Stacks of Circles: Volume of Cylinders

Teacher		**Class**	Grade 8
Subject	Math	**Topic**	Volume of cylinders
Date		**Room**	
Lesson length	60 minutes	**Country**	United States

Students learn that cylinder volume is circle area stacked by height. They measure, calculate, and solve cylinder problems in pairs.

Curriculum links

- Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems [2]
- Given the formulas for the volume of cones, cylinders, and spheres, solve mathematical and real-world problems [2]

Learning objectives

- Students will find the volume of cylinders using V equals pi r squared h.
- Students will solve real-world cylinder problems and report answers in cubic units.

Success criteria

- I can calculate base area first and then multiply by height.
- I can find cylinder volume from radius or diameter correctly.

What students already know

2-minute check: ask students to write the area of a circle with radius 3 cm and share with a partner, listening for pi times r squared.

Key words

volume	the three-dimensional amount of space that an object occupies [3]
radius	the distance from the center of the circular base to its edge [22]
height	the distance between the two circular bases [22]
base area	the flat circular face size found with pi times r squared [7]
cubic units	units used to report volume, like cubic inches or cubic centimeters [4]

Materials

- printed circles with radius labeled
- rulers
- calculators
- tape
- Slides 1-11
- Worksheet Task B and Task D

Before the lesson

- Print circles with radius labeled and Worksheet Task B and Task D for pairs
- Test Slide 6 Video clip 3 (0:00–3:31) and check calculators work
- Set desks for pairs with space for stacking circles and taping

Lesson outline

0–8 min **Starter** 8 min · Whole class

Spark curiosity about capacity and recall circle area for cylinder volume.

YOU DO

1. Show Slide 1: Volume of Cylinders [title]: How much can it hold inside? and read the title question.
2. Show Slide 2 Tall or Wide? vote and ask: What if a cylinder is just a stack of circles — how many would we need?
3. Take a vote for tall thin can, short wide can, or about equal and ask 2 students to explain.
4. Link answers to lesson goal: find cylinder volume from base area times height.

STUDENTS DO

1. Vote for Tall, thin can, Short, wide can, or They look about equal.
2. Explain prediction to a partner in 30 seconds.

Say: Look at the two containers. Vote with your hand which holds more inside. A cylinder is like a stack of thin circles. Today we will learn how that stack tells us the volume.

Ask: If you know a circle's area, what one step gives cylinder volume? (Multiply by height, stack the layers.) · What do we need to know about the circle first? (Radius, then pi times r squared for area.)

Check understanding: Quick show of hands for each choice and thumbs up if they can state circle area; if unsure, restate area equals pi r squared before moving on.

Support: Show a printed circle and point to center to edge while restating radius. **Stretch:** Ask what would happen to the stack if height doubled but circle stayed same.

Use: Slides 1-2

8–20 min **Teaching** 12 min · Whole class

Model how base circle area times height gives V equals pi r squared h.

YOU DO

1. Show Slide 3 Prism vs Cylinder compare and explain prism layers stack up by height.
2. Show Slide 4 fact that a 10-cm cube holds 1 liter and Slide 5 Think, pair, share question.
3. Play Slide 6 Video clip 3 (0:00–3:31) with focus: watch for circle area first and how height stacks layers.
4. Model worked example on board and state Slide 7 Big idea: Cylinder volume is base circle area stacked by height.

STUDENTS DO

1. Think, pair, share Slide 5 question with a partner.
2. Copy the 2-step model and the formula V = pi r squared h [7] into notebooks.

Say: A cylinder works like a prism. First find the area of the circle, pi r squared. Then multiply by height to stack it up. Keep all lengths in the same unit before multiplying [4].

Worked example: Find volume with r = 2 in, h = 6 in. Step 1: base area = pi x 2 squared = 4 pi in2. Step 2: volume V = pi r squared h [7] = 4 pi x 6 = 24 pi cubic inches [4]. Step 3: with 3.14 as an approximation for pi [22], 24 x 3.14 = 75.36, so about 75.4 in3.

Ask: Why do we square first and then multiply by height? (Base area pi r squared comes first, then stack by height.) · What units must the answer have? (Cubic units, because volume is three-dimensional [3].) · If diameter is 6 in, what is radius? (3 in, because radius is half the diameter [7].)

Check understanding: Mini-whiteboards: all write V formula and base area for r=2 in; scan and reteach if squaring is wrong.

Support: Give formula card and remind students to find the area of the cross-section first [11]. **Stretch:** Ask students to predict volume change if radius doubled while height stayed same.

Use: Slides 3-7, Video clip 3 (0:00–3:31)

20–40 min **Main activity** 20 min · Pairs

Build cylinder volume by measuring circles and multiplying base area by height.

YOU DO

1. Hand out printed circles, rulers, calculators, and tape and show Slide 9 Your task steps.
2. Demo: measure radius, which is the distance from the center of the circular base to its edge [22], find base area, then multiply by height, which is the distance between the two circular bases [22].
3. Have pairs build two stacks with same base but different heights and calculate V = pi r squared h [7], which works because volume is the area of the cross-section multiplied by its height [10].
4. Circulate, check units in cubic units [4], and prompt comparison of the two stacks.

