

# Density Lesson

The notes are at the bottom if you can access the video

## Density Tutorial Questions

Just before we start there is something we need you to check

- 1) Just before we start there is something we need you to check
  - a. State the number of centimetres there are in one metre
  - b. So carefully think how many square centimetres there are in a square metre
  - c. Now go on and think how many cubic centimetres there are in a cubic metre.
- 2)
  - a. Measure or estimate the length, width and height volume of one of the rooms in your home (if you are in school you can go and collect a metre stick)
  - b. Calculate the volume of the room you are in.
  - c. Now calculate the mass of the air in the room taking the density of air as  $1.1 \text{ kg m}^{-3}$
- 3) What is the density of a concrete beam of mass 24 750 kg and volume 4.5 cubic metres?
- 4) A candyfloss has a volume of 5 litres or  $0.005 \text{ m}^3$  and a density of  $10 \text{ kgm}^{-3}$ .
  - a. Determine the volume of the candyfloss in cubic metres
  - b. Calculate the mass of the candyfloss.
- 5) Since the density of water is  $1 \times 10^3 \text{ kgm}^{-3}$ , calculate the volume 100 g of water would have.
- 6) Rock 1 has a volume of  $15 \text{ cm}^3$  and a mass of 45 g. Calculate the density of Rock 1 in  $\text{g/cm}^3$
- 7) Rock 2 has a volume of  $30 \text{ cm}^3$  and a mass of 60g. Calculate the density of Rock 2 in  $\text{g/cm}^3$
- 8) In the above two examples is Rock 1 or Rock 2 heavier? You must justify your answer.
- 9) In the above two examples is Rock 1 or Rock 2 more dense? You must justify your answer.
- 10) You decide you want to carry a boulder home from the beach. It is 30 centimetres on each side, and so has a volume of  $27,000 \text{ cm}^3$ . It is made of granite, which has a typical density of  $2.8 \text{ g/cm}^3$ . Calculate the mass of this boulder
- 11) Rocks are sometimes used along coasts to prevent erosion. If a rock needs to have a mass of 2,000 kilograms (in order not to be shifted by waves), calculate

the volume of the rock. You are using basalt, which has a typical density of 3200 kg/m<sup>3</sup>

- 12) A golden-coloured cube is handed to you. The person wants you to buy it for \$100, saying that is a gold nugget. You pull out your old geology text and look up gold in the mineral table, and read that its density is 19.3 g/cm<sup>3</sup>. You measure the cube and find that it is 2 cm on each side, and weighs 40 g. What is its density? Is it gold? Should you buy it?.... this is the basis of ARCHIMEDES PRINCIPLE! I'll find some video stories.

*Have you heard the old children's question "Which is heavier: a tonne of feathers or a tonne of bricks?" Your immediate reaction (if you haven't heard the puzzle a million times before) is that it must be the bricks, as bricks are "heavier" than feathers. However, the question asked about a tonne of each and a tonne is a unit of mass. Therefore if both have the same mass then they would weigh the same. The problem arose, not because of the mass but because we are thinking of the **density** of each. The feathers would take up much more space than the bricks since the bricks are heavier for the same volume, i.e. the bricks have a much bigger density.*

*Density  $\rho$  (rho) is defined as:*

***mass per unit volume of a substance.***

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{m}{v}$$

*The SI unit (look this up if you have forgotten this term) for DENSITY is KILOGRAM PER METRE CUBED (kg m<sup>-3</sup>)*

*If you think of the molecular behaviour of a substance it is obvious that there is a connection between density and heat. The spacing of the particles increases with temperature, therefore the density of a substance must decrease as temperature increases.*

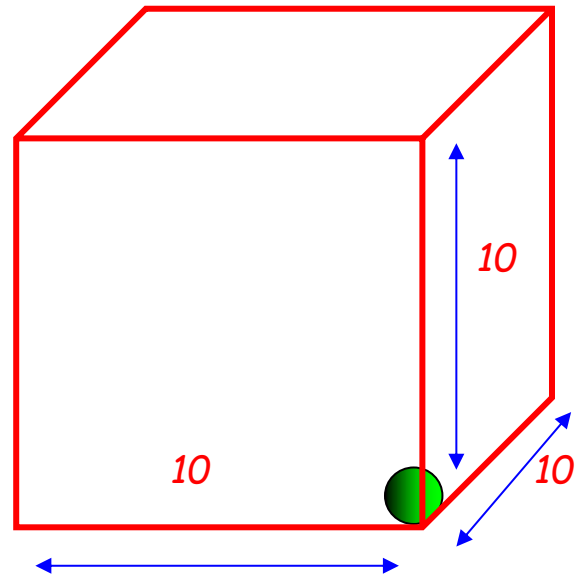
*Knowing about the spacing of particles in solids, liquids and gases also ought to give us an indication as to how density and state are related.*

*In general the density of a gas is 1000 times less than the density of the corresponding liquid or solid. NB the size of the particles does not change but the spacing between the particles alters.*

