

Grade 7 Science
Week of November 16– November 20

Mass and Volume

Mass and Volume

Now we have a general idea about what matter is, but a formal definition is needed.

Matter is anything that has mass and volume (takes up space).

In order to understand matter, we need to understand mass and volume.

MASS

Mass is a way to measure the **amount of matter** in an object. Mass is often measured in grams; large objects in kilograms. We often refer to mass as the weight of an object, although mass refers to the amount of matter. The mass of an object on the moon will remain the same as on earth, but the weight may change because there is less gravity on the moon.



Measuring Mass: <https://youtu.be/6h0G-7WxSDk>

VOLUME

Volume is the measure of the amount of **space** that is occupied by matter. A liquid is often measured in litres (L) or millilitres (mL). The volume of a solid object (like a box) is measured in cubic units such as cm^3 .

Millilitres and cubic centimeters are equivalent. In other words 24 mL is the same volume as 24 cm^3 .



Cubic Cm and Mm: <https://youtu.be/KCjTgC5gCO0>

For a nice regular shape like a box, we can **directly** determine the volume.

Volume = length x width x height

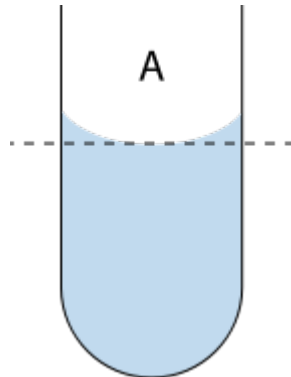
So if you have a box that is 6 cm long, 3 cm wide, and 2 cm high, what is its volume?



How to Calculate Volume of a Regular Prism: <https://youtu.be/u1nWI2b0fT4>

If the object is irregular, we need an **indirect** method to determine its volume. One way of doing this is by submerging the object in water and seeing how much water is displaced (or moved aside) by the object. This method is called the **displacement** method.

A graduated cylinder is a tall, narrow cylinder that is often used to accurately measure the volume of a liquid. When you put water in a container you'll notice a slight curve on the top surface, called the meniscus. Always take your measurements at the bottom of the meniscus.



Below, determine the volume of the object by observing the difference in height of the water level in the cylinder.



Volume: Water Displacement: <https://youtu.be/Tpovo-JwF2U>

Metric Prefix and Conversions

We usually calculate mass in **milligrams**, **grams**, or **kilograms**. We'll do a quick review of metric prefixes to remind ourselves how to convert between these mass measurements.



Common Metric Prefixes: <https://youtu.be/7ynq0iYZZeg>

Spring Scale and Balance Scale

A spring scale, which you might use to measure a fish, is a device that measures the pull of gravity on the object.

Therefore, a spring scale measures weight, not mass.



A spring scale measures weight.



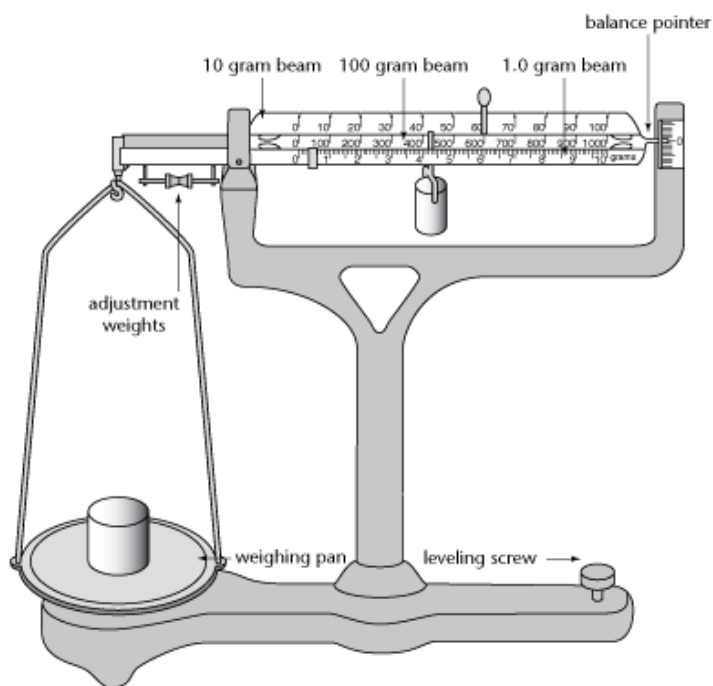
A balance scale measures mass.

Measuring Mass

Good measurements are fundamental to good science, and a great deal of information can be gained about something by measuring it. For example, to calculate density we must be able to measure the mass and volume of an object or substance. In this lesson we will look at two ways to measure mass and volume—direct measurement and indirect measurement.

- direct measurement is measuring in one step
- indirect measurement is measuring that involves more than one step

We measure the mass of many things. We measure the mass, not the weight, of a package when it goes in the mail. At the grocery store,



customers and cashiers measure the mass, not the weight, of many items, such as apples from the produce department and jelly beans from the bulk food bins.

Mass is measured in grams (g) or units based on grams, such as kilograms (kg) or milligrams (mg). Mass can be measured by placing an item on a triple beam balance or on an electronic balance and recording the number. This one-step method of measuring mass is an example of **direct measurement**.

