

Student Name

Mathematics Stage 4

VOLUME

Book 4 Choose appropriate units of measurement for volume and capacity and convert between units

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OVERVIEW

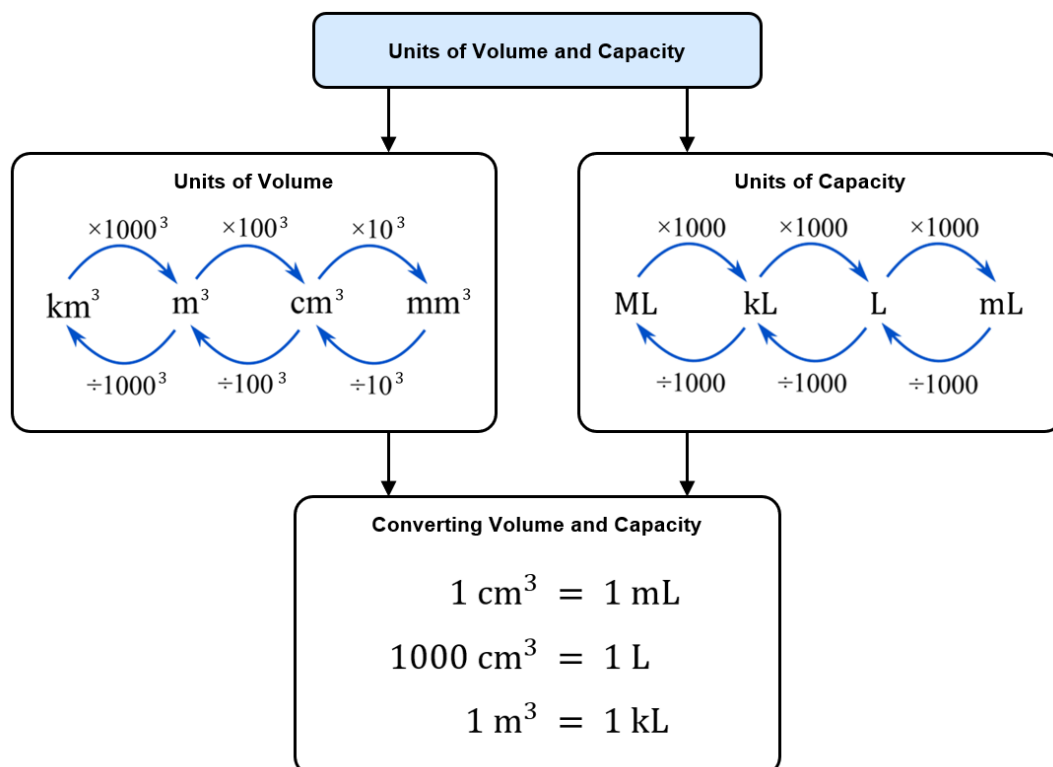
SYLLABUS CONTENT

MA4-VOL-C-01 applies knowledge of volume and capacity to solve problems involving right prisms and cylinders

Choose appropriate units of measurement for volume and capacity and convert between units

- Recognise that 1000 L is equal to 1 kilolitre (kL) and use the abbreviation
- Recognise that 1000 kL is equal to 1 megalitre (ML) and use the abbreviation
- Choose an appropriate unit to measure the volume or capacity of different objects and justify the choice
- Convert between metric units of volume and capacity
($1 \text{ cm}^3 = 1000 \text{ mm}^3$, $1 \text{ cm}^3 = 1 \text{ mL}$, $1 \text{ m}^3 = 1000 \text{ L} = 1 \text{ kL}$)
- Solve practical problems involving the volume and capacity of right prisms and cylinders

