# Cylinders and equations

Students will use geometric shapes to estimate volume and calculate the stuffing needed for plush toys.

## Visible learning

### Learning intention

* To be able to use a formula to find unknown values.

### Success criteria

* I can substitute numbers into a formula.
* I can use the circumference formula to find the radius.
* I can use the volume of a cylinder formula to find the height.
* I can use the volume of a cylinder formula to find the radius.

### 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 knowledge of volume and capacity to solve problems involving right prisms and cylinders **MA4-VOL-C-01**
* solves linear equations of up to 2 steps and quadratic equations of the form    
  **MA4-EQU-C-01**

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Table 1: lesson summary

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| --- | --- | --- | --- |
| Section | Summary of activity | Teaching strategies | Teaching points |
| **Launch** | Students watch the video ‘How to stuff a knitted toy | Fiber fill’ (11:54) ([bit.ly/StuffingToys](https://bit.ly/StuffingToys)) and discuss how the stuffing is evenly distributed and consider how to predict the amount needed. | Notice and wonder | Students recognise and identify three-dimensional geometric shapes in the real world. |
| **Explore** | Students discuss how to identify three-dimensional geometric shapes that can model the sections of a plush toy and measure their dimensions. They calculate the volume of each section using familiar formulas and determine the amount of stuffing required based on a given density. | Think-Pair-Share | Students calculate the volume of composite shapes made up of cylinders and prisms. |
| **Summarise** | Students practise rearranging the volume of a cylinder formula through explicit teaching and faded worked examples. | Worked examples (Your turn)  Faded examples | Students are explicitly taught how to rearrange the volume of a cylinder formula to calculate the radius and height. |
| **Apply** | Students design and calculate the approximate volume of a custom plush toy before working out the stuffing requirements and refining their designs based on peer feedback. | Visibly random groups of 3  Vertical non-permanent surfaces  Gallery walk  Two stars and a wish | Create a design that uses different applications of volume formulas. |

### Activity structure

Please use the associated PowerPoint *Cylinder and equations* (CAE PPT) to display images in this lesson.

### Launch

Students could be encouraged to bring a plush toy from home. Alternatively, a collection of plush toys could be supplied from donations or a local charity store or the teacher can provide from a private collection. Alternatively, all the work with the toys is completed in pairs and students could be paired with a partner who did bring a toy.

1. Show students the video, ‘How to stuff a knitted toy | Fiber fill’(11:54) ([bit.ly/StuffingToys](https://bit.ly/StuffingToys)) starting at 6:25 and play until 8:35.

In addition to this, the video can be shown from 9:36 to 11:22 to show the tail being stuffed.

1. Ask students to consider what they notice and wonder ([bit.ly/noticewonderstrategy](https://bit.ly/noticewonderstrategy))about the video.

Students might notice that the video demonstrates the process of hand-stuffing a plush toy and the stuffing is distributed evenly to give the plush toy its shape. Students may wonder how much stuffing is needed for a standard-sized plush toy and how we could predict it.

1. Initiate a sharing of responses and reasoning using the Pose-Pause-Pounce-Bounce questioning strategy (PDF 557 KB) ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)).

### Explore

1. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), prompt students to explore how they could use 3D geometric shapes to estimate the volume of stuffing needed for their plush toy.

Students should identify that they could match each body section to a shape they know, such as a cylinder or prism.

1. Distribute a measuring tape to each pair of students and ask them to identify which measurements they can take of their plush toy.

Students might identify that they can measure the height and circumference of each approximately cylindrical section, as well as the dimensions of any approximate prisms.

1. In a Think-Pair-Share, ask students how they could use the circumference to calculate the volume of a cylindrical section of their plush toy.

Students have previously explored rearranging the circumference formula in Lesson 3 – applying circumference formula of Unit 15 – exploring circles and were explicitly taught the technique of backtracking in Lesson 1 – ways of working (equations) of Unit 10 – investigating triangles.

1. In their pairs, ask students to calculate an estimate of the volume of each section of their plush toy and record their working out.
2. Pose to students ‘If you need approximately 400 g of stuffing for every 10 000 cm3 of volume, determine how much stuffing you need.’
3. In their pairs, ask students to determine the amount of stuffing they need.
4. In a Think-Pair-Share, ask students to consider if they had 200 g of stuffing remaining, what volume could they fill?
5. In another Think-Pair-Share, ask students if they wanted to use the remaining 200 g of stuffing to make a crochet snake which is approximately shaped like a cylinder with:

* a radius of 5 cm, how could they calculate the required length of the snake?
* length of 50 cm long, how could they calculate the required radius of the snake?

### Summarise

1. Use slides 3–6 from the PowerPoint (CAE PPT) for explicit teaching of using the volume of a cylinder formula to find the height 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 A ‘Unknown height’.
3. Use slides 7–10 from the PowerPoint (CAE PPT) for explicit teaching of using the volume of a cylinder formula to find the radius using the Worked examples (Your turn) method.
4. Students are to complete the faded worked examples in Appendix B ‘Unknown radius’.

