

# Measuring mass and volume accurately

Grade 6 science (Year 7 · Class 6) · Lesson

**Quick answer:** Mass is the amount of matter in an object, measured in kilograms or grams with a balance. Volume is the space an object takes up, measured in litres, millilitres or cubic centimetres. For a liquid in a graduated cylinder, keep your eye level with the surface and read the bottom of the meniscus.

**Level:** Grade 6 science (Year 7 · Class 6) · **Curriculum:** SEP measurement

## What are mass and volume?

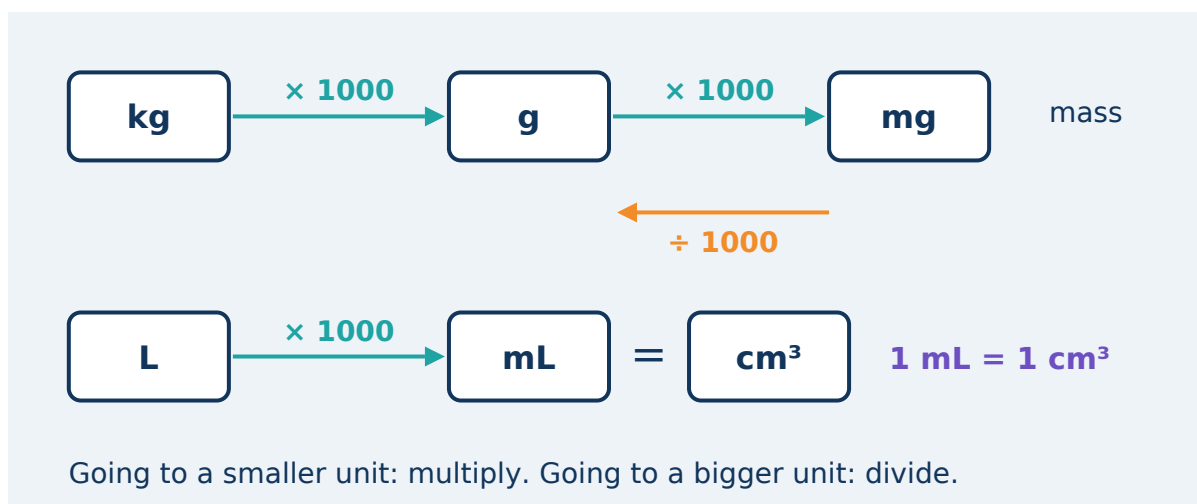
Everything around you is made of matter. Two measurements describe how much of it you have. **Mass** tells you how much matter is in an object. **Volume** tells you how much space the object takes up. A bag of cotton wool and a bag of sand can have the same volume but very different masses.

**Definition**  
**Mass** is the amount of matter in an object. It does not change when you move the object to another place. **Volume** is the amount of space that an object or a liquid occupies.

## Which units do we use?

Scientists use the metric system, so every unit is linked to the next one by a factor of 10, 100 or 1000. The base unit of mass is the kilogram. Liquids are usually measured in litres and millilitres, while solids with a regular shape can be measured in cubic centimetres.

| Quantity | Unit             | Symbol          | Everyday example            |
|----------|------------------|-----------------|-----------------------------|
| Mass     | kilogram         | kg              | A bag of flour              |
| Mass     | gram             | g               | A paper clip is about 1 g   |
| Mass     | milligram        | mg              | A grain of salt             |
| Volume   | litre            | L               | A large water bottle        |
| Volume   | millilitre       | mL              | A spoonful of syrup is 5 mL |
| Volume   | cubic centimetre | cm <sup>3</sup> | A small sugar cube          |



Moving down one unit multiplies by 1000; moving up divides by 1000. A millilitre and a cubic centimetre are the same volume.

### Formula

1 kg = 1000 g | 1 g = 1000 mg | 1 L = 1000 mL | 1 mL = 1 cm<sup>3</sup> | 1 m<sup>3</sup> = 1000 L. To change unit, multiply when the new unit is smaller and divide when it is bigger.