CONTENT



REVIEW OF PRIOR KNOWLEDGE

1 Convert these units of length.

a 5 cm to mm

b 2 m to cm

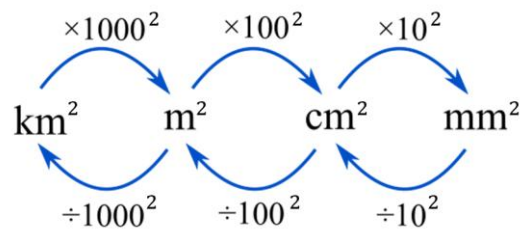
c 3.5 km to m

d 2.1 m to mm

e 400 mm to m

f 500 cm to km

2 Convert these units of area.



a 5 cm² to mm²

b 2 m² to cm²

a 3.5 km² to ha

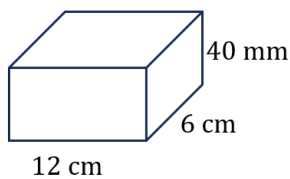
c 2.1 m² to mm²

d 400 mm² to m²

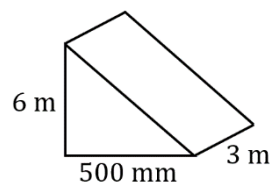
b 500 cm² to ha

3 Calculate the volume of these solids. Answer in the smaller unit.

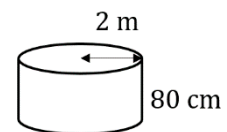
a



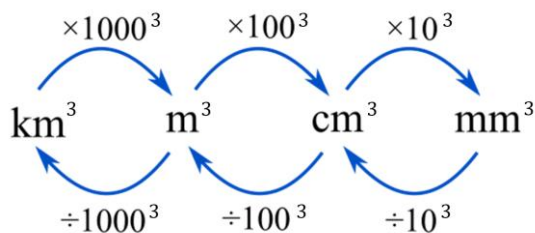
b



c



CONVERTING UNITS OF VOLUME



Example Convert units of volume.

20 m³ to cm³ $\text{km}^3 \quad \text{m}^3 \xrightarrow{\times 100^3} \text{cm}^3 \quad \text{mm}^3$ $20 \text{ m}^3 \times 100^3$ $= 20\,000\,000 \text{ cm}^3$	5000 mm³ to cm³ $\text{km}^3 \quad \text{m}^3 \quad \text{cm}^3 \xleftarrow{\div 10^3} \text{mm}^3$ $5000 \text{ mm}^3 \div 10^3$ $= 5 \text{ cm}^3$	150 000 mm³ to m³ $\text{km}^3 \quad \text{m}^3 \xleftarrow{\div 100^3} \text{cm}^3 \xleftarrow{\div 10^3} \text{mm}^3$ $150\,000 \text{ mm}^3 \div 10^3 \div 100^3$ $= 0.00015 \text{ m}^3$
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Convert these units of volume.

a 5 cm³ to mm³ 5000 mm³	b 2 m³ to cm³ 2 000 000 cm³	c 40 000 mm³ to m³ 0.000 04 m³
d 0.15 m³ to mm³ 150 000 000 mm³	e 35 000 m³ to km³ 0.000 035 km³	f 5 500 000 cm³ to m³ 5.5 m³

Key ideas

- Volume is measured using units;
5 m³ means the volume that 5 cubes of side length would cover.
- To convert between metres and centimetres, the conversion factor is
- To convert between square metres and square centimetres, the conversion factor is
- To convert between cubic metres and cubic centimetres, the conversion factor is