STUDENTS DO

1. Measure radius, calculate base area, then multiply by height to find volume.
2. Tape stacks, record both volumes in cubic units, and compare which is larger and why.

Say: Measure your radius in centimeters. Calculate pi r squared first for your circle area. Multiply by your stack height. Write volume in cubic units and compare your two stacks.

Worked example: Circle radius 3 cm, stack height 10 cm. Base area = 3.14 x 3 x 3 = 28.26 cm2. Volume = 28.26 x 10 = 282.6 cm3. A 5-cm stack with same base would be half: 141.3 cm3.

Ask: Why did the taller stack have larger volume with the same base? (More layers of the same base area stacked by height.) · Where did you use 3.14? (As approximation for pi times radius squared.)

Check understanding: Pairs hold up record sheets; teacher checks base-area-first step and cubic units, pulls small group to remodel if missing.

Support: Give circles with the radius labeled and remind students to find the area of the cross-section first [11].
Stretch: Give the volume and radius and ask students to work backward to find the missing height.

Use: Slide 9

40–52 min **Paired practice** 12 min · Pairs

Apply the formula quickly to find volumes from radius and height.

YOU DO

1. Hand out Worksheet Task D: Solve each volume problem. Use 3.14 for pi.
2. Remind class: check radius or diameter, square first then multiply, and keep all lengths in the same unit before multiplying [4].
3. Set timer for 8 minutes for pairs to solve and label cubic units [4].
4. Stop and have pairs trade papers to check base area times height matches volume.

STUDENTS DO

1. Solve Task D problems in pairs, showing base area then height multiplication.
2. Trade papers and check partner work for correct radius and cubic units.

Say: You have four cylinder problems. First decide if you have radius or diameter. If diameter, divide by 2 to find radius [22]. Square first, then multiply by height and use 3.14 for pi.

Worked example: Diameter = 6 cm, height = 8 cm. Radius = 6 / 2 = 3 cm. Base = 3.14 x 9 = 28.26 cm2. Volume = 28.26 x 8 = 226.08 cm3.

Ask: How did you know to divide by 2? (Problem gave diameter, radius is half.) · Why label cm3 not cm2? (Volume is measured in cubic units [4].)

Check understanding: Cold-call two pairs to share base area and final volume; correct whole class on board if diameter error appears.

Support: Provide formula card and multiplication chart and circle the diameter numbers that need halving.
Stretch: Let students round final volume to nearest tenth and explain the rounding choice.

Use: Worksheet Task D

52–60 min **Plenary** 8 min · Whole class

Confirm the formula, units, and radius check before leaving.

YOU DO

1. Show Slide 10 What to remember mindmap and ask students to recite V = pi r squared h together.
2. Show Slide 11 Quick quiz and solve r = 2 in, h = 6 in together in terms of pi.
3. Ask exit questions on formula, radius from diameter, and sense-checking result.
4. Preview homework from Worksheet Task B.

STUDENTS DO

1. Choral response to quiz and write exit ticket answers on slips.
2. Self-rate with thumbs up if they can state formula and steps.

Say: Tell your partner the two steps in order. Base area first, then times height. Radius is diameter divided by 2. Answers go in cubes. We now have a tool to solve real-world and mathematical problems [2].

Ask: What is the volume formula for a cylinder? (V = pi r squared h.) · Diameter = 6 cm, what radius do you use? (3 cm.)

Check understanding: Collect exit slips; if more than a third miss radius or units, start next lesson with reteach on diameter and cubes.

Support: Point to mindmap steps: radius = diameter / 2, base area first, multiply by height. **Stretch:** Ask what happens to volume if height doubled and how they know.

Use: Slides 10-11

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Common mistakes

Mistake	How to spot it	How to fix it
Using diameter as radius	Volume 4 times too big, base uses full diameter	If the diameter is provided, divide it by 2 to find the radius [22]
Multiplying radius by height before squaring	Work shows r x h in parentheses squared	Remind students of order and link to prism formula: finding the area of the cross-section first [11]
Labeling volume in square units or no units	Answer says cm2 or just a number	Restate volume is measured in cubic units [4] and capacity in cubic units [4]

Support

- Give circles with radius labeled and formula cards with squared numbers table

Stretch

- Ask for missing height from given volume and radius and a second design with same volume but wider base

For the LSE or teaching assistant

Stay with target pairs during stacking and Task D; prompt base area first, check halving of diameter, and confirm cubic units.

Check for understanding

Question	Answer
What is the volume formula for a cylinder?	V = pi r squared h
r = 2 in, h = 6 in. Volume in terms of pi?	24 pi cubic inches, about 75.4 in3
Diameter = 6 cm, height = 8 cm. What radius and volume with pi = 3.14?	r = 3 cm, volume = 226.08 cm3

Homework

Complete Worksheet Task B: find each volume using 3.14 for pi with cubic units.

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