Metric units may be made larger or smaller by adding PREFIXES.

A few common metric prefixes:

mega-	10^{6}	M
kilo-	10^{3}	k
centi-	10^{-2}	c
milli-	10^{-3}	m
micro-	10^{-6}	μ

Bigger units

smaller units (or mc-)

MEMORIZE the common metric prefixes listed in the study guide

Applying prefixes

1 _____ m = _____ m

1 km = 10^{3} m (1000 m)

1 cm = 10^{-2} m (1/100 m)

Scaling units with metric prefixes ... examples

The distance between here and Columbia, SC is about 107,000 meters. What metric unit would be best suited for a distance like this?

$K = 10^3$ (1000)

107 Km

By "best suited", we mean a metric unit that would represent the number without many beginning or end zeros. These kinds of numbers are easier for us to remember!

A piece of chalk is 0.080 meters long. What metric unit would be best suited for this length?

$c = 10^{-2}$ (1/100)

8.0 cm

Derived Units

- are units that are made up of combinations of metric base units with each other and/or with prefixes

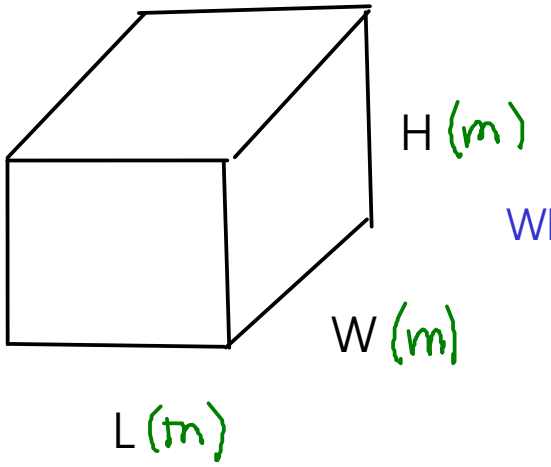
velocity: $\frac{\text{miles}}{\text{hr}}$ $\frac{\text{km}}{\text{hr}}$ $\left(\frac{\text{m}}{\text{s}}\right)$ $\frac{\text{length}}{\text{time}}$

Two derived units are particularly important in general chemistry:

1) VOLUME

2) DENSITY

VOLUME

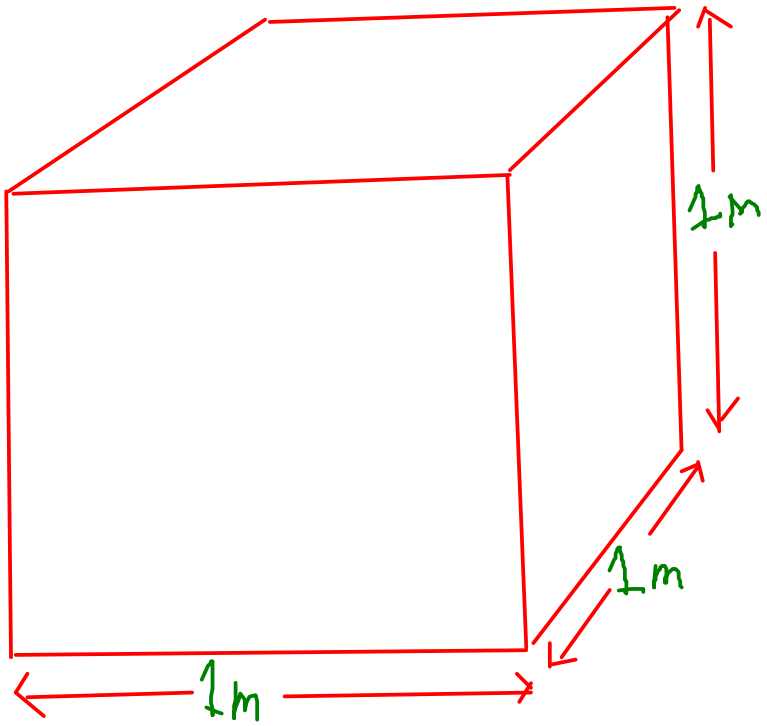


VOLUME = L × W × H

What are the units of volume in the metric system?