1 Express these volumes in cm^3

a 2.5 m^3

$2\,500\,000 \text{ cm}^3$

b $\frac{3}{4} \text{ m}^3$

$750\,000 \text{ cm}^3$

c 5000 mm^3

5 cm^3

d 100 mm^3

0.1 cm^3

e 62 m^3

$62\,000\,000 \text{ cm}^3$

2 Express these volumes in m^3

a $2\,000\,000 \text{ cm}^3$

2 m^3

b 50000 cm^3

0.05 m^3

c $850\,000 \text{ cm}^3$

0.85 m^3

3 Convert these units of volume.

a 8 cm^3 to mm^3

8000 mm^3

b 3000 mm^3 to cm^3

3 cm^3

c $90\,000\,000 \text{ cm}^3$ to m^3

90 m^3

d 18 m^3 to cm^3

$18\,000\,000 \text{ cm}^3$

e 30 mm^3 to cm^3

0.03 cm^3

f 0.02 m^3 to cm^3

$20\,000 \text{ cm}^3$

4 Convert these units of volume.

a 2 cm^3 to mm^3

2000 mm^3

e 0.002 km^3 to m^3

$2\,000\,000 \text{ m}^3$

i 0.04 m^3 to mm^3

$40\,000\,000 \text{ mm}^3$

b 2 mm^3 to cm^3

0.002 cm^3

f 0.00002 cm^3 to mm^3

0.02 mm^3

j 0.0016 km^3 to m^3

$1\,600\,000 \text{ m}^3$

c 2 m^3 to cm^3

$2\,000\,000 \text{ cm}^3$

g 0.4 m^3 to cm^3

$400\,000 \text{ cm}^3$

k 0.00016 km^3 to m^3

$160\,000 \text{ m}^3$

d 2 km^3 to m^3

$2\,000\,000\,000 \text{ m}^3$

h 0.04 m^3 to cm^3

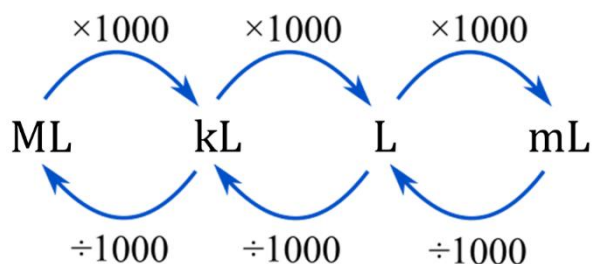
$40\,000 \text{ cm}^3$

l 0.1 km^3 to m^3

$100\,000\,000 \text{ m}^3$

UNITS OF CAPACITY

- **Volume** is the amount of space a solid takes up
- **Capacity** is the amount of liquid/gas that an object can hold.
 - A solid block of wood has volume but no capacity.
It takes up space but cannot hold anything inside it.
 - A plastic bottle has volume and capacity.
It takes up space and can hold liquid or gas.
- Metric units for capacity are millilitres (mL), litres (L), kilolitres (kL), and megalitres (ML).



Example Convert between metric units of capacity.

5.7 kL to L ML kL L mL $\times 1000$ $5.7 \text{ kL} \times 1000$ $= 5700 \text{ L}$	450 mL to L ML kL L mL $\div 1000$ $450 \text{ mL} \div 1000$ $= 0.45 \text{ L}$	920 000 L to ML ML kL L mL $\div 1000$ $\div 1000$ $920\,000 \text{ L} \div 1000 \div 1000$ $= 0.92 \text{ ML}$
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Convert these units of capacity.

a 60.42 kL to L 60420 L	b 45 mL to L 0.045 L	c 0.42 kL to mL 420 000 mL
d 0.0304 L to mL 30.4 mL	e 5.43 ML to kL 5430 kL	f 670 400 L to ML 0.6704 ML

Key ideas

1. Capacity is the amount of or that a container can hold.
2. Capacity is measured using the unit:

Converting Volume and Capacity

$$1 \text{ cm}^3 = 1 \text{ mL}$$

$$1000 \text{ cm}^3 = 1 \text{ L}$$

$$1 \text{ m}^3 = 1 \text{ kL}$$

Example Convert between volume and capacity.

Convert 257 cm ³ to mL	Convert 32.5 m ³ to kL	Convert 4500 cm ³ to L
257 mL	32.5 kL	4.5 L

Convert these units.

a 5 cm ³ to mL	b 2 m ³ to kL	c 40 000 cm ³ to L
5 mL	2 kL	40 L
d 2.34 m ³ to L	e 8920 cm ³ to kL	f 0.023 cm ³ to mL
2340 L	0.00892 kL	0.023 mL

Key ideas

- 1 mL is the amount of fluid/gas that can fit in
- 1 is the amount of fluid/gas that can fit in 1 m³.

