesson summary

|  |  |  |  |
| --- | --- | --- | --- |
| Section | Summary of activity | Teaching strategies | Teaching points |
| Launch | Students consider a scenario from the PowerPoint *Area of a circle* (AOAC PPT) to decide whether the offered pizza deal is fair. | Think-Pair-Share | Students consider a scenario where they compare the area of different circles and how they vary. |
| Explore | Students divide a circle into as many sectors as possible, line them up to form an approximate rectangle and use this relationship to develop the formula of a circle. | Think-Pair-Share | Students look at an estimate of the area of a circle by looking at circles on grids before developing the formula of a circle from a rectangle. |
| Summarise | Students review the worked examples from slides 7–14 from the PowerPoint before completing [Appendix A](#_Appendix_B). | Worked examples (Your turn)  Faded examples | Students review examples of finding the area of a circle. |
| Apply | Students revisit the scenario from the launch to decide whether it was a good deal. They then look at the costs of the pizza and compare them for the best value for their size using the questions and scenario from [Appendix B](#_Appendix__C). | Think-Pair-Share  Turn and talk | Students apply these skills to finding areas of circles in real-life applications, including finding the radius given the area. |

## Activity structure

Please use the associated PowerPoint *Area of a circle* (AOAC PPT) to display images in this lesson.

### Launch

1. Display slide 3 from the PowerPoint (AOAC PPT)showing a character, Lui, and the sizes of the pizzas available at his pizza shop. Read the following scenario to students:

Jack wants to order an epic-sized pizza for his birthday celebrations. He orders his pizza but finds that Lui has sold out of epic-sized pizza bases. Lui offers to give Jack 2 large-sized pizzas for the same price as an epic-sized pizza. Lui thinks this is a good deal for Jack.

1. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), ask students to discuss whether they think this is a good deal for Jack and why. Ask students to record their initial thoughts and reasoning in their workbooks.

### Explore

1. Distribute a sheet of A4 square centimetre graph paper to each student.

Graph paper can be found on the website ‘Free Printable Graph Paper’ ([print-graph-paper.com/](https://print-graph-paper.com/)

1. Have students draw a circle with a radius of 10 cm using a pair of compasses and cut out the circle. Have students cut the circle into quarters.

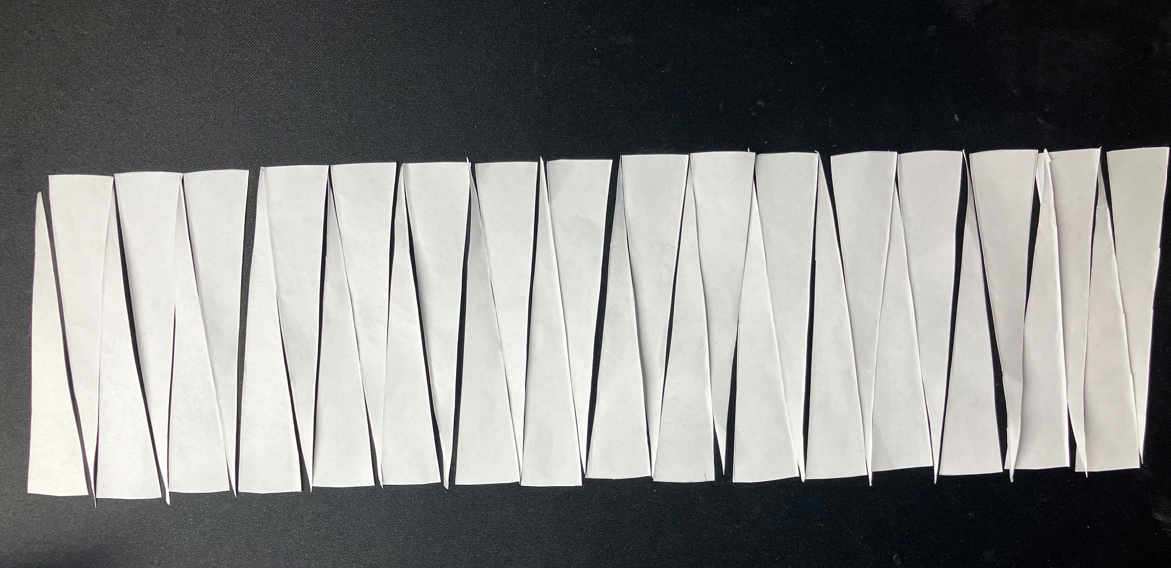
To divide the circle into quarters, students might find it easiest to fold the circle in half and then half again.

1. Remind students that we can divide up a shape and reorganise it to make a known shape to work out its area.
2. Ask the students if they can rearrange the pieces to form a shape they know the area of.

Students will not be able to form an area they know due to the curved edges.

1. Have students continue to cut each piece in half until they have at least 32 pieces.
2. In pairs, ask students to rearrange their pieces to see if they can form a rectangle or a parallelogram. We are looking to make the connection between the area of these shapes to derive the formula for the area of a circle.
3. If students haven’t already, ask them to rearrange their pieces as shown in Figure 1.

Figure 1: circle split up to make a parallelogram



Rather than students cutting out pieces, teachers could show the clip ‘Why is a circle's area ²?’ (0:11) ([bit.ly/sector\_pizza](https://bit.ly/sector_pizza)) to model the process.