*How does the spacing change?*

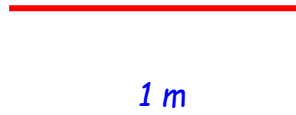
*Volume = 1000 × original volume*

*This means that the new spacing is 10 times greater since  $10^3 = 1000$ .*

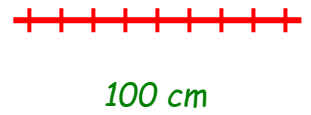


## Converting between metres and centimetres

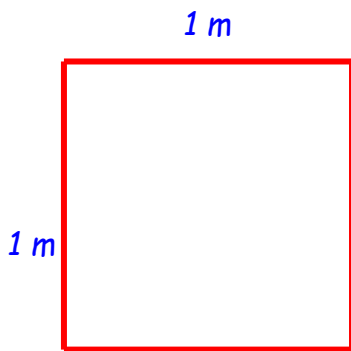
Length



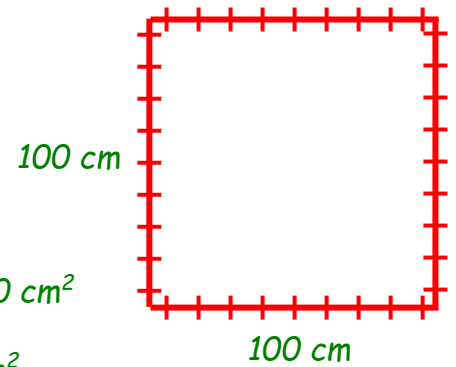
$$1 \text{ m} = 100 \text{ cm}$$



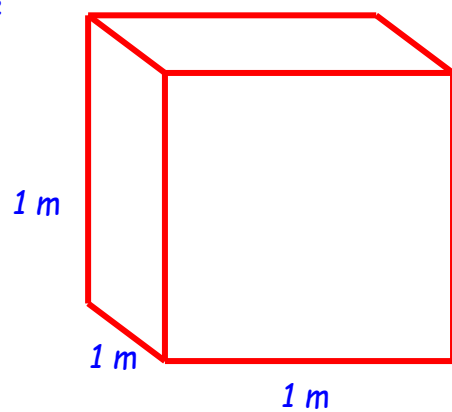
Area



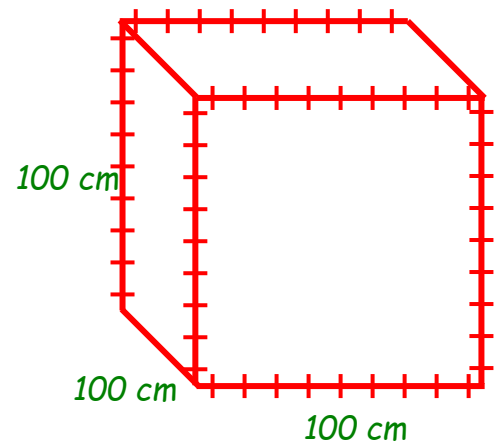
$$\begin{aligned} 1 \text{ m}^2 &= 10\,000 \text{ cm}^2 \\ &= 10^4 \text{ cm}^2 \end{aligned}$$



Volume



$$\begin{aligned} 1 \text{ m}^3 &= 1\,000\,000 \text{ cm}^3 \\ &= 10^6 \text{ cm}^3 \end{aligned}$$



$$1 \text{ l} = 1000 \text{ cm}^3$$

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$$1 \text{ m}^3 = 1\,000\,000 \text{ cm}^3$$

$$= 10^6 \text{ cm}^3$$

	<i>Solid</i>	<i>Liquid</i>	<i>Gas</i>
<i>Density</i>	1 1000	1 1000	$\frac{1}{1000}$ 1
<i>Volume</i>	1 $\frac{1}{1000}$	1 $\frac{1}{1000}$	1000 1
<i>Spacing of particles</i>	1	1	10

When submerged the anchor displaces a volume of water equal to its own volume. When in the boat, the anchor is associated with displacing a volume of water with a weight equal to its own weight - this is a larger volume than its own volume because the anchor's density is higher than water's. Because the anchor displaces less water when it is submerged, the water level drops when the anchor is thrown overboard.

[http://physics.bu.edu/~duffy/sc527\\_notes01/weight.html#:~:text=Beca use%20the%20anchor%20displaces%20less,the%20anchor%20is%20thro wn%20overboard.](http://physics.bu.edu/~duffy/sc527_notes01/weight.html#:~:text=Beca use%20the%20anchor%20displaces%20less,the%20anchor%20is%20thro wn%20overboard.)

# Tutorials

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  - Calculate the volume of the room you are in.
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- Determine the volume of the candyfloss in cubic metres
  - Calculate the mass of the candyfloss.
- 17) Since the density of water is  $10^3 \text{ kg m}^{-3}$ , what volume does 100 g occupy?