1 Convert these units of capacity

a 2000 mL to L 2 L	b 1500 L to kL 1.5 kL	c 900 L to kL 0.9 kL
d 6 L to mL 6000 mL	e 1.25 L to mL 1250 mL	f 0.8 kL to L 800 L
g 1375 mL to L 1.375 L	h 505 L to kL 0.505 kL	i 10 mL to L 0.01 L
j 0.01 kL to L 10 L	k 3.05 kL to L 3050 L	l 5.03 L to mL 5030 mL
m 4070 L to kL 4.07 kL	n 60 mL to L 0.06 L	o 0.07 L to mL 70 mL
p 3.5 ML to L 3 500 000 L	q 890 ML to kL 0.89 kL	r 0.0087 kL to L 8.7 L

2 1 litre = 1000 cm³. Express the following in litres.

a 45 000 cm ³ 45 L	b 800 cm ³ 0.8 L	c 1 m ³ 1000 L
d $\frac{1}{2}$ cm ³ 0.0005 L	e 600 000 mm ³ 0.6 L	

3 Convert these units.

a 4 cm ³ to mL 4 mL	b 2000 cm ³ to L 2 L	c 70 cm ³ to mL 70 mL
d 34 000 m ³ to L 34 000 000 L	e 900 cm ³ to mL 900 mL	f 55 m ³ to L 55 000 L
g 43 m ³ to kL 43 kL	h 3.52 m ³ to L 3520 L	i 79 m ³ to kL 79 kL

4 A pint is an imperial unit for measuring capacity. Five pints is approximately 3 L. Approximately how many mL is one pint?

Around 600 mL

CAPACITY AND VOLUME

- If you are asked to calculate the capacity of a container:
 - Calculate the volume.
 - Convert to capacity.

Example Calculate capacity of a container.

The milk carton has base dimensions 6 cm by 9 cm and height 21 cm.
What is its capacity in litres?

1. Calculate volume

$$\begin{aligned} V &= Ah \\ &= (21)(9)(6) \\ &= 1134 \text{ cm}^3 \end{aligned}$$

2. Convert to capacity

$$\begin{aligned} &= 1134 \text{ mL} \\ &= 1.134 \text{ L} \end{aligned}$$



A cylindrical tank has a radius of 2 m and height of 3 m.

What is its capacity to the nearest whole L?

1. Calculate volume

$$\begin{aligned} V &= \pi r^2 h \\ &= \pi(2)^2(3) \\ &= 37.69911184 \dots \text{ m}^3 \end{aligned}$$

2. Convert to capacity

$$\begin{aligned} &= 37.69911184 \dots \text{ kL} \\ &= 37\,699 \text{ L} \end{aligned}$$

Calculate the capacity of these containers.

- a** A plastic takeaway container measuring 12 cm by 17.5 cm by 6.5 cm

1. Volume



$$1365 \text{ cm}^3$$

2. Capacity

$$1.365 \text{ L}$$

- b** A soft drink can with a 3.25 cm radius and 12.3 cm height.

1. Volume



$$408.15 \text{ cm}^3$$

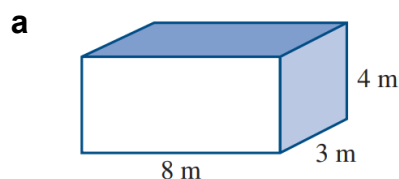
2. Capacity

$$408.15 \text{ mL}$$

Key ideas

- To find the capacity of an object, first calculate its then convert to capacity.

- 1 Calculate the volume of these solids, then convert to capacity. Answer in an appropriate unit.