### Worked example 1

Convert 2.45 kg to grams and 350 mL to litres.

Data: 2.45 kg and 350 mL.

Method: kg to g means a smaller unit, so multiply by 1000; mL to L means a bigger unit, so divide by 1000.

$2.45 \times 1000 = \mathbf{2450\ g}$ .  $350 \div 1000 = \mathbf{0.350\ L}$ .

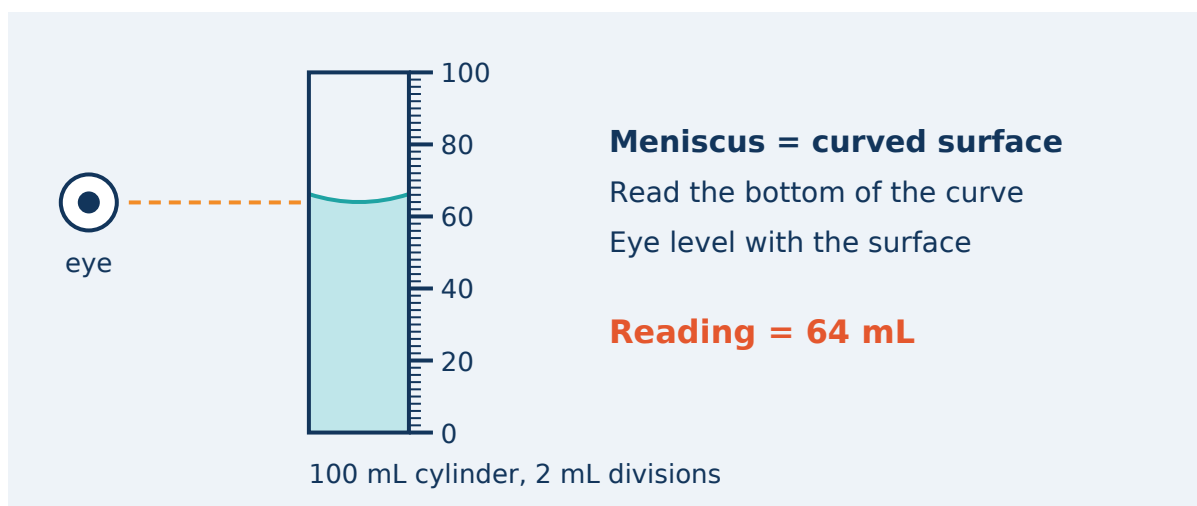
## How do you use a balance correctly?

1. Stand the balance on a flat, steady table and check that it reads 0.
2. Put the object in the centre of the pan, never on the edge.
3. Wait until the number stops changing.
4. Write the reading with its unit straight away.

To weigh a powder or a liquid, put an empty container on the pan first and press the *tare* button. The display goes back to 0, so the next reading is the mass of the contents only.

## How do you read a graduated cylinder?

Water climbs slightly up the glass wall, so its surface is curved. This curve is called the **meniscus**. Always stand the cylinder on the bench, bring your eye level with the surface and read the bottom of the curve.



*A graduated cylinder: keep your eye level with the bottom of the meniscus and read 64 mL.*

Before you read, find the value of one small division. Take two neighbouring numbered marks, subtract them and divide by the number of spaces between them.

### Worked example 2

A cylinder has numbered marks at 20 mL and 30 mL, with 5 equal spaces between them.

