

# Volume

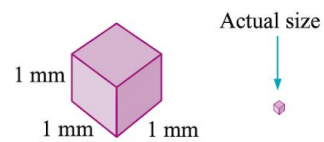
View the video given

## [The volume of prisms and cylinders](#) Video

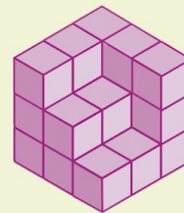
**Volume** refers to the amount of space that an object occupies. The volume of a solid is the number of **cubic units** that it occupies. The most common metric units for measuring volume are:

- cubic millimetres ( $\text{mm}^3$ )
- cubic centimetres ( $\text{cm}^3$ )
- cubic metres ( $\text{m}^3$ ).

A cubic millimetre ( $1 \text{ mm}^3$ ) is the amount of space occupied by a cube of side length 1 mm.



Find the volume of this solid by counting cubes.

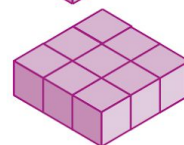
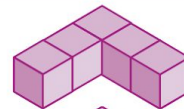


*Method 1:* Count the cubes in each layer separately.

3rd layer = 5 cubes

2nd layer = 7 cubes

1st layer = 9 cubes  
 Total = 21 cubes



*Method 2:* Alternatively, make a plan of the solid and count the number of cubes in each stack.

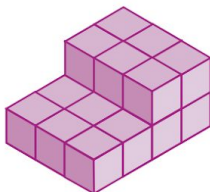
Total =  $(3 \times 5) + (2 \times 2) + (1 \times 2) = 21$  cubes

By both methods, the volume of the solid is 21 cubic units.

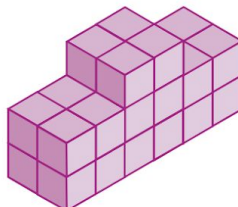
3	3	3
2	2	3
1	1	3

**1** If the solids below are made from  $1 \text{ cm}^3$  cubes, calculate the volume of each solid.

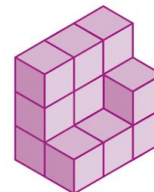
**a**



**b**



**c**



**2 a** Explain the meaning of a cubic centimetre. Illustrate with a diagram.

**b** Explain the meaning of a cubic metre.

# Volumes in life

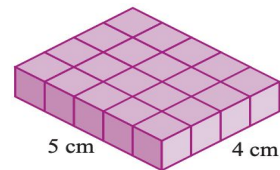
- 1
  - a Make a cube of side length 1 m. Use the cube to estimate the volume of your classroom, in cubic metres.
  - b Write a short report on how you made the cube and the method your group used to find the volume of your classroom.
  
- 2 Discuss which unit ( $\text{mm}^3$ ,  $\text{cm}^3$  or  $\text{m}^3$ ) would be the most suitable to measure the volume of a:
 

a fruit juice carton	b key	c caravan
d refrigerator	e garage	f house brick

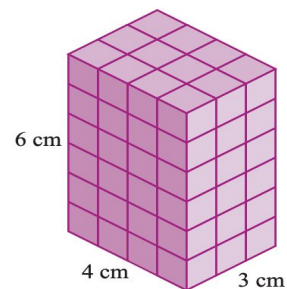


# Volume of a rectangular prism

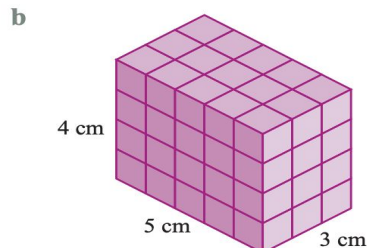
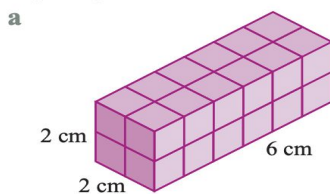
- 1
  - a Calculate the volume of this layer of cubes.
  - b What would be the volume of the rectangular prism formed by stacking up:
    - i 3 layers?
    - ii 5 layers?
    - iii 10 layers?



- 2 This rectangular prism was formed by stacking layers of cubes on top of each other.
  - a How many cubic centimetres are there in the bottom layer?
  - b How many layers are stacked on top of each other?
  - c What is the volume of this prism?

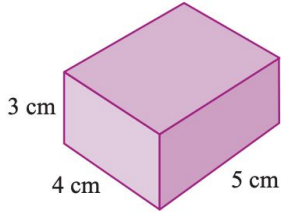


- 3 Repeat question 2 for each of these rectangular prisms.