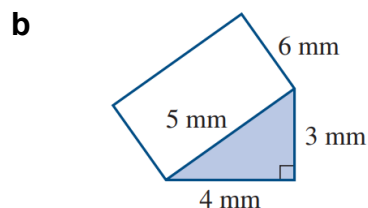


Volume:

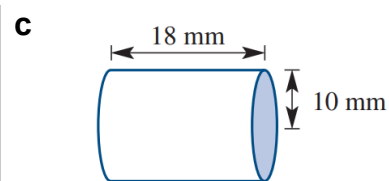
Capacity:

$$96 \text{ m}^3$$

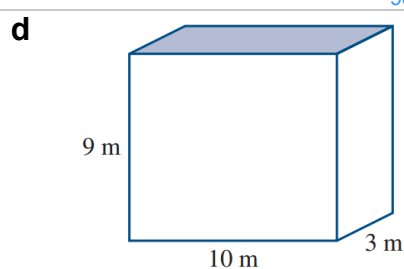
$$96 \text{ kL}$$



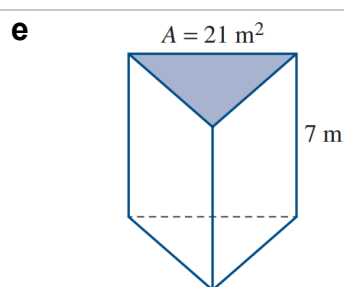
$$36 \text{ mm}^3 = 0.036 \text{ mL}$$



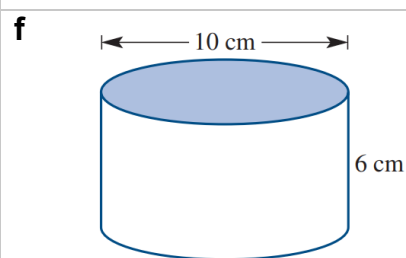
$$5.655 \text{ cm}^3 = 5.655 \text{ mL}$$



$$270 \text{ m}^3 = 270 \text{ kL}$$



$$147 \text{ m}^3 = 147 \text{ kL}$$



$$471.24 \text{ cm}^3 = 471.24 \text{ mL}$$

- 2 A fish tank measures 80 cm by 60 cm by 50 cm.
Find, in litres, the volume of the fish tank.

$$240 \text{ L}$$

- 3 How many litres of fuel can a tanker carry if its tank is cylindrical with a 2 m diameter and is 12 m in length? Round to the nearest litre.

$$37\,700 \text{ L}$$

- 4 Which has a bigger volume and what is the difference in volume to 2 decimal places:
a cube with side length 1 m, or a cylinder with radius 1 m and height 0.5 m?

$$0.57 \text{ m}^3$$

- 5 Samantha is inviting 18 friends to a party.
She estimates that each person will drink 700 mL of soft drink.
- How many litres of soft drink does she need to buy?
 - If each large bottle of soft drink is 2.5 L, how many bottles does she need?

$$19 \times 700 = 13300 \text{ mL} = 13.3 \text{ L}$$

$$13.3 \div 2.5 = 5.32$$

$$\therefore 6 \text{ bottles}$$

- 6 Samira has a 2-litre bottle of cola.
She pours the cola into cylindrical glasses with radius 3 cm and a height of 11 cm.
- What is the capacity of each cylindrical glass?
 - How many full glasses can be filled from the bottle of cola?

$$V = \pi r^2 h = \pi(3)^2(11) = 99\pi \approx 311 \text{ cm}^3$$

$$\text{Number of glasses} = 2000 \div 311 \approx 6.4$$

$$6 \text{ full glasses}$$

- 7 A juice carton measures 8 cm by 8 cm by 15 cm. It is 80% full.
Abby uses the juice to fill some cups. Each cup holds 230ml.
How many full cups of juice will Abby be able to fill?