### Apply

1. Assign students to visibly random groups of 3 ([bit.ly/visiblegroups](https://bit.ly/visiblegroups)) at vertical non-permanent surfaces ([bit.ly/VNPSstrategy](https://bit.ly/VNPSstrategy)).
2. Ask students to design a new plush toy, using a combination of 3D geometric shapes for the body parts. Students should sketch their design on the vertical non-permanent surface, labelling each section with its approximate geometric shape, dimensions and the measurements they would take.

Encourage students to calculate the total volume of their custom toy by summing the individual volumes of each part.

1. Based on the stuffing density provided in the lesson (400 g per 10 000 cm3), students determine how much stuffing would be needed for their creation.
2. Students go on a gallery walk ([bit.ly/DLSgallerywalk](https://bit.ly/DLSgallerywalk)) and give peer feedback in the form of Two stars and a wish ([bit.ly/DLSpeerfeedback](https://bit.ly/DLSpeerfeedback)).
3. Students return to their vertical non-permanent surface to implement the suggested improvements from the feedback provided in the ‘wish’ component.
4. Ask the students to discuss, ‘If you designed a cylindrical snake toy with radius of 8 cm using the same amount of stuffing as your plush toy, how long would it be?’

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* A notice and wonder strategy is used where there is no correct answer, so that all students can participate in the discussion.

**Explore**

* Students may benefit from revising the method of backtracking to check student understanding of using the circumference formula to find the diameter.
* Students may need to be reminded of how to use a rate to make calculations.
* Students who are ready could be introduced to shapes such as spheres, cones and pyramids from Stage 5.
* Students who show readiness to rearrange the equation to change the subject of the equation could be explicitly taught this process.
* Students who are not ready to use the circumference formula and solve could be encouraged to make an estimate of the radius and discuss this as a limitation of their estimate.

**Summarise**

* Question prompts could be modified on the slide based on student need.
* Faded examples could be modified to include decimals or different units.
* More examples could be added to the Worked examples (Your turn) if required.

**Apply**

* Students could be given a model or creature to replicate.
* Students could be challenged to use solids beyond the scope of Stage 4.

### Suggested opportunities for assessment

**Explore**

* Students give each other peer feedback, before sharing with the class in a Think-Pair-Share.
* Evaluate students' accuracy and understanding as they take measurements of their plush toys and identify relevant dimensions.
* Assess students' ability to correctly substitute and apply the circumference and volume formulas when calculating the volumes of different sections.
* Monitor discussions while students brainstorm strategies to calculate unknown values using the volume of a cylinder.

**Summarise**

* Teacher could facilitate class discussions and observe students’ reasoning and justification in response to the provided prompts from the slide deck.
* Monitor student responses in the ‘Your turn’ section to check for understanding of solving equations.
* When discussing work with students, teachers can encourage students to think about what happens next in each step of the faded examples.
* Student responses to the faded worked examples could be collected as a work sample for assessment of student’s ability to communicate using notation.

**Apply**

* Students will demonstrate their Working mathematically skills in discussions and justifications of the different parts of the toy design and how to stuff it.
* **Students working at vertical non-permanent surfaces means the teacher can assess student progress and provide support where appropriate.**

## Appendix A

### Unknown height

|  |  |  |  |
| --- | --- | --- | --- |
| Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 462 cubic centimetres and a radius of 7 centimetres. | Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 9651 cubic centimetres and a radius of 16 centimetres. | Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 3619 cubic centimetres and a radius of 8 centimetres. | Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 4084 cubic centimetres and a radius of 10 centimetres. |
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## Appendix B

### Unknown radius

|  |  |  |  |
| --- | --- | --- | --- |
| Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 2262 cubic centimetres and a height of 5 centimetres. | Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 201 cubic centimetres and a height of 16 centimetres. | Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 9698 cubic centimetres and a height of 7 centimetres. | Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 2375 cubic centimetres and a height of 21 centimetres. |
|  |  |  |  |

## Sample solutions

### Appendix A – unknown height

|  |  |  |  |
| --- | --- | --- | --- |
| Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 462 cubic centimetres and a radius of 7 centimetres. | Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 9651 cubic centimetres and a radius of 16 centimetres. | Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 3619 cubic centimetres and a radius of 8 centimetres. | Calculate the unknown height, correct to the nearest whole number.  A cylinder with a volume of 4084 cubic centimetres and a radius of 10 centimetres. |
|  |  |  |  |

### Appendix B – unknown radius

|  |  |  |  |
| --- | --- | --- | --- |
| Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 2262 cubic centimetres and a height of 5 centimetres. | Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 201 cubic centimetres and a height of 16 centimetres. | Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 9698 cubic centimetres and a height of 7 centimetres. | Calculate the unknown radius, correct to the nearest whole number.  A cylinder with a volume of 2375 cubic centimetres and a height of 21 centimetres. |
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## References

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