

Volume

Volume is a measure of **real space** (eg cupboard space, box capacity, room in a bottle). It is **3-dimensional**, whereas length is 1-dimensional and area is 2-dimensional.

Length is often measured in **metres** (m), area in **square metres** (m^2) and volume in **cubic metres** (m^3).

Common units for volume include:

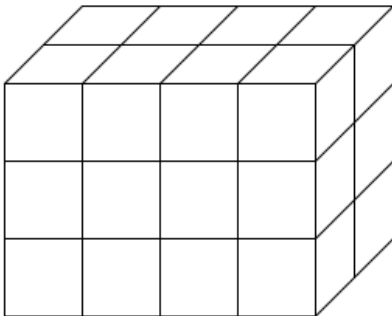
Cubic centimetres (cm^3): A small 6-sided dice has a volume of about $1cm^3$.

Cubic metres (m^3): The space under a dining room table has a volume of around $1m^3$.

Cubic kilometres (km^3): A large lake might hold about $1km^3$.

Bonus unit: Because a cubic metre is a million times bigger than a cubic centimetre*, a useful unit for things much bigger than dice but much smaller than the space under a table (like a school bag) is the **litre** (l) which is $1000cm^3$. $1l$ is the size of a bottle of pop (1.75 pints).

Because volume is about how many cubes would fit inside a shape, the volume of a cuboid is easy to find:



This cuboid contains **2 layers of 3 rows of 4** cubes.

Or, equivalently, **4 layers of 2 columns of 3** cubes, etc.

Therefore the volume (the number of cubes) is:

$$2 \text{ lots of } 3 \text{ lots of } 4 = 2 \times 3 \times 4 = \mathbf{24cm^3}$$

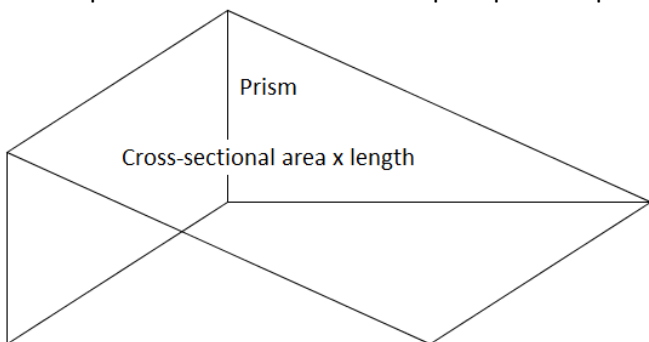
(24 cubic centimetres)

(we include cm^3 to show the size of cube we're using)

Don't use 'just multiply all the lengths' because a) that doesn't tell the whole story and b) for most problems you are given, using that simplistic idea will get you the wrong answer. Learn **why** we multiply.

Other common shapes also have quick rules for finding volume, which we can discover by comparing the shapes to rectangles:

- If you know the area of the front face of a prism, volume is just this area multiplied by the length.
- If you know the area of a circle, notice that a cylinder is just a circular prism, and see the rule above.
- Shapes built from these can be split up into separate bits, then the total volume found by adding each part.



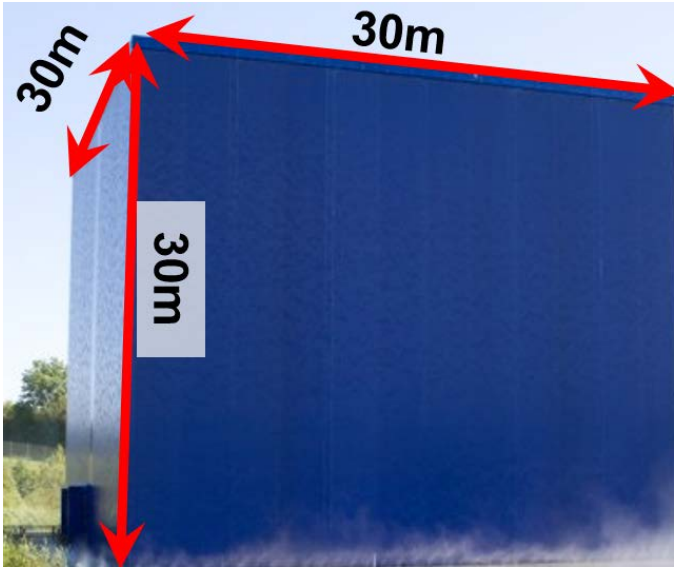
For most shapes, volume is somewhat more complicated to work out, but there are formulae for you to use.