VOLUME = m × m × m

= m^3 "cubic meters"



Problem: The cubic meter is too large for laboratory-scale work. The solution is to scale the unit down to make something more manageable...

Practical issues for volume units

- Cubic meters are too large! A meter is very similar in length to a yard, so a cubic meter is a cube that is approximately a yard long on each side!

A smaller unit For volume?

cubic decimeters! dm^3

(decimeter = 1/10 meter)

Cubic decimeters are given the name "liters", abbreviation "L"

In the lab, we typically need an even smaller unit than the liter, so we use milliliters (mL)

"cc"
cubic centimeter
=
milliliter

$1\ mL = 10^{-3} L$

-or-

$1000\ mL = 1\ L$

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?

$$\text{DENSITY} = \frac{kg}{m^3}$$

Base unit of mass

Simplest metric volume

We usually use a different unit nhere because we do lab-scale experiments. Both cubic meter and the kilogram are too big. For example, the balances used in our labs have a maximum capacity of 210 grams ...

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

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

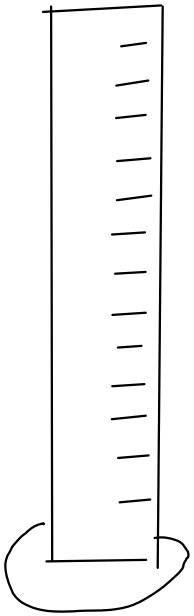
$$\left(\frac{g}{cm^3}\right) \quad \left(\frac{g}{cc}\right)$$

A useful density to remember:

WATER at room temp: Density = 1 g/mL

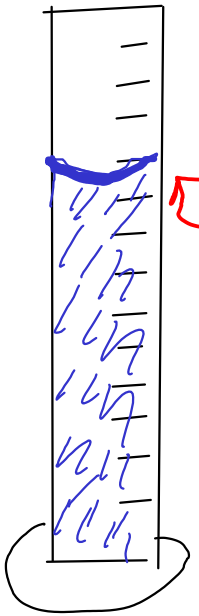
Measuring density

... of a liquid



1) Measure mass of empty cylinder

mass = 97.35 g



2) Fill cylinder and measure volume of liquid

volume = 25.3 mL

3) Measure mass of filled cylinder

mass = 130.55 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

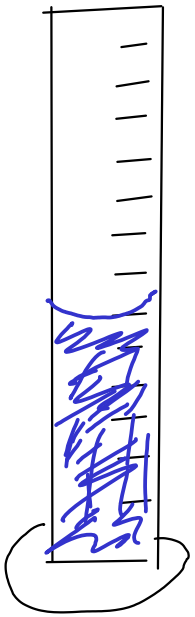
$$\text{Density} = \frac{33.20\ \text{g}}{25.3\ \text{mL}}$$

$$= 1.31\ \text{g/mL}$$

...of an object

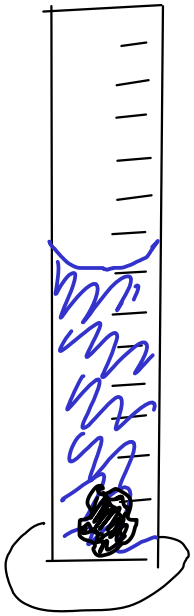
1) Measure mass of object

mass = 9.78 g



2) Partially fill cylinder with liquid, record volume.

volume = 25.0 mL



3) Put object into cylinder, record new volume

volume = 26.6 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

$$km = 10^3 m$$

$$kg = 10^3 g$$

$$kL = 10^3 L$$

$$ks = 10^3 s$$

Just apply the prefix to the base unit!

How do we actually USE a conversion factor?

Convert 15.75 m to cm

$cm = 10^{-2} m$

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

* Similar to...

If X = 2, then

$$\frac{X}{2} = 1$$

15.75 / EE −2 .. on TI-83

* This fraction equals one, so multiplying by it does not change the VALUE of the number, only its UNITS!

Convert 0.01893 kg to g

$Kg = 10^3 g$

$$0.01893\ Kg \times \frac{10^3 g}{Kg} = 18.93 g$$

DRAG AND DROP

- Drag the part of the factor that contains the unit you want to get rid of (cancel out) to the BOTTOM.

- Then, drag the other half of the factor to the TOP