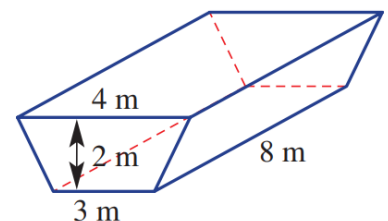
$$\text{Carton volume} = 8 \times 8 \times 15 = 960 \text{ cm}^3$$

$$\text{Juice available} = 960 \times 0.8 = 768 \text{ cm}^3$$

$$\text{Number of cups} = 768 \div 230 = 3.34$$

$$\text{Abby can fill 3 cups}$$

- 8 A swimming pool is a prism with a cross-section that is a trapezium.
- Find the capacity of the pool in litres.
 - The pool is being filled at a rate of 1000 litres per hour.
How long will it take to fill the pool?

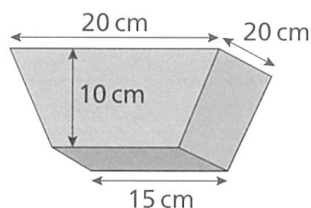


$$\text{Trapezium area} = \left(\frac{2}{2}\right)(3 + 4) = 7 \text{ m}^2$$

$$\begin{aligned} \text{Pool volume} &= Ah = 7 \times 8 = 56 \text{ m}^3 \\ &= 56,000 \text{ L} \end{aligned}$$

$$\text{Time} = 56\,000 \div 1000 = 56 \text{ hours}$$

- 9 Jakub fills an empty flowerpot with soil. The flowerpot is a prism. Its cross-section is a trapezium. Jakub has 2.5 litres of soil. Does Jakub have enough soil to fill the flowerpot?



$$\text{Trapezium area} = \left(\frac{10}{2}\right)(15 + 20) = 175 \text{ cm}^2$$

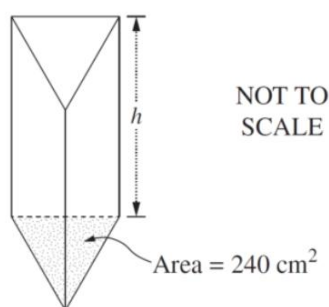
$$\text{Volume needed} = 175 \times 20 = 3500 \text{ cm}^3 = 3.5 \text{ L}$$

Jakub has 2.5 L, so not enough soil.

10 2016 HSC Standard 2 Band 4

A container is in the shape of a triangular prism that has a capacity of 12 litres.

The area of the base is 240 cm^2 . What is the distance, h , between the ends of the container?



$$V = \text{Base area} \times \text{height}$$

$$12 \text{ L} = 240 \text{ cm}^2 \times h$$

$$12000 \text{ cm}^3 = 240h$$

$$h = 50 \text{ cm}$$

11 2010 HSC Standard 2 Band 5

During a flood 1.5 hectares of land was covered by water to a depth of 17 cm.

How many kilolitres of water covered the land? (1 hectare = 10 000 m^2)

(A) 2.55 kL

(B) 2550 kL

(C) 255 000 kL

(D) 2 550 000 kL

$$\text{Area} = 1.5 \text{ ha} \times 10000 \text{ ha/m}^2 = 15000 \text{ m}^2$$

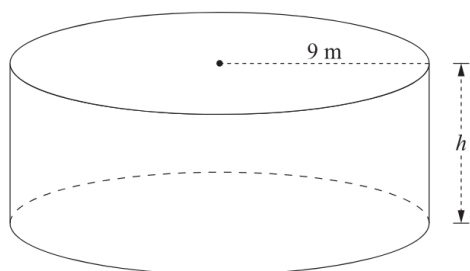
$$\text{Volume} = 15000 \text{ m}^2 \times 0.17 \text{ m} = 2550 \text{ m}^3 = 2550 \text{ kL}$$

B

12 2018 HSC Standard 2 Band 5

A cylindrical water tank has a radius of 9 metres and a capacity of 1.26 megalitres.