1. In a Think-Pair-Share ask students to find the length and breadth of the rectangle. Some prompting questions could include

* What part of the circle makes up the length of the parallelogram?
* What part of the parallelogram is the radius of the circle?

Students should see that the breadth of the parallelogram is the radius of the circle, and the length is half of the circumference .

1. Conclude by displaying slide 5 of the PowerPoint (AOCA PPT) which shows a circle cut into sectors and arranged to create a shape close to a parallelogram. Explain that the equation of a circle, can be found by finding the area of the parallelogram.

### Summarise

1. Use slides 7–14 from the PowerPoint (AOCA PPT) for explicit teaching of area of a circle using the Worked examples (Your turn) method ([bit.ly/supportingstrategies](https://bit.ly/supportingstrategies)).
2. Students are to complete the faded worked examples ([bit.ly/fadedexamplesstrategy](https://bit.ly/fadedexamplesstrategy)) in Appendix B ‘Faded examples.’

### Apply

1. Revisit slide 3 of the PowerPoint (AOCA PPT) from the Launch and remind students of their predictions about whether Jack was getting a good deal from Lui.
2. In a Think-Pair-Share have students review their prediction by calculating the area of both pizzas, to show whether their prediction was correct.
3. Show students slide 16 from the PowerPoint (AOCA PPT). Read the following scenario:

Joey has a rival pizza shop that sells square pizzas. He is known for his giant-sized pizza which has a side length of 50 cm.

1. Continuing in pairs, distribute a copy of Appendix C ‘Pizza deals’ to each pair, and have students answer the questions on mini whiteboards.

Teachers can revisit the explicit teaching of solving simple quadratic equations in Lesson 1 – ways of working – equations and Lesson 2 – quadratic equations of Unit 10 – investigating triangles.

1. Students should turn and talk with a neighbouring pair about their answers, comparing responses.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* There are no correct answers during the launch and all students should be encouraged to participate and share their thoughts and reasoning.

**Explore**

* Provide students who might have difficulty with their fine motor skills with a series of circles already created on grid paper.
* Students could be challenged to make a connection to the area of a parallelogram rather than a rectangle, as the height remains the radius, and the breadth is half of the circumference.
* Students could explore developing the formula using the circumference of concentric circles and the area of a triangle formula as seen on the website ‘Area of a Circle 2’ ([people.wku.edu/tom.richmond/circle2.html](https://people.wku.edu/tom.richmond/circle2.html)).

**Summarise**

* Students should be challenged to make connections with the prior knowledge they have regarding circles where the diameter is given, and its connection to the radius.
* Students are supported through examples by Worked examples (Your turn) and faded examples.

**Apply**

* Students could be challenged to find the radius of a circle that would give an area of the square giant pizza, or the radius of a large pizza needed to make an area of 2 large pizzas equivalent to one epic pizza.
* Students could look at the effect that doubling the radius has on the area to develop a relationship between the ratio of the area of shapes once the radius is doubled. This could be done either by looking at measurements and developing a pattern or algebraically.

### Suggested opportunities for assessment

**Launch**

* Teachers can assess students on their understanding of the concept of area from listening to student discussions and reading the student justifications on their mini whiteboards.

**Explore**

* Students give each other peer feedback, before sharing with the class in the Think-Pair-Share activities.
* Students can demonstrate their conceptual understanding of area during the grid activity and the rearrangement of the circle activity.

**Summarise**

* Monitor student responses in the Worked examples (Your turn) section to ensure students understand the circle formula's application.
* The completed faded questions activity could be collected as evidence of understanding of the area of a circle formula.

**Apply**

* Students’ responses to Appendix B could be used as samples of understanding and application of the area of a circle formula.

## Appendix A

### Faded examples

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Find the area of the circle.  Circle with radius of 4 metres. | Find the area of the circle.  Circle with radius of 2 metres. | Find the area of the circle.  Circle with diameter of 2 metres. | Find the area of the circle.  Circle with diameter of 1 metre. | Find the area of the circle.  Circle with diameter of 4 metres. |
|  |  |  |  |  |

## Appendix B

### Pizza deals

The first sign says Lui's pizza shop, giving diameter sizes and cost of pizzas as follows: 
Medium, 30cm, $15.
Large, 35cm, $19.
Epic, 55cm, $28. 
The sign has a picture of a round pizza and the diameter marked onto the pizza with an arrow.
The second sign shows Joeys pizza shop menu. The table has Pizza, giant, 50 cm in side length and costs $24. There is a square pizza with an arrow showing the diameter.

1. What is the area of each of the pizzas?
2. Which pizza would be the best value for money?
3. What would be the radius of the equivalent round pizza to the giant square one?
4. What would be the radius of the 2 large pizzas that would give Jack the same amount of pizza as the epic pizza?

## Sample solutions

### Appendix A – faded examples

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Find the area of the circle.  Circle with radius of 4 metres. | Find the area of the circle.  Circle with radius of 2 metres. | Find the area of the circle.  Circle with diameter of 2 metres. | Find the area of the circle.  Circle with diameter of 1 metre. | Find the area of the circle.  Circle with diameter of 4 metres. |
|  |  |  |  |  |

### Appendix B – pizza deals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Question | Medium | Large | Epic | Giant |
| 1 |  |  |  |  |
| 2 |  |  |  | This is the best value for money. |
| 3 |  |  |  |  |
| 4 |  |  |  |  |

## References

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