

Measurements

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

ENGLISH / US SYSTEM OF UNITS:

$$1 \text{ foot} = \underline{12} \text{ inches} \quad 1 \text{ yard} = \underline{3} \text{ feet} \quad 1 \text{ mile} = \underline{\underline{1760}} \text{ yards}$$
$$\underline{\underline{5280}} \text{ feet} = 1 \text{ mile}$$

So what's the problem?

- 1) The English system is hard to use, since it's made of essentially independent units for measuring the same things - and all relationships between units must be memorized.
- 2) The relationships in the English system don't work well for "mental math". You need a calculator.

2
English units are nonstandard and difficult to use. Solution?

THE METRIC SYSTEM

Metric Base Units:

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

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

*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

$$1 \text{ km} = 10^3 \text{ m} \quad (1000 \text{ m})$$

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

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?

$$k = 10^3 \text{ (1000)}$$

$$107 \text{ km}$$

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?

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

$$8 \text{ cm}$$

Derived Units

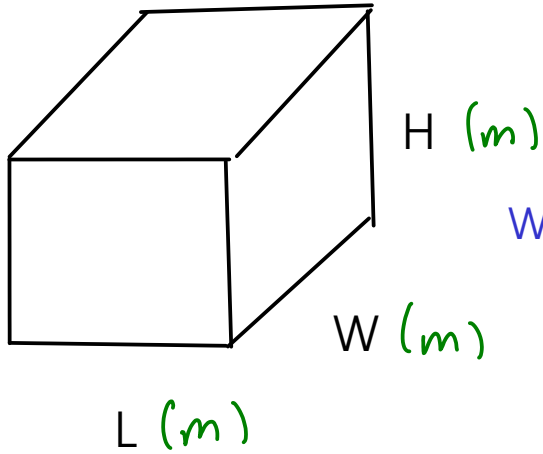
- are units that are made up of combinations of metric base units with each other and/or with prefixes

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

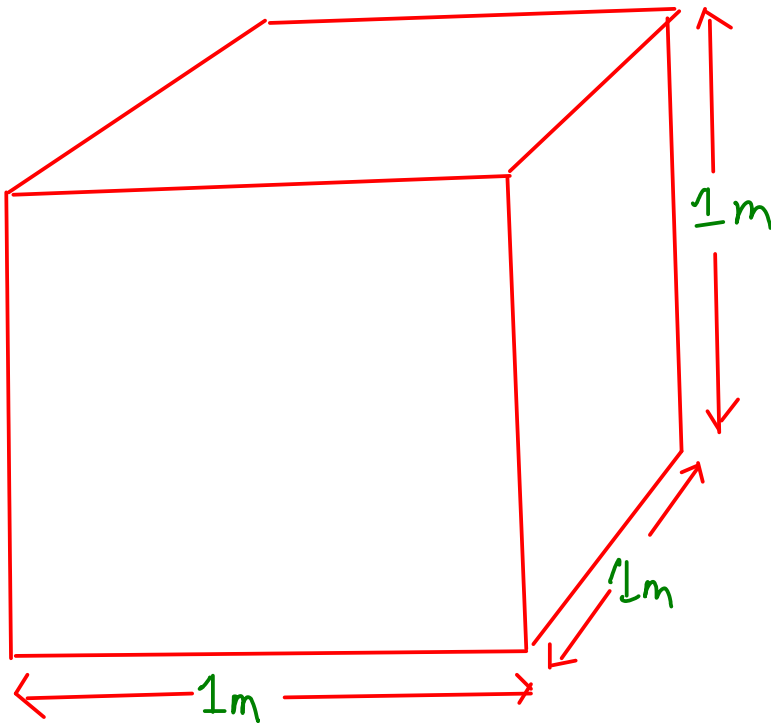
2) DENSITY

VOLUME

$$\text{VOLUME} = L \times W \times H$$

What are the units of volume in the metric system?

$$\begin{aligned} \text{VOLUME} &= (m) \times (m) \times (m) \\ &= m^3 \text{ "cubic meters"} \end{aligned}$$



One problem: The cubi meter is too large for lab scale and medical scale work.

Solution: scale it down!

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 = $\frac{1}{10}$ 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)

mL
cubic centimeter
=
milliliter

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

-or-

$$1000 \text{ mL} = 1 \text{ L}$$

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?

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

Base unit of MASS

Simplest volume unit

The cubic meter is still too big for lab work, and even the kilogram is very large. We need to scale these units down.

9
In the lab, we typically measure masses as grams and volumes as milliliters, so the density unit we will use most often is:

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

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

$$\left(\frac{g}{cc} \right)$$

A useful density to remember:

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