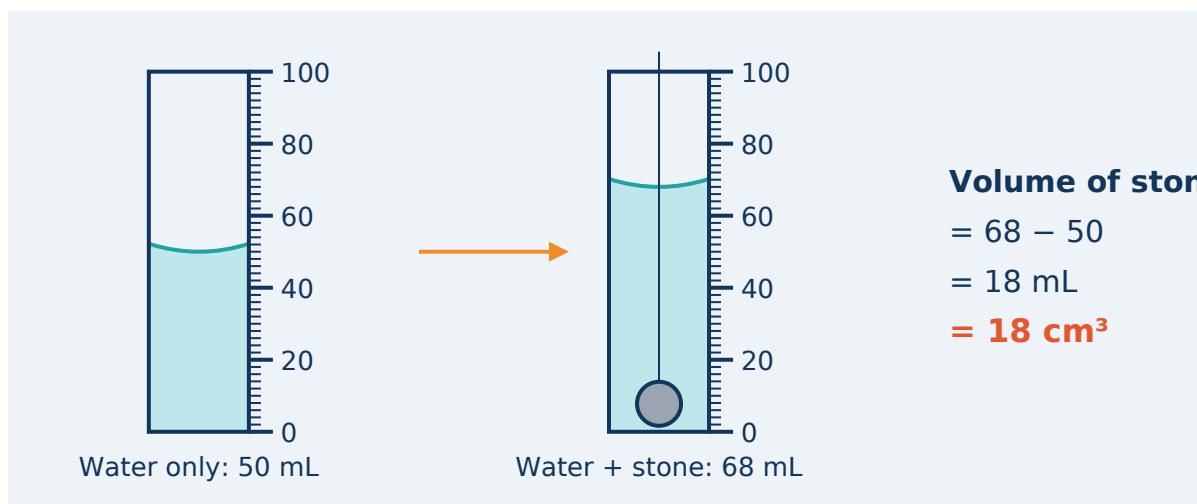
The water surface is at the third mark above 20 mL.

One division =  $(30 - 20) \div 5 = 2$  mL.

Reading =  $20 + 3 \times 2 = 26$  mL.

## How do you find the volume of an irregular solid?

A stone has no simple shape, so a ruler cannot give its volume. Instead, pour water into a cylinder, note the level, lower the stone in gently on a thread and note the new level. The solid pushes aside, or *displaces*, its own volume of water.



*Displacement: the rise in water level equals the volume of the stone.*

### Worked example 3

The water level rises from 50 mL to 68 mL when a stone is added.

Volume of stone = final level – start level =  $68 - 50 = 18$  mL =  $18 \text{ cm}^3$ .

**Common mistake**

Do not read the top edge of the meniscus or look at the cylinder from above or below. Either habit gives a wrong value. Also remember that the mass of a container is included in the reading unless you tare the balance.

**Lina's tip**

Choose the smallest cylinder that can hold your liquid. A 10 mL cylinder has finer divisions than a 100 mL one, so a reading of 6 mL is more precise in the small cylinder.

## Why does the choice of instrument matter?

Every instrument has a smallest division, and your reading can only be as good as that division. A kitchen scale that moves in steps of 5 g cannot show a 2 g difference, but a laboratory balance that moves in steps of 0.01 g can. Using the right instrument gives measurements you can trust and compare.

**Key points to remember**

- Mass is measured in kg or g with a balance; volume in L, mL or  $\text{cm}^3$ .
- $1 \text{ kg} = 1000 \text{ g}$  and  $1 \text{ L} = 1000 \text{ mL}$ .
- $1 \text{ mL} = 1 \text{ cm}^3$ .
- Read a meniscus at its lowest point with your eye level with the surface.
- Volume of an irregular solid = final water level – starting water level.

## Measuring mass and volume accurately: frequently asked questions

**What is the difference between mass and volume?**

Mass is how much matter an object contains, while volume is how much space it takes up. Two objects can have the same volume but different masses, like a football and a ball of the same size made of lead.

**Why do we read the bottom of the meniscus?**

Water clings to the glass and curves upward at the edges. The lowest point of the curve is the agreed reading point, so everyone measures in the same way and gets consistent results.

**How many millilitres are in a litre?**

There are 1000 mL in 1 L. To change litres to millilitres, multiply by 1000. To change millilitres to litres, divide by 1000.

**Is 1 mL the same as  $1 \text{ cm}^3$ ?**

Yes. A cube measuring 1 cm along each edge holds exactly 1 mL of liquid. That is why displacement results in mL can be written in  $\text{cm}^3$ .

**How do you measure the volume of a stone?**

Half-fill a graduated cylinder with water and read the level. Lower the stone in on a thread and read again. The difference between the two readings is the volume of the stone.