Volume Relay: From Cross-Section to Prisms

Teacher		**Class**	Year 8
Subject	Maths	**Topic**	Volume of prisms
Date		**Room**	
Lesson length	60 minutes	**Country**	United Kingdom

Students derive area formulae then use them to find prism volumes. They work in teams round four prism stations to solve volume problems.

Curriculum links

- derive and apply formulae to calculate and solve problems involving: perimeter and area of triangles, parallelograms, trapezia, volume of cuboids (including cubes) and other prisms (including cylinders)

Learning objectives

- Students will derive area formulae for triangles, parallelograms and trapezia.
- Students will solve mixed prism volume problems quickly and accurately in teams.
- Students will calculate cylinder volumes and convert container volumes to litres.

Success criteria

- I can find perimeter and area of triangles, parallelograms and trapezia.
- I can find prism volume from cross-section area times length.
- I can find cylinder volume and use 1000 cm³ = 1 litre.

What students already know

Ask: What is the area of a 6 cm by 4 cm rectangle? How could that help with a triangle with the same base and height? Listen for 24 cm² and half of it.

Key words

prism	a solid with the same flat shape all the way through it [1][4]
cross-section	the flat face made by cutting straight through a solid [1]
volume	the amount of space taken up by a closed solid shape
area	the amount of flat surface inside a 2D shape
perimeter	the total distance all the way round the edge of a shape
cylinder	a solid with a circle at each end and the same circle all through [1]

Materials

- slide deck Slides 1-12
- sets of task cards for four stations
- answer sheets
- timers
- formula reminder cards for triangle, parallelogram and trapezium areas
- calculators

Before the lesson

- print sets of task cards for four stations and answer sheets, one per team
- print formula reminder cards for triangle, parallelogram and trapezium areas
- test Slide 6 Video clip 1 (0:00–3:28) with sound and subtitles

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- mini whiteboards and pens
- arrange desks into four stations with walkways clear and calculators ready

Lesson outline

0–7 min **Starter** 7 min · Whole class

Recall area facts and set up the team relay challenge for the lesson.

YOU DO

1. Show Slide 1 and give the hook: Four stations, four prisms, one winning team. No skipping the working.
2. Show Slide 2 and explain we will use 1000 cm³ in every 1 litre of space to sense-check container volumes later.
3. Show Slide 5 mystery and read the riddle about two identical triangular ends and three rectangles.
4. Ask what students already know about rectangle area and perimeter to link to new formulae.

STUDENTS DO

1. Listen to the hook and look at Slides 1-2 and 5.
2. Call out guesses for the mystery object and explain which 2D shape runs through it.
3. Write rectangle area and perimeter for 6 cm by 4 cm on mini whiteboards.

Say: Today is our Volume Relay. Four stations, four prisms, one winning team. No skipping the working. Every team must show the cross-section area first, then multiply by the length. The fastest team with correct working and cubic units wins.

Ask: What am I if I have two identical triangular ends and three rectangles round me? (A triangular prism, like a tent lying on its side.) · What are the area and perimeter of a 6 cm by 4 cm rectangle? (Area 24 cm² by length times width; perimeter 20 cm by adding all sides.)

Check understanding: Check whiteboards for 24 cm² and 20 cm. If mixed up, hold up line for cm and flat square for cm² and redo one example.

Support: Give a squared-paper rectangle 6 by 4 to count squares for area and count edges for perimeter.
Stretch: Ask students to predict the area of a triangle with base 6 cm and height 4 cm before we derive it.

Use: Slides 1-2, 5

7–20 min **Teaching** 13 min · Whole class

Derive 2D area formulae and link them to volume as cross-section area times length.

YOU DO

1. Show Slide 3 mindmap and model cutting a paper parallelogram into a rectangle to show area is base times perpendicular height [1].
2. Show cutting that parallelogram along a diagonal to give triangle area as half times base times height [5], then joining two identical trapezia to give half times sum of parallel sides times height, as in half × (6 + 10) × 4 [3].
3. Show Slide 4 steps: spot the repeating end, work out its area in cm², multiply straight through, give cm³.
4. Play Slide 6 Video clip 1 and ask students to spot how the cross-section stays the same all through the prism [1][4].

STUDENTS DO

1. Watch the cut-and-rearrange demonstration and copy the three area formulae.
2. Watch the video and note the rule area times length in own words.
3. Chant the steps with teacher: spot it, area it, times length, cubic units.

