# Volume of a cylinder

Students explore milk trucks to deepen their understanding of the volume of a cylinder formula, followed by calculating the volume of various water tanks and silos across New South Wales.

## Visible learning

### Learning intention

* To be able to apply the formula to calculate the volume of a cylinder.

### Success criteria

* I can write and explain what the variables represent in the formula for the volume of a cylinder.
* I can substitute values into the volume formula.
* I can correctly calculate the volume of a cylinder.

### 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**

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Table 1: lesson summary

|  |  |  |  |
| --- | --- | --- | --- |
| Section | Summary of activity | Teaching strategies | Teaching points |
| **Launch** | Show students the video ‘Tankers Principles Animation’ (1:17) ([bit.ly/tankers-animation](https://bit.ly/tankers-animation)) and discuss which tanker would be best to transport milk. | Think-Pair-Share  Notice and wonder | This section aims to introduce students to the volume of milk tankers. |
| **Explore** | Students are explicitly taught how to use the volume of a cylinder formula using slides 3–6 of the PowerPoint Volume of a cylinder (VOC PPT) before finding the volume of various milk tankers using banner tasks in [Appendix A](#_Appendix_A). Students then investigate how much volume is taken up by bulkhead in a tanker. | Worked examples (Your turn)  Visibly random groups of 3  Vertical non-permanent surfaces  Pose-Pause-Pounce-Bounce  Turn and talk | This section aims for students to investigate different milk trucks and their volumes and further develop the formula . |
| **Summarise** | Students complete variation questions in [Appendix B](#_Appendix_B_1) and then develop notes using [Appendix C](#_Appendix_C). | Four quadrant notes | This section aims to consolidate learning and develop notes for future reference. |
| **Apply** | Students find the volume of various silos or water tanks from around NSW using [Appendix D](#_Appendix_D). |  | Students apply their knowledge to other cylinders. |

## Activity structure

Please use the associated PowerPoint *Volume of a cylinder* (VOC PPT) to display images in this lesson.

### Launch

1. Show students the video ‘Tankers Principles Animation’ (1:17) ([bit.ly/tankers-animation](https://bit.ly/tankers-animation)).
2. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), ask students to comment on what they notice and what they wonder ([bit.ly/noticewonderstrategy](https://bit.ly/noticewonderstrategy)) about the video.

Students might notice that the milk moves a lot during transportation or that the milk tanker is cylindrical or elliptical. Students may wonder how much liquid can be transported, how much the baffle or bulkhead takes away from the capacity of the tankers or why these trucks are cylindrical.

1. In another Think-Pair-Share, ask students what type of truck they think would be best to transport milk and why.

Students might say a truck with a baffle as driving the truck would be smoother, whereas others may say a smoothbore as it can be sterilised.

1. Inform students that we will consider the tanks as cylinders for this lesson.

### Explore

1. Use slides 3–6 from the PowerPoint (VOC PPT) for explicit teaching of using the volume of a cylinder formula using the Worked examples (Your turn) method ([bit.ly/supportingstrategies](https://bit.ly/supportingstrategies)).
2. 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%22%20/t%20%22_blank)).
3. Students complete the banner task ([bit.ly/supportingstrategies](https://bit.ly/supportingstrategies)) in Appendix A ‘Milk tankers’.
4. In a turn and talk ([bit.ly/classroomtalkmoves](https://bit.ly/classroomtalkmoves)) ask students to discuss the volume that a bulkhead would take up inside a tanker.
5. Use the Pose-Pause-Pounce-Bounce questioning strategy (PDF 557 KB) ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)) to ask students what information would be needed to calculate this.
6. Ask students to find the area of the face of a baffle to fit into a milk tanker truck with a radius of 1.5 m.
7. Using the area of the cross-section of the tanker from the previous calculation, have students work in their groups to find the volume of a bulkhead when varieties can come with thicknesses of 2 cm, 3 cm, 4 cm, 5 cm or 10 cm.

Sample solutions are provided for this activity.

1. In a turn and talk, ask students to discuss which is the better option, one 3 cm bulkhead or 3 × 1 cm bulkheads.

Students should recognise that the volume taken up by the baffles is the same but should consider the stability of the truck. This would result in 3 × 1 cm baffles being the better solution.

1. Use the Pose-Pause-Pounce-Bounce questioning strategy to discuss how finding the area of the cross-section of the tanker assisted in finding the volume. Have students consider if this is true for all cylindrical shapes.

Students should link the area of a circle to the   in the formula and recognise that if they calculate this, they can multiply the area by different heights to find different volumes.

