

3.1.1 Density

Density (ρ) is the mass contained in a unit volume of a material.

$$\rho = \frac{M}{V}$$

where M =mass, V =volume.



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(1) *Looking at the equation (above), what are two suitable units for density? (Hint: think about what units you could use for mass, and volume.)*

(2) *A lump of copper metal has a mass of 150g, and a volume of 16.7cm³. Calculate the density of copper.*

(3) *Rearrange the equation to make volume the subject (i.e. $V = \dots$).*

(4) *What volume would 300g of water occupy. The density of water = 1.0g/cm³. (Hint: Use your rearranged equation from (3).)*

(5) *Rearrange the equation to make mass the subject (i.e. $M = \dots$).*

(6) *A container of hydrogen gas has a volume of 2.3m³. What is the mass of hydrogen contained. The density of hydrogen = 90kg/m³. (Hint: Use your rearranged equation from (5).)*

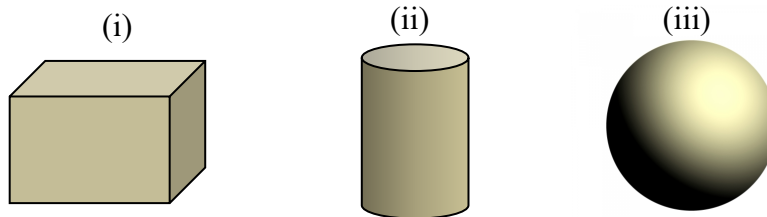
Measuring density

To measure the density of a material, you need to measure both the *mass* of the material and the *volume* it occupies. You then calculate the density by dividing the *mass* by the *volume*.

The mass is determined using a top pan balance.

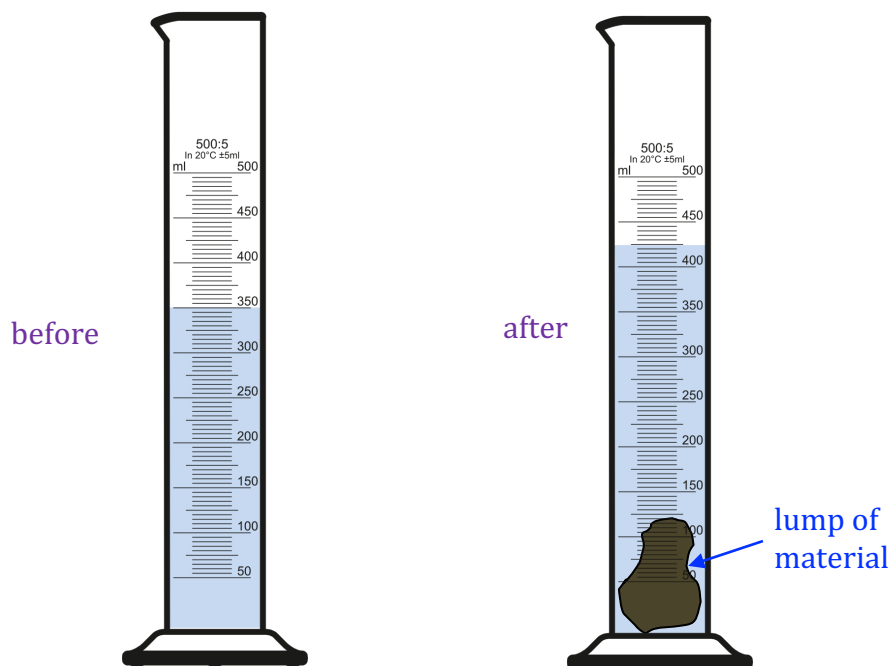
If the material occupies a regular shape, measurements can be made to determine the dimensions, and so calculate the volume.

(7)  What measurements would you need to take, and what calculation would you use to determine the volume of the following:



For solid, irregular-shaped objects, we can use a displacement method to determine the volume of the material. The lump of material can be lowered into water. The amount of space it takes up is the volume of the lump of material.

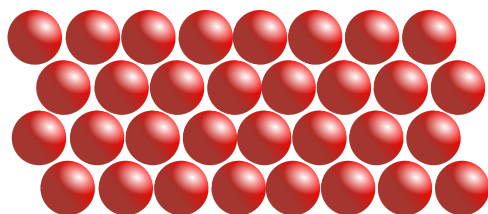
(8)  In the experiment (below) a lump of material is lowered into a measuring cylinder. What is the volume of the lump of material? (Note: $1\text{ml} = 1\text{cm}^3$)



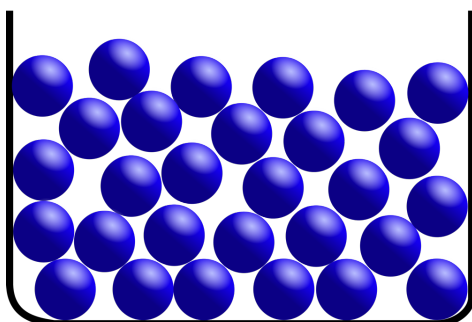
(9)  The mass of the lump of material (above), was found to be 105g. What is the density of the material?

The particle model of matter

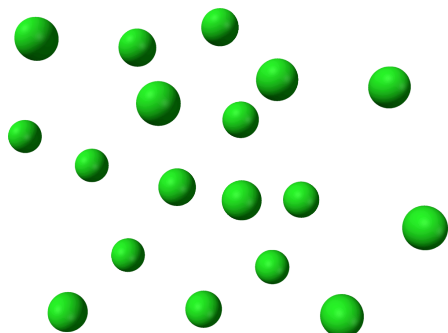
It is useful, in this topic, to think about materials in terms of their constituent particles/atoms/molecules.



In a solid, particles are closely packed. The force between particles is strong, so particles are held in fixed positions.



In a liquid, particles are closely packed. The force between particles is weaker, so particles can move around.



In a gas, particles are widely spaced. The force between particles is very weak, so particles can move around freely.

(10) ✎ Which of the 3 states of matter (above) would tend to have the highest density?

(11) ✎ In terms of the particle model, what two factors determine the density of a material?