Measuring Volume

Finding the volume of an object or substance depends on its state—whether it is a solid or a liquid. The methods for finding the volumes of liquids and solids are different. Wait a minute!

What about finding the volume of a gas? Remember that a gas will continue to expand in all directions, including upward, until its container is filled. If you add the gas to a larger container, it simply spreads out to fill it up. The spaces between the gas particles get larger. So a gas doesn't have a definite volume.

Volume of a Liquid

The volume of a liquid can be measured directly by using a graduated cylinder. Liquid volumes are measured in litres (L) and units based on litres, such as millilitres (mL).

At home you probably use a measuring cup to measure liquids for a recipe.

To accurately measure volume, it is important to position the graduated cylinder or measuring cup so the surface of the liquid is at eye level.

Water and most other liquids will stick to the glass cylinder and the surface of the liquid will droop into a shape called the **meniscus**. When taking the measurement be sure to measure from the bottom of the meniscus.



Remember that solid volumes are measured in cubic metres (m³) and units based on cubic metres, such as cubic centimetres (cm³).

Finding the volume of a regularly shaped solid involves taking some measurements and applying a mathematical formula. Write the following formulae on your flashcards or in your notebook.

Formulae to calculate the volume of regularly-shaped objects: (use the value 3.14 for pi (π); r is the radius)

rectangular prism (box): $V = \text{length} \times \text{width} \times \text{height}$

Sphere: $V = \frac{4}{3} \pi r^3$

Cylinder: $V = \pi r^2 \times \text{height}$

Cone: $V = \frac{1}{3} \pi r^2 \times \text{height}$

Note:

You will sometimes see the term depth used instead of height. Both are acceptable.

The units for volume are cubic centimetres or cubic metres. One cubic centimetre equals one millilitre. One thousand cubic centimetres equals one litre. This method of finding volume uses direct measurement because measuring the object only involves one step.

Try It Out!

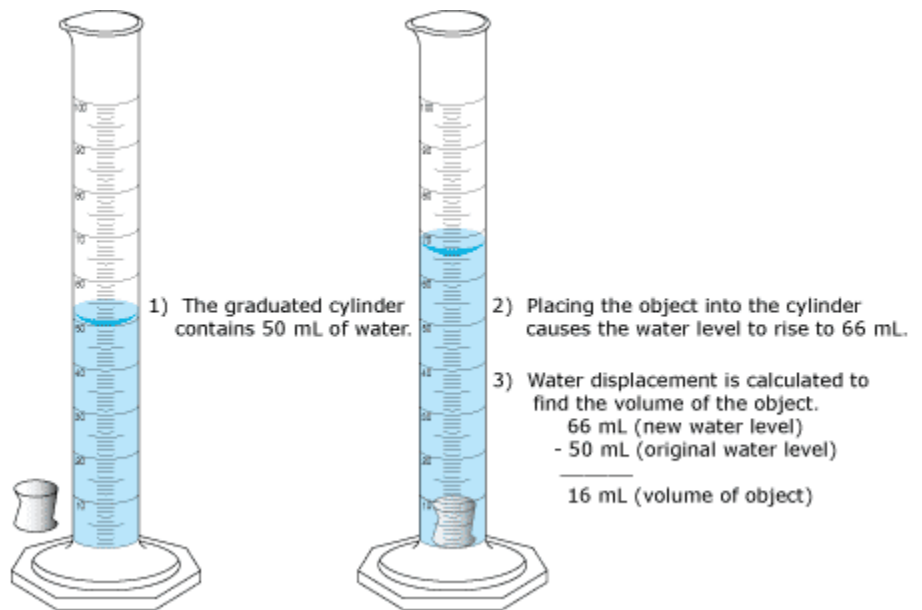
Calculating Volume

- Find at least five objects in your house that have a regular shape.
- Measure them and calculate their volume.
- In your notebook, record the name of the item, the measurements, including the units, and show your calculations.

Was one of your items a milk carton? Remember that the milk only fills the bottom part that is a box shape. How do your calculations compare to the volume given on the label?

Most objects do not have a regular shape so we cannot apply a formula to calculate their volumes. Calculating the volume of irregularly shaped objects requires the **water displacement method**, and that involves more than one step. This makes it an **indirect measurement**.

Here's how the displacement method works. Partially fill a graduated cylinder with a measured amount of water. Write down that measurement. Then put an irregularly shaped solid object into the cylinder and measure the combined volume of the solid and the water. To find how much water was displaced by the object, subtract the volume of the water alone from the combined volume. The amount of water that was displaced is equal to the volume of the object.



Did You Know...?

Have you noticed that the water level in a bathtub or hot tub rises after you climb in? The amount of water displaced by your body is equivalent to your volume. This principle is credited to a Greek mathematician called Archimedes who, more than 2 000 years ago, observed this phenomenon. He is said to have jumped out of his bath and run naked through the streets yelling "Eureka," which is Greek for "I have found it." Archimedes made many contributions to mathematics and physics, and many of his principles still apply today.

Complete the following.

1. Describe how you would measure the following substances.

a. Volume of a water sample -

b. Mass of a water sample -

c. Volume of a metal block -

d. Mass of a metal block -

e. Volume of a Gold ring -

f. Mass of a Gold ring –

2. Which types of materials cannot be measured using the displacement of water method?

3. Record the formulas you would use for calculating the values of mass and volume.