

DENSITY

- Density is a measure of the concentration of matter; of how much matter is present in a given space
- Density is defined as the MASS per unit VOLUME, or ...

$$\text{Density} = \frac{\text{mass}}{\text{Volume}}$$

What are the metric units of DENSITY?

metric mass unit = kilogram

metric volume unit = cubic meter

So, density unit =

$$\boxed{\frac{\text{Kg}}{\text{m}^3}}$$

In the lab, we typically measure masses as grams and volumes as milliliters, so the density unit we will use most often is:

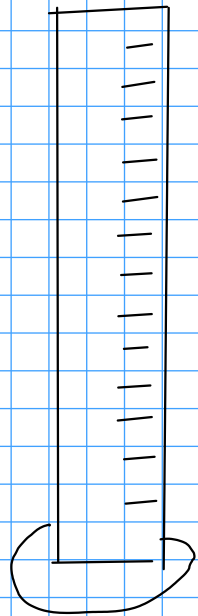
$$\frac{g}{mL}$$

A useful density to remember:

WATER at room temp: Density = $1 \frac{g}{mL}$

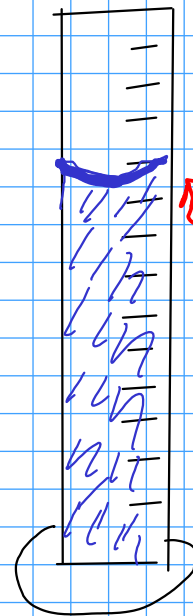
Measuring density

... of a liquid



1) Measure mass of empty cylinder

$$\text{mass} = 97.35 \text{ g}$$



2) Fill cylinder and measure volume of liquid

$$\text{volume} = 25.3 \text{ mL}$$

3) Measure mass of filled cylinder

$$\text{mass} = 130.55 \text{ g}$$

4) Subtract to find mass of liquid

$$\begin{array}{r} 130.55 \text{ g} \\ - 97.35 \text{ g} \\ \hline 33.20 \text{ g} \end{array}$$

5) Density = mass liquid / volume liquid

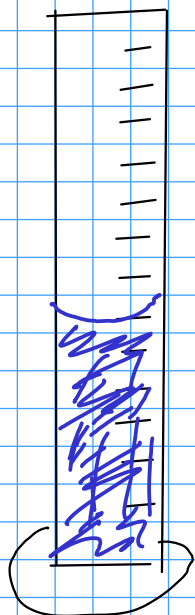
$$\begin{aligned} \text{Density} &= \frac{33.20 \text{ g}}{25.3 \text{ mL}} \\ &= 1.31 \text{ g/mL} \end{aligned}$$

...of an object



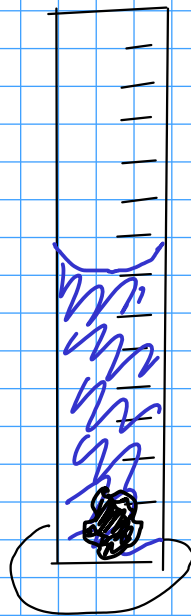
1) Measure mass of object

$$\text{mass} = 9.78 \text{ g}$$



2) Partially fill cylinder with liquid, record volume.

$$\text{volume} = 25.0 \text{ mL}$$



3) Put object into cylinder, record new volume

$$\text{volume} = 26.6 \text{ mL}$$

4) Subtract to find volume of object

$$\begin{array}{r} 26.6 \text{ mL} \\ - 25.0 \text{ mL} \\ \hline 1.6 \text{ mL} \end{array}$$

5) Density = mass object / volume object

$$\text{Density} = \frac{9.78 \text{ g}}{1.6 \text{ mL}}$$

$$= 6.1 \text{ g/mL}$$

Converting from one unit to another

We will use the method of dimensional analysis, sometimes called the factor-label method.
... or, the "drag and drop" method!

Dimensional analysis uses conversion factors to change between one unit and another

What's a conversion factor? A simple equality.

Example

$$12 \text{ in} = 1 \text{ ft}$$

Conversion factors in metric

In the metric system, conversion factors between units may always be made from the metric prefixes!

For example, "kilo-" means 10^3

$$K = 10^3$$

so

$$K m = 10^3 m$$

$$K g = 10^3 g$$

$$K L = 10^3 L$$

$$K s = 10^3 s$$

Just apply the prefix to the base unit!

How do we actually USE a conversion factor?

Convert 15.75 m to cm $\text{cm} = 10^{-2} \text{ m}$

$$15.75 \cancel{\text{m}} \times \frac{\text{cm}}{10^{-2} \cancel{\text{m}}} = 1575 \text{ cm}$$

DRAG
AND
DROP!

Convert 0.01893 kg to g $\text{kg} = 10^3 \text{ g}$

$$0.01893 \cancel{\text{kg}} \times \frac{10^3 \text{ g}}{\cancel{\text{kg}}} = 18.93 \text{ g}$$

Convert 14500 mg to kg

$$\text{mg} = 10^{-3} \text{g}$$

$$\text{kg} = 10^3 \text{g}$$

DRAG
AND
DROP!

$$14500 \text{ mg} \times \frac{10^{-3} \text{g}}{\text{mg}} \times \frac{\text{kg}}{10^3 \text{g}} = \boxed{0.0145 \text{ kg}}$$

Convert 0.147 mm to μm

$$\text{mm} = 10^{-3} \text{m}$$

$$\mu\text{m} = 10^{-6} \text{m}$$

$$0.147 \text{ mm} \times \frac{10^{-3} \text{m}}{\text{mm}} \times \frac{\mu\text{m}}{10^{-6} \text{m}} = \boxed{147 \mu\text{m}}$$