Measurements

Measurements are comparisons of properties against accepted standards, called units.

ENGLISH / US SYSTEM OF UNITS:

1 foot = 12 inches   1 yard = 3 feet   1 mile = 1760 yards

5280 feet = 1 mile

So what's the problem?

1) The relationships between different sized units don't make logical sense - they're essentially random numbers.
2) The conversions between English units aren't really easy to do mentally.

English units are nonstandard and difficult to use. Solution?

THE METRIC SYSTEM

Metric Base Units:

All metric units are made up of COMBINATIONS of BASE UNITS!

Length	meter	m
Mass	*kilogram	kg
Temperature	Kelvin	K
Time	second	s

*we usually treat the gram as if it's the base unit for mass!

- One meter is approximately 3.3 feet.
- One kilogram is approximately 2.2 pounds.

What about SIZE?

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

$$1 \underline{\quad} m = \underline{\quad} m$$

$$1 \, Mm = 10^6 \, m \quad (1000000 \, m)$$

$$1 \, cm = 10^{-2} \, m \quad \left(\frac{1}{100} \, m\right)$$

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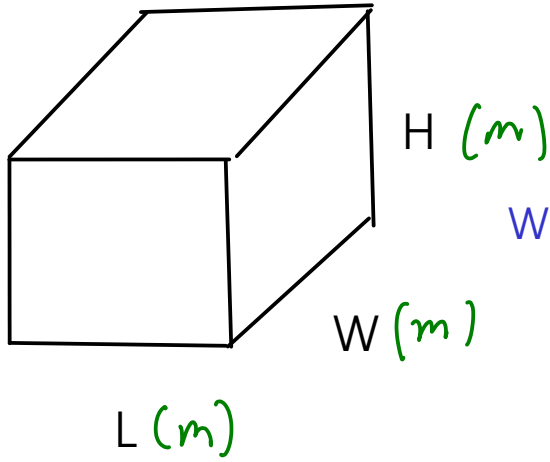
$$c = 10^{-2} \ (1/100)$$

$$8 \ cm$$

Derived Units

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

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

Two derived units are particularly important in general chemistry:

1) VOLUME

2) DENSITY

VOLUME

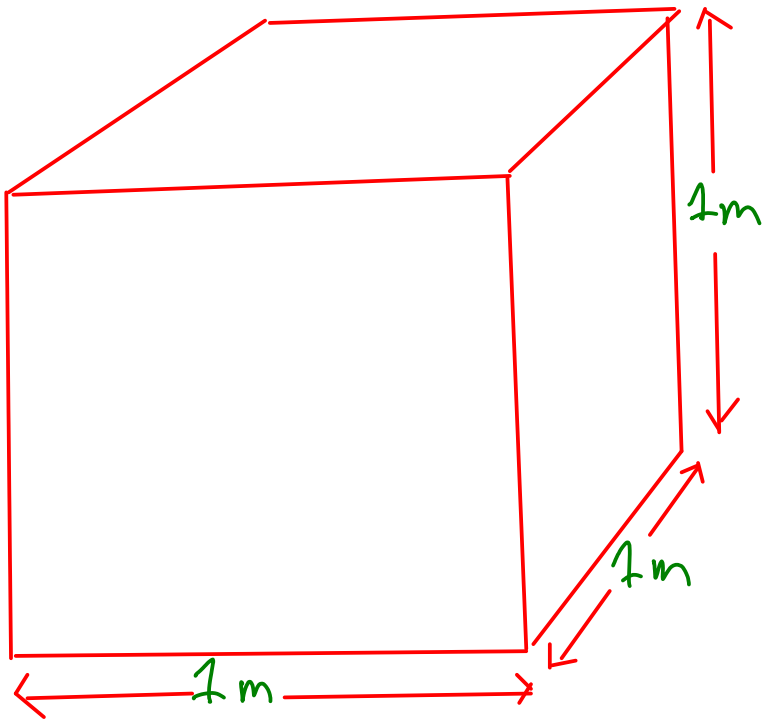VOLUME = L × W × H

What are the units of volume in the metric system?

$$VOLUME = (m) × (m) × (m)$$

$$= m^3 \text{ "cubic meters"}$$

H (m)

W (m)

L (m)

1m

1m

1m

Problem: The cubic meter is too large! We need a smaller unit to work in the lab!

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

$\left(\text{decimeter} = \frac{1}{10} \text{ meter}\right)$

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 ...

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

What are the metric units of DENSITY?

$$DENSITY = \frac{Kg}{m^3}$$

← base unit of mass

← simplest volume unit

This unit uses parts that are still too big for lab work!

Even the kilogram ... typical lab balances (analytical balances) have a capacity of about 200 grams.

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

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

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

A useful density to remember:

WATER at room temp: Density $= 1 \; g/mL$