Say: We get every area from a rectangle. A parallelogram rearranges to base times height. A triangle is half of that, so half times base times height. A trapezium made from two copies gives half times a plus b times height. For any prism, volume is area of the cross-section multiplied by the length [2].

Worked example: Trapezium with parallel sides 6 cm and 10 cm, height 4 cm: area = 1/2 × (6 + 10) × 4 = 1/2 × 16 × 4 = 32 cm². If prism length is 15 cm, volume = 32 × 15 = 480 cm³ [3].

Ask: Why is a triangle half times base times height? (Because two identical triangles make a parallelogram, so one is half.) · What is volume of any prism? (Area of the cross-section multiplied by the length [1][2].)

Check understanding: Mini whiteboards up: write volume rule in words. Reteach with sliced loaf image if students write any face instead of repeating end.

Support: Give pre-drawn parallelogram and trapezium on squared paper to count squares and check the halving idea. **Stretch:** Ask why perimeter needs adding all sides while area needs multiplying, using the cut shapes.

Use: Slides 3-4, 6, Video clip 1 (0:00–3:28)

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20–30 min **Guided practice** 10 min · Whole class

Model correct two-step working and avoid common traps with units and faces.

YOU DO

1. Show Slide 7 photo and stress makers often use prism shapes for packaging where every slice straight through is exactly the same shape.
2. Model cuboid 9 cm by 4 cm by 5 cm: cross-section 9 × 4 = 36 cm², volume 36 × 5 = 180 cm³ [1][3].
3. Model triangular prism base 6 cm, height 4 cm, length 10 cm: triangle 1/2 × 6 × 4 = 12 cm², volume 12 × 10 = 120 cm³ [3].
4. Show Slide 10 traps and set Worksheet Task B: Practice questions: Find each area or perimeter. Include the correct units.

STUDENTS DO

1. Copy the two worked examples step by step with units cm² then cm³.
2. Complete Worksheet Task B: Practice questions: Find each area or perimeter. Include the correct units.
3. Compare answers in pairs and flag any halving or radius error.

Say: Always show the cross-section area first, then multiply by the length [4]. Use the repeating end, not any face [4]. Halve for triangles. Use radius, not diameter, for cylinders [5]. Volume needs cubic units because three dimensions are multiplied together [2].

Worked example: Cuboid 9 cm by 4 cm by 5 cm: 9 × 4 = 36 cm² cross-section, 36 × 5 = 180 cm³ volume. Triangular prism: 1/2 × 6 × 4 = 12 cm², 12 × 10 = 120 cm³. Cylinder radius 3 cm, height 7 cm: pi × 3 × 3 × 7 = 63 pi ≈ 197.9 cm³ [2][5].

Ask: Why did we do 9 × 4 first for the cuboid? (That is the rectangular cross-section area, then we multiply by the remaining length [2].) · What units for perimeter, area and volume? (cm for perimeter, cm² for area, cm³ for volume.)

Check understanding: Cold-call pairs to read cross-section area and volume. If halving is missed, redraw triangle inside parallelogram.

Support: Provide formula reminder card and prompt card showing line for cm, square for cm² and cube for cm³. **Stretch:** Ask students to explain what changes if the prism is lying on its side and which face is still the cross-section [2].

Use: Slides 7, 10, Worksheet Task B: Practice questions: Find each area or perimeter.

30–52 min **Main activity** 22 min · Groups

Students solve mixed prism volume problems quickly and accurately in teams.

YOU DO

1. Set out four stations with task cards, answer sheets and timers. Station A: cuboid 9 cm by 4 cm by 5 cm. Station B: triangle base 6 cm, height 4 cm, length 10 cm. Station C: pentagonal cross-section area 20 cm², length 15 cm, so 20 × 15 = 300 cm³ [1]. Station D: cuboid container 10 cm by 10 cm by 10 cm = 1000 cm³ = 1 litre [4].
2. Show Slide 9 task and explain teams rotate, find cross-section area first then multiply by length [4], recording both with cubic units.
3. Remind of safety: walk quickly between stations, keep bags under desks and keep walkways clear to avoid trips.
4. Start timers, circulate to check choice of repeating end and correct use of half and radius.

STUDENTS DO

1. In teams of three or four, rotate round stations with answer sheet and calculator.
2. Complete Worksheet Task D: Practice questions: Show the cross-section area first, then multiply by the length.
3. Hand in one answer sheet with areas, volumes and correct cm³, and attempt bonus if finished.

Say: You have four stations and a timer. At each one, spot the repeating end, work out its area, then times length. Hand in one answer sheet with both the cross-section area and volume for each station. Walk between stations and keep walkways clear.