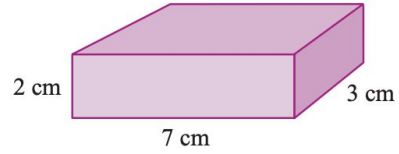
1 Complete the following to calculate the volume of each rectangular prism.

a



$$\begin{aligned} V &= lbh \\ &= 5 \times \underline{\quad} \times \underline{\quad} \\ &= \underline{\quad} \text{ cm}^3 \end{aligned}$$

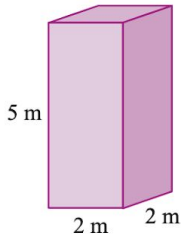
b



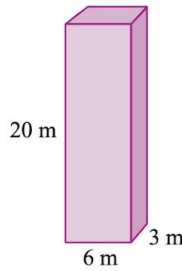
$$\begin{aligned} V &= lbh \\ &= \underline{\quad} \times 3 \times \underline{\quad} \\ &= \underline{\quad} \text{ cm}^3 \end{aligned}$$

2 Calculate the volumes of these rectangular prisms.

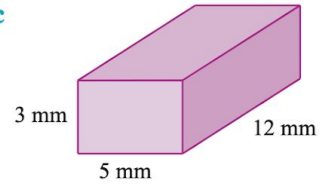
a



b



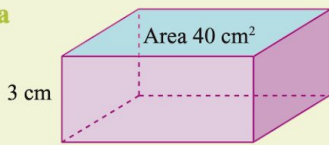
c



### EXAMPLE 2

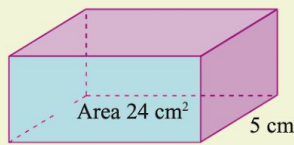
Calculate the volume of this rectangular prism. A different face has been selected as the base each time.

a



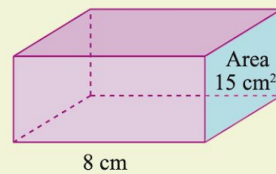
$$\begin{aligned} \text{a } V &= \text{area of base} \times \text{height} \\ &= 40 \times 3 \\ &= 120 \text{ cm}^3 \end{aligned}$$

b



$$\begin{aligned} \text{b } V &= \text{area of base} \times \text{height} \\ &= 24 \times 5 \\ &= 120 \text{ cm}^3 \end{aligned}$$

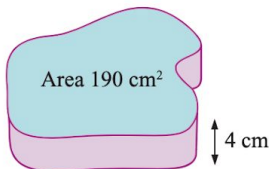
c



$$\begin{aligned} \text{c } V &= \text{area of base} \times \text{height} \\ &= 15 \times 8 \\ &= 120 \text{ cm}^3 \end{aligned}$$

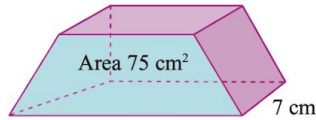
3 Calculate the volume of each solid, given the area of its base.

a



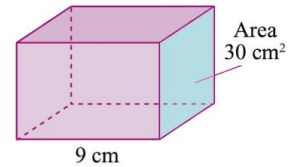
$$\begin{aligned} V &= \text{area of base} \times \text{height} \\ &= 190 \times \underline{\quad} \\ &= \underline{\quad} \text{ cm}^3 \end{aligned}$$

b



$$\begin{aligned} V &= \text{area of base} \times \text{height} \\ &= \underline{\quad} \times 7 \\ &= \underline{\quad} \text{ cm}^3 \end{aligned}$$

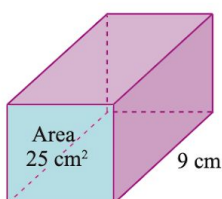
c



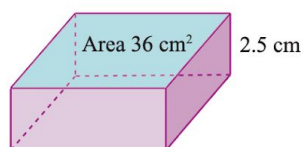
$$\begin{aligned} V &= \text{area of base} \times \text{height} \\ &= \underline{\quad} \times \underline{\quad} \\ &= \underline{\quad} \text{ cm}^3 \end{aligned}$$