What is the height of the water tank? Give your answer in metres, correct to two decimal



$$V = \pi r^2 h$$

$$1.26 \text{ ML} = \pi(9)^2 h$$

$$1\,260\,000 \text{ L} = 81\pi h$$

$$h = \frac{1260000}{81\pi} = 4.95 \text{ m}$$

- 13** Warragamba Dam is filled by runoff from a catchment area of 9050 square kilometres. In a storm, 40 mm of rain fell. What is the increase in the volume of the dam?

$$\begin{aligned}\text{Volume} &= \text{area} \times \text{depth} = 9050 \text{ km}^2 \times 0.04 \text{ m} \\ &= (9050 \times 1\,000\,000) \text{ m}^2 \times 0.04 \text{ m} = 362\,000\,000 \text{ m}^3\end{aligned}$$

- 14** Water is being poured into a fish tank at a rate of 2 L every 10 seconds. The tank is 1.2 m long by 1 m wide by 80 cm high. How long will it take to fill the tank? Give the answer in minutes.

$$\begin{aligned}\text{Tank volume} &= 1.2 \times 1 \times 0.8 = 0.96 \text{ m}^3 = 960 \text{ L} \\ \text{Rate} &= 2 \text{ L per } 10 \text{ seconds} = 0.2 \text{ L/s} = 12 \text{ L/min} \\ \text{Time} &= 960 \div 12 = 80 \text{ minutes}\end{aligned}$$

- 15** A saltwater swimming pool requires 2 kg of salt to be added for every 10 000 litres of water. Joan's pool is a rectangular prism 1.5 metres deep, 5 metres wide and 15 metres long. How much salt will she need to add to her pool? (Hint: $1 \text{ m}^3 = 1000 \text{ L}$)

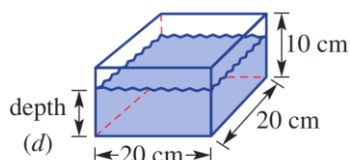
$$\begin{aligned}\text{Pool volume} &= 1.5 \times 5 \times 15 = 112.5 \text{ m}^3 = 112500 \text{ L} \\ \text{Salt needed} &= (112500 \div 10000) \times 2 = 22.5 \text{ kg}\end{aligned}$$

- 16** Each day a factory produces 5000 litres of soft drink in their 13 vats. The soft drink is distributed in cans 13 centimetres high with diameter 6.5 centimetres. How many cans does one vat produce each day?

$$\begin{aligned}\text{Can volume} &= \pi(3.25)^2(13) = 433.7 \text{ cm}^3 \\ \text{Daily production per vat} &= 5000 \text{ L} \div 13 = 384.6 \text{ L} = 384615 \text{ cm}^3 \\ \text{Cans per vat} &= 384615 \div 433.7 = 887 \text{ cans}\end{aligned}$$

- 17 A rectangular container is partially filled with 2.4 litres of water.

a Calculate the base area of the container, in square cm.



$$A = 20 \text{ m} \times 20 \text{ m} = 400 \text{ cm}^2$$

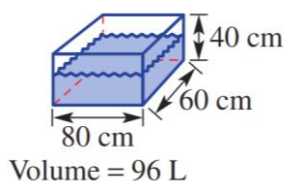
b Calculate the depth of the water using $V = Ah$, where the height is d .

$$2400 \text{ cm}^3 = (400 \text{ cm}^2)h$$

$$h = 6 \text{ cm}$$

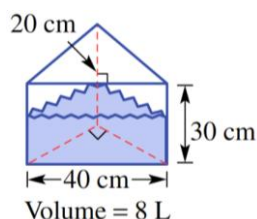
- 18 Use the same method as the previous question to calculate the depth of water in these prisms.

a



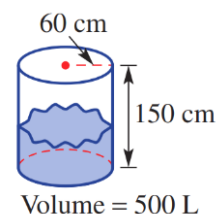
$$20 \text{ cm}$$

b



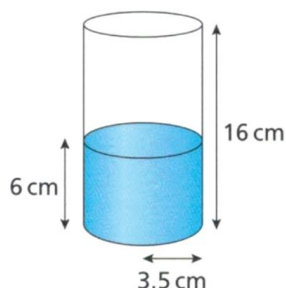
$$20 \text{ cm}$$

c



$$44.2 \text{ cm}$$

- 19 A cylindrical vase is filled with water to the height shown. Sven pours in another 200 ml of water. Calculate the new depth of the water.