Bonus fact: Any pyramid's volume is exactly a third of the volume of the prism it fits into. So a square-based pyramid is $\frac{1}{3}$ the volume of a cuboid with the same base and height, and a cone has volume $\frac{1}{3}$ of a cylinder.

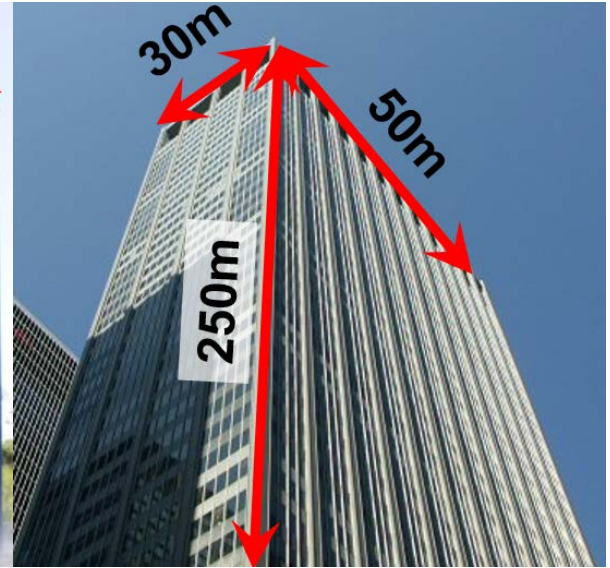
*There are 100cm in 1m, so $1m^3$ is a cube measuring 1m by 1m by 1m, or 100cm by 100cm by 100cm, which is $1000000cm^3$.

Find the volume of each of the following shapes (by splitting them into simpler shapes first if necessary). Don't forget to include the units with your answers.

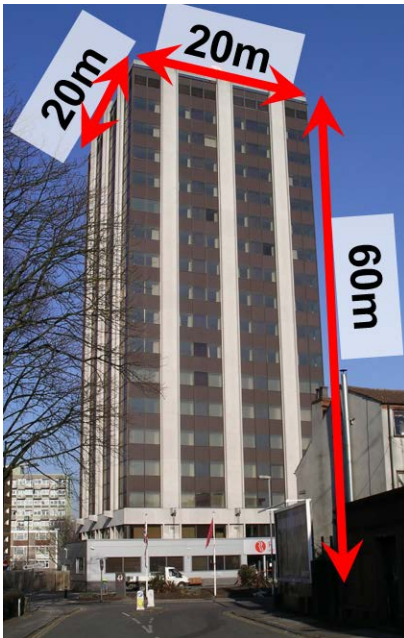
1.



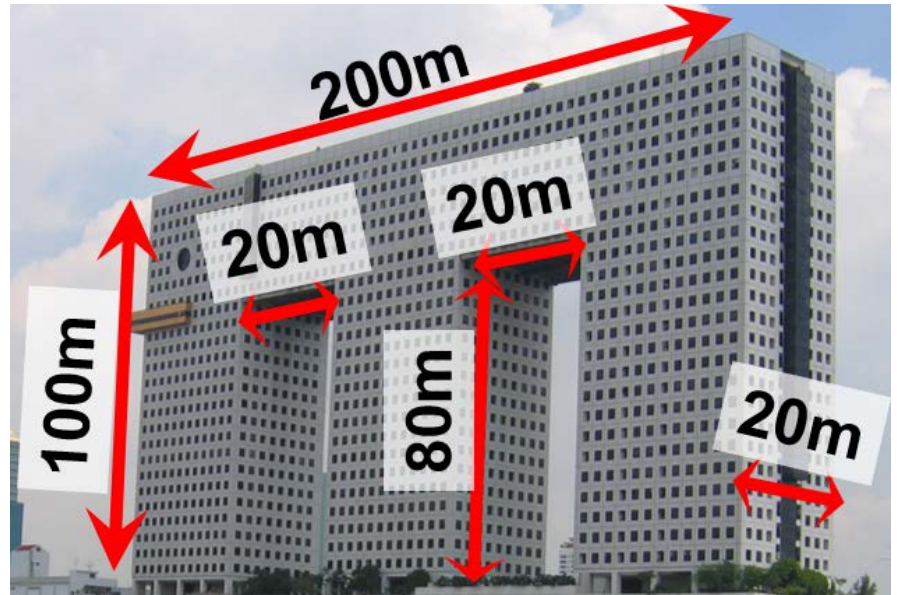
2.



3.



4.



5.



This tent has a rectangular base 2.2m long and 1.5 metres wide. The height in the middle is 1.2m.

6.



This hollow box-section steel profile has a square profile with outer width 32mm and inner width 30mm, and length 2m.