4 Calculate the volume of each solid, given the area of its base.

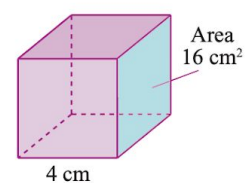
a

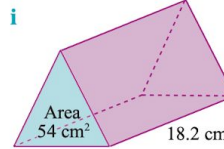
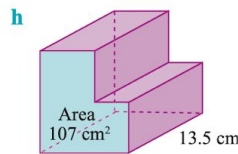
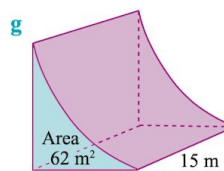
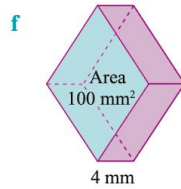
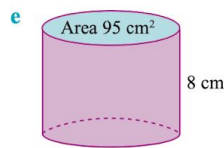
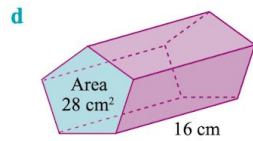


b

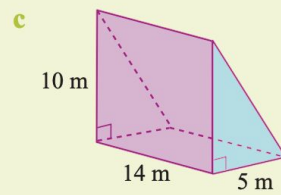
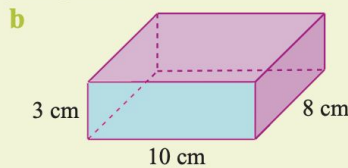
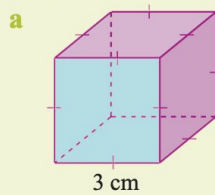


c





Calculate the volume of each rectangular prism.

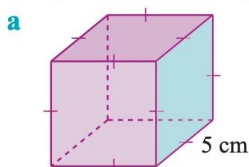


**a**  $V = \text{area of base} \times \text{height}$   
 $= (3 \times 3) \times 3$   
 $= 9 \times 3 = 27 \text{ cm}^3$

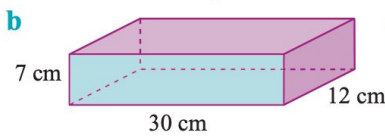
**b**  $V = \text{area of base} \times \text{height}$   
 $= (10 \times 8) \times 3$   
 $= 80 \times 3 = 240 \text{ cm}^3$

**c**  $V = \text{area of base} \times \text{height}$   
 $= \frac{1}{2}(5 \times 10) \times 14$   
 $= 25 \times 14 = 350 \text{ cm}^3$

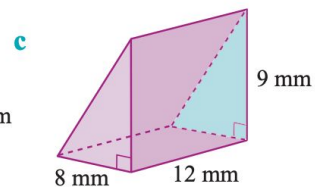
**5** Complete the following to calculate the volume of each prism.



$V = \text{area of base} \times \text{height}$   
 $= (5 \times 5) \times \underline{\hspace{1cm}}$   
 $= \underline{\hspace{1cm}} \text{ cm}^3$

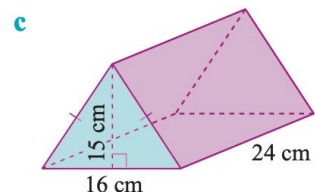
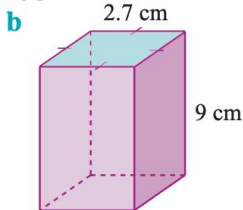
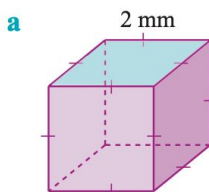


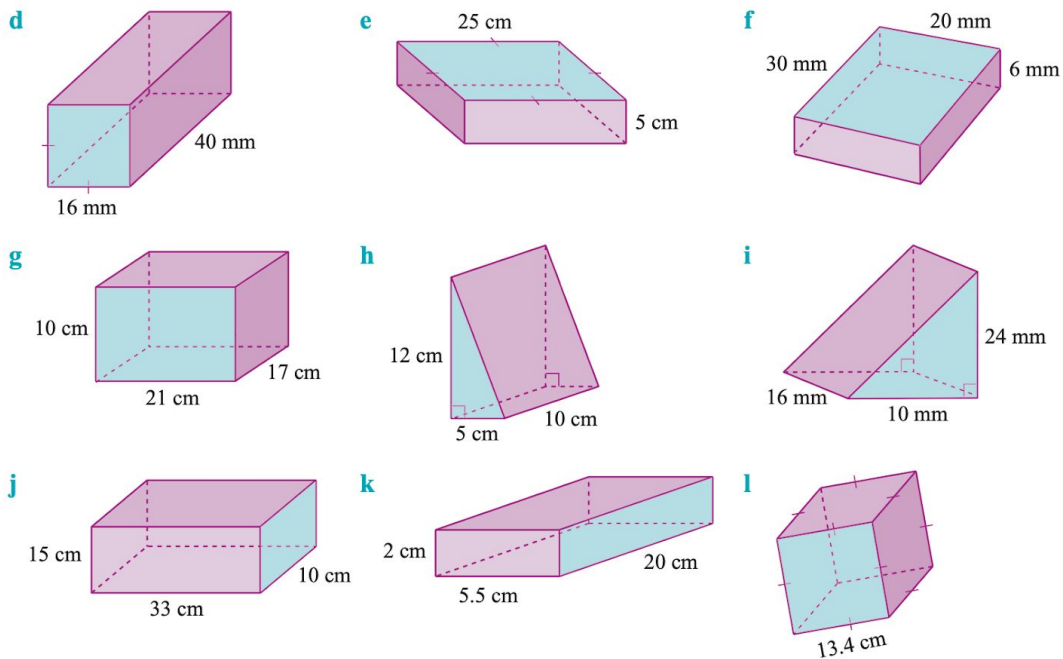
$V = \text{area of base} \times \text{height}$   
 $= (30 \times \underline{\hspace{1cm}}) \times \underline{\hspace{1cm}}$   
 $= \underline{\hspace{1cm}} \text{ cm}^3$