First figure out how high 200 mL would be

$$V = Ah$$

$$200 = (\pi(3.5)^2)h$$

$$h = 5.2$$

$$5.2 + 6 = 11.2 \text{ cm}$$

- 20 A pool is 50 metres long, 25 metres wide, 1 m deep at one end and 2 m deep at the other.

a Draw a diagram of the pool. What 3D solid is this?

Trapezoidal prism

b Calculate the capacity of the pool in kilolitres.

$$V = Ah$$

$$V = \frac{50}{2}(1 + 2)(25) = 1875 \text{ m}^3 = 1875 \text{ kL}$$

c If the level of the pool dropped by 75 cm on a hot day, calculate how much water is needed to replace the evaporated water, answer in kilolitres.

$$V = Ah = (25)(50)(0.75) = 937.5 \text{ m}^3$$

$$937.5 \text{ kL}$$

CHECK YOUR UNDERSTANDING

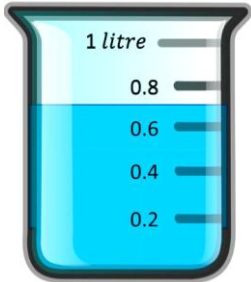
Units of volume

1	How do you convert m^3 to cm^3 ?			
a	$\times 100$	b	$\times 1\,000\,000$	c $\div 100$ d $\div 1\,000\,000$
2	How do you convert cm^3 to m^3 ?			
a	$\times 100$	b	$\times 1\,000\,000$	c $\div 100$ d $\div 1\,000\,000$
3	$0.45\text{ m}^3 = \dots\dots\dots \text{cm}^3$			
a	45	b	450	c 45 000 d 450 000
4	$2\,500\,000\text{ cm}^3 = \dots\dots\dots \text{mm}^3$			
a	0.25	b	2.5	c 25 d 25 000
5	$2.5\text{ m}^3 = \dots\dots\dots \text{cm}^3$			
a	250	b	2500	c 2 500 000 d 25 000 000
6	$350\,000\text{ cm}^3 = \dots\dots\dots \text{m}^3$			
a	0.35	b	35	c 350 d 3500

Units of capacity

1	6.2 L = mL							
	a	0.0062	b	6.20000	c	620	d	6200
2	3900 mL = L							
	a	390	b	39 000	c	3.9	d	39
3	A can holds 330 mL of soft drink. What is this in litres?							
	a	0.33 L	b	3.3 L	c	0.033 L	d	33 L
4	A barrel holds 1200 mL of water. Half a litre is poured out. How much water is left?							
	a	700 mL	b	500 mL	c	600 mL	d	1199.5 mL
5	A glass has a capacity of 300 mL. What is the total capacity of 6 glasses, in Litres?							
	a	1800 mL	b	1800 L	c	18 L	d	1.8 L

Calculating capacity

1	1 L = cm ³								
	a	1	b	10	c	100	d	1000	
2	100 cm ³ = mL								
	a	100	b	1000	c	0.1	d	0.01	
3	A bucket can hold 900 cm ³ . What is this in litres?								
	a	90 L	b	900 L	c	0.9 L	d	9 L	
4	A bucket can hold 7000 cm ³ . What is this in litres?								
	a	7000 L	b	700 L	c	70 L	d	7 L	
5	Which of these is not a correct measurement for the amount of water in the beaker?								
	a	700 cm ³	b	700 mL	c	0.7 L	d	0.7 m ³	