Worked example: Station C: cross-section area given as 20 cm², length 15 cm. Volume = 20 × 15 = 300 cm³ [1]. Station B: 1/2 × 6 × 4 = 12 cm², 12 × 10 = 120 cm³ [3].

Ask: Which face is the cross-section here? (The identical face at each end that stays the same all through, not just any face [2][4].) · How do you know to use cm³? (Volume multiplies three lengths, so units are cubed [2].) · How many cm³ in a litre and how does that help Station D? (1000 cm³ = 1 litre [4], so 1000 cm³ container holds exactly 1 litre.)

Check understanding: Collect answer sheets and check both area and volume per station. If errors, send team back to checklist: Which face repeats? Halved? Times length? Radius or diameter?

Support: Give a formula reminder card for triangle, parallelogram and trapezium areas plus a calculator for the multiplication step. **Stretch:** Add a bonus card where the volume and two dimensions are given and students must find the unknown length [6].

Use: Slide 9, Worksheet Task D: Practice questions: Show the cross-section area first, then multiply by the length.

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

Check objectives, fix traps and confirm litre link and vote.

YOU DO

1. Show Slide 11 vote: Which prism shape would make the best pencil case? Flat cuboid box, triangular tube or cylinder tube.
2. Revisit Slide 2: use 1000 cm³ in every 1 litre to sense-check Station D container.
3. Show Slide 12 exit ticket and collect three answers from all students.
4. Summarise rule and name next lesson link to surface area.

STUDENTS DO

1. Vote for best pencil case and justify with volume and shape of cross-section.
2. Confirm 1000 cm³ = 1 litre for container sense-check [3][4].
3. Complete exit ticket on mini whiteboards or slips.

Say: Vote with reasons using maths, not just looks. Think about volume from cross-section times length and capacity in litres. Then complete your exit ticket. Volume of any prism equals area of cross-section times length. Tell me one calculation you are confident with and one question you still have.

Ask: Why might a cylinder tube hold more than a triangular tube of similar length? (Its circular cross-section area pi times radius squared [5] may be larger, so area times length is larger.) · What are the three traps to avoid? (Wrong face, forgetting to halve for triangle [4], using diameter not radius [5].)

Check understanding: Read exit tickets for volume rule and litre conversion. Reteach any missing halving or units next lesson.

Support: Give sentence starters: Volume of any prism = ... One calculation I am confident with is ... **Stretch:** Ask students to explain why doubling radius quadruples cylinder volume while doubling length only doubles it.

Use: Slides 2, 11-12

Common mistakes

Mistake	How to spot it	How to fix it
Using the wrong face as the cross-section, especially when prism lies on its side	Volume far too big or small and working starts with a face that does not repeat	Mark the two identical ends and redraw the cross-section separately, then do area times length [2][4].
Forgetting to halve for triangular cross-section	Answer exactly double the correct volume, e.g. 240 cm³ not 120 cm³	Insist on 1/2 × base × height first, then times length, and check against half a cuboid [4].
Stopping after cross-section area or using diameter instead of radius for cylinders	Answer in cm², or cylinder volume four times too big	Require two lines: area in cm² then volume in cm³; halve diameter to get radius for pi × radius² × height [5].

Support

- Give a formula reminder card for triangle, parallelogram and trapezium areas plus a calculator for the multiplication step.
- Give pre-drawn shapes on squared paper and prompt cards for cm, cm² and cm³.

Stretch

- Add a bonus card where the volume and two dimensions are given and students must find the unknown length [6].
- Ask students to redesign with double radius or double length and explain the effect on volume.

For the LSE or teaching assistant

Stay with relay groups needing support: prompt which face repeats, check halving and radius, and scribe the two-step working while students explain.

Safety

- Walk quickly between stations, keep bags under desks and keep walkways clear to avoid trips.

Check for understanding

Question	Answer
Triangular prism, base 6 cm, height 4 cm, length 10 cm. Volume?	1/2 × 6 × 4 = 12 cm², 12 × 10 = 120 cm³
Pentagonal prism, cross-section 20 cm², length 15 cm. Volume?	20 × 15 = 300 cm³
Cuboid container 10 cm × 10 cm × 10 cm. Volume in cm³ and litres?	1000 cm³ = 1 litre

Homework

Complete Worksheet Task D practice questions to show the cross-section area first, then multiply by the length and Worksheet Task F to find the area of each cross-section with the correct units.

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