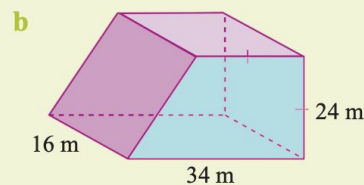
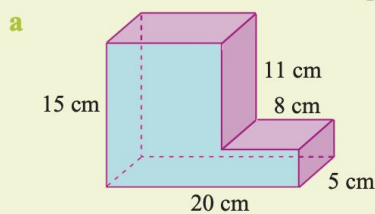
$V = \text{area of base} \times \text{height}$   
 $= \frac{1}{2}(8 \times \underline{\hspace{1cm}}) \times \underline{\hspace{1cm}}$   
 $= \underline{\hspace{1cm}} \text{ mm}^3$

**6** Calculate the volumes of the following prisms.

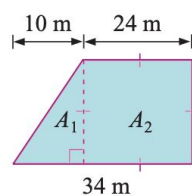
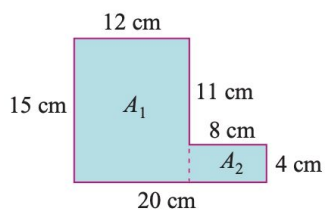




Calculate the volume of each **composite solid**.



First draw the base of the solid. Use addition or subtraction to find any missing dimensions.



**a** Area of base =  $A_1 + A_2$   
 $= (15 \times 20) + (8 \times 4)$   
 $= 300 + 32$   
 $= 332 \text{ cm}^2$   
 Height = 5 cm  
 Volume = area of base  $\times$  height  
 $= 332 \times 5$   
 $= 1660 \text{ cm}^3$

**b** Area of base =  $A_1 + A_2$   
 $= \frac{1}{2}(10 \times 16) + (24 \times 16)$   
 $= 80 + 384$   
 $= 464 \text{ m}^2$   
 Height = 16 m  
 Volume = area of base  $\times$  height  
 $= 464 \times 16$   
 $= 7424 \text{ m}^3$



7 Complete the calculate the volumes of these composite shapes.

**a**

Area of base =  $A_1 + A_2$   
 $= (14 \times \underline{\quad}) + (4 \times \underline{\quad})$   
 $= \underline{\quad} + \underline{\quad} = \underline{\quad} \text{ mm}^2$

Volume = area of base  $\times$  height  
 $= \underline{\quad} \times \underline{\quad} = \underline{\quad} \text{ mm}^3$

Height =  $\underline{\quad}$  mm

**b**

Area of base =  $A_1 + A_2$   
 $= \frac{1}{2} (14 \times \underline{\quad}) + (32 \times \underline{\quad})$   
 $= \underline{\quad} + \underline{\quad} = \underline{\quad} \text{ cm}^2$

Volume = area of base  $\times$  height  
 $= \underline{\quad} \times \underline{\quad} = \underline{\quad} \text{ cm}^3$

Height =  $\underline{\quad}$  cm

8 Calculate the volumes of the following composite shapes.

**a**

**b**

**c**

**d**

**e**

**f**

**g**

**h**

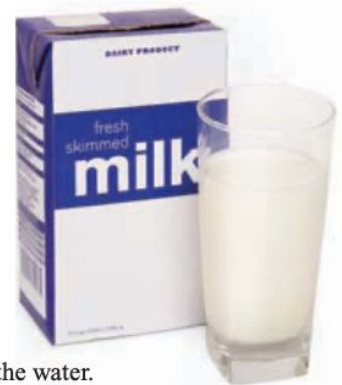
**i**

# Investigation

## Volume and capacity

- 1** *Step 1:* Take an empty milk carton and open the top so that it is in the shape of a rectangular prism.  
*Step 2:* Measure the length and breadth of the base (bottom).  
*Step 3:* Pour one litre (1 L) of water into the carton and measure the height of the water in the carton.  
*Step 4:* Calculate the volume of water in cubic centimetres. How much space does 1 L of water occupy?