### Summarise

1. Distribute Appendix B ‘Variation problems’ to each student to complete. This Appendix uses Variation Theory ([variationtheory.com/introduction/](https://variationtheory.com/introduction/)) to highlight changes to the volume when changing the radius or height of a cylinder.
2. Have students check their solutions with a partner. Have them discuss any differing solutions and find the correct solution together, or discuss how the change in each question changed the result.
3. Students are to return to their groups of 3 at vertical non-permanent surfaces to complete four quadrant notes to their future forgetful selves ([bit.ly/supportingstrategies](https://bit.ly/supportingstrategies)) from Appendix C ‘Four quadrant notes’.

### Apply

1. Place several copies of Appendix D ‘NSW cylinder art’ around the room.
2. Have students move around the room to choose 3 different images and use the information to find the volume of the water tank or silo.
3. Have students pair up with another student who chose the same cylinder art and compare their answers. If the students disagree, have them negotiate the correct answer.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Explore**

* Students may benefit from being given the thickness of the bulkheads in metres.

**Summarise**

* Students could be asked to find variables such as height, radii or area.
* Four quadrant notes allow for self-differentiation.

**Apply**

* Students could be encouraged to find the dimensions for a piece of silo art in their local area and find its volume.
* Students could convert the volume to litres or kilolitres.
* Students could estimate which silo they think is the largest and justify their thinking using calculations.

### Suggested opportunities for assessment

**Explore**

* Monitor student responses in the ‘Your turn’ section to check for understanding.
* Monitor responses in class discussions to check for student understanding of connecting the area and .
* When placed in groups of 3, students provide and receive peer feedback on their understanding.
* Students working at vertical non-permanent surfaces means the teacher can assess student progress and provide support where appropriate.

**Summarise**

* The teacher could collect Appendix B ‘Variation problems’ or Appendix C ‘Four quadrant notes’ to check for understanding of finding the volume of a cylinder.

**Apply**

* Create an exit ticket where students need to choose a silo and find the volume.

## Appendix A

### Milk tankers

Find the volume of a cylindrical milk tanker:

1. 15 m long with a radius of 1.5 m.
2. 12 m long with a radius of 1 m
3. with 2 compartments, each 7 m long, radius 1.2 m
4. with 3 compartments, each 4 m long, radius 1.2 m
5. with 4 compartments, each 3.5 m long, radius 1.2 m

## Appendix B

### Variation problems

|  |  |  |  |
| --- | --- | --- | --- |
| 1. | Cylinder with height 14 cm and radius 6 cm. | 2. | Cylinder with height 10 cm and radius 6 cm. |
| 3. | Cylinder with height 10 cm and diameter 6 cm. | 4. | Cylinder with height 10 cm and diameter 12 cm. |
| 5. | Cylinder with height 10 cm and area of circle 60 cm^2. | 6. | Cylinder with height 10 cm and area of circle 600 cm^2. |

## Appendix C

### Four quadrant notes

|  |  |
| --- | --- |
| **Example 1**  Find the volume of the following cylinder.  Cylinder with height 15 cm and radius 6 cm. | **Example 2**  Find the volume of the following cylinder.  Cylinder with height 22 cm and diameter 18 cm. |
| **Things to remember** | **Example 3** |

## Appendix D

### NSW cylinder art

|  |  |
| --- | --- |
| Dunedoo | Bourke |
| 4 large silos in a square formation, only seeing the 2 front silos with a horse on them. | A large water tower. |
| Four silos stand 28 m tall with a diameter of 8 m. | A water tower, height 35 m, radius 688 cm. |
| Harden | Hay |
| A silo with a painting of men. | A large water tower with a mural on it. |
| Two silos stand 32 m tall with a radius of 4.3 m. | A water tower 24 m high with diameter 12 m |

|  |  |
| --- | --- |
| Merriwa | Deniliquin |
| Three large silos with sheep painted on it. | Water tower with a kookaburra painted on it. |
| Three silos stand 30 m tall with a radius of 5 m. | A water tower 22.8 m high, diameter 7.6 m. |

## Sample solutions

### Appendix A – milk tankers

|  |  |
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|  |  |

### Explore questions

#### Area of cross-section

#### Volumes of the bulkheads

|  |  |
| --- | --- |
| Thickness of bulkhead (h) | Volume () |
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|  |  |
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### Appendix B – variation problems

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| --- | --- | --- | --- |
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### Appendix C – four quadrant notes

|  |  |
| --- | --- |
| **Example 1**  Find the volume of the following cylinder.  Cylinder with height 15 cm and radius 6 cm. | **Example 2**  Find the volume of the following cylinder.  Cylinder with height 22 cm and diameter 18 cm. |

### Appendix D – NSW cylinder art

|  |  |  |
| --- | --- | --- |
| **Dunedoo** | **Bourke** | **Harden** |
| 4 in total = |  | 2 in total = |
| **Hay** | **Merriwa** | **Deniliquin** |
|  | 3 in total = |  |

## References

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