- 2** *Step 1:* Take a small box of fruit-drink that is in the shape of a rectangular prism.  
*Step 2:* Measure the dimensions of the box, and calculate its volume in cubic centimetres.  
*Step 3:* Compare this volume with the number of millilitres (mL) marked on the box (the **capacity** of the box). What do you notice?



- 3** Repeat question 2 for a 1 L box of fruit-drink or milk.
- 4** *Step 1:* Pour some water into a measuring cylinder and accurately note the level of the water in the cylinder in millilitres (mL).  
*Step 2:* Drop 10 plastic centicubes into the cylinder. Record the new level of the water.  
*Step 3:* Calculate how much water has been displaced by the 10 centicubes. This is the amount of water that occupies  $10 \text{ cm}^3$ . How much water would occupy  $1 \text{ cm}^3$ ?

- 5** Repeat question 4 for 20 and 30 centicubes. How many centicubes would it take to displace:  
a 100 mL of water?                      b 500 mL of water?                      c 1 L of water?

- 6** From the investigation, what conclusions can be drawn about the quantities 1 mL and 1 L and the volume that each occupies?

There are 1000 mL in 1 L. ! .....

- 7** Complete these definitions of volume and capacity:  
a \_\_\_\_\_ is the amount of space occupied by a solid or quantity of liquid.  
b \_\_\_\_\_ is the volume of liquid that a container can hold.

## Check your answers

- 1 a**  $V = 5 \times 4 \times 3 = 60 \text{ cm}^3$   
**b**  $V = 7 \times 3 \times 2 = 42 \text{ cm}^3$
- 2 a**  $20 \text{ m}^3$                       **b**  $360 \text{ m}^3$                       **c**  $180 \text{ mm}^3$
- 3 a**  $V = 190 \times 4 = 760 \text{ cm}^3$   
**b**  $V = 75 \times 7 = 525 \text{ cm}^3$   
**c**  $V = 30 \times 9 = 270 \text{ cm}^3$
- 4 a**  $225 \text{ cm}^3$                       **b**  $90 \text{ cm}^3$                       **c**  $64 \text{ cm}^3$   
**d**  $448 \text{ cm}^3$                       **e**  $760 \text{ cm}^3$                       **f**  $400 \text{ mm}^3$   
**g**  $930 \text{ m}^3$                       **h**  $1444.5 \text{ cm}^3$                       **i**  $982.8 \text{ cm}^3$
- 5 a**  $V = (5 \times 5) \times 5 = 125 \text{ cm}^3$   
**b**  $V = (30 \times 12) \times 7 = 2520 \text{ cm}^3$   
**c**  $V = \frac{1}{2}(8 \times 9) \times 12 = 432 \text{ mm}^3$
- 6 a**  $8 \text{ mm}^3$                       **b**  $65.61 \text{ cm}^3$                       **c**  $2880 \text{ cm}^3$   
**d**  $10\,240 \text{ mm}^3$                       **e**  $3125 \text{ cm}^3$                       **f**  $3600 \text{ mm}^3$   
**g**  $3570 \text{ cm}^3$                       **h**  $300 \text{ cm}^3$                       **i**  $1920 \text{ mm}^3$   
**j**  $4950 \text{ cm}^3$                       **k**  $220 \text{ cm}^3$   
**l**  $2406 \text{ cm}^3$  (rounded)
- 7 a** Area of base =  $(14 \times 6) + (4 \times 4)$   
 $= 84 + 16 = 100 \text{ mm}^2$   
Height =  $8 \text{ mm}$   
Volume =  $100 \times 8 = 800 \text{ mm}^3$   
**b** Area of base =  $\frac{1}{2}(14 \times 8) + (32 \times 12)$   
 $= 56 + 384 = 440 \text{ cm}^2$   
Height =  $15 \text{ cm}$   
Volume =  $440 \times 15 = 6600 \text{ cm}^3$
- 8 a**  $1098 \text{ mm}^3$                       **b**  $3136.5 \text{ cm}^3$                       **c**  $1080 \text{ m}^3$   
**d**  $1212 \text{ cm}^3$                       **e**  $3200 \text{ cm}^3$                       **f**  $1792 \text{ m}^3$   
**g**  $1860 \text{ m}^3$                       **h**  $7250 \text{ m}^3$                       **i**  $68\,900 \text{ cm}^3$