

## Measurements

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

### ENGLISH / US SYSTEM OF UNITS:

$$1 \text{ foot} = \underline{12} \text{ inches}$$

$$1 \text{ yard} = \underline{3} \text{ feet}$$

$$1 \text{ mile} = \underline{1760} \text{ yards}$$

$$\underline{5280} \text{ feet} = 1 \text{ mile}$$

So what's the problem?

- 1) Relationships between units don't often make logical sense, so they all must be memorized.
- 2) The relationships often aren't easy to use for "mental math".

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-	$10^{-6}$	$\mu$

Bigger units:

smaller units  
(or mc-)

MEMORIZE the common metric prefixes listed in the study guide

Applying prefixes

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

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

$$1 \text{ mm} = 10^{-3} \text{ m} \quad \left( \frac{1}{1000} \text{ m} \right)$$

## 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 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 cm

## Derived Units

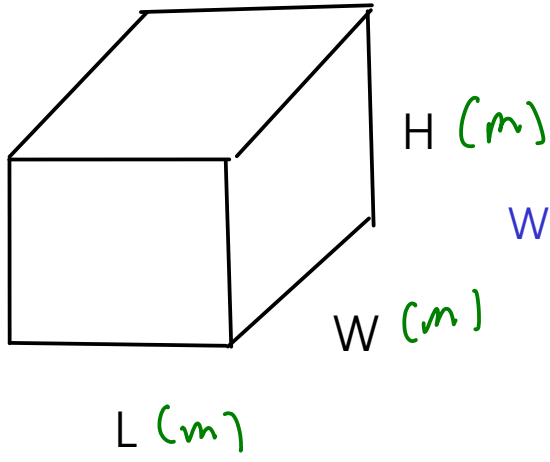
- are units that are made up of combinations of metric base units with each other and/or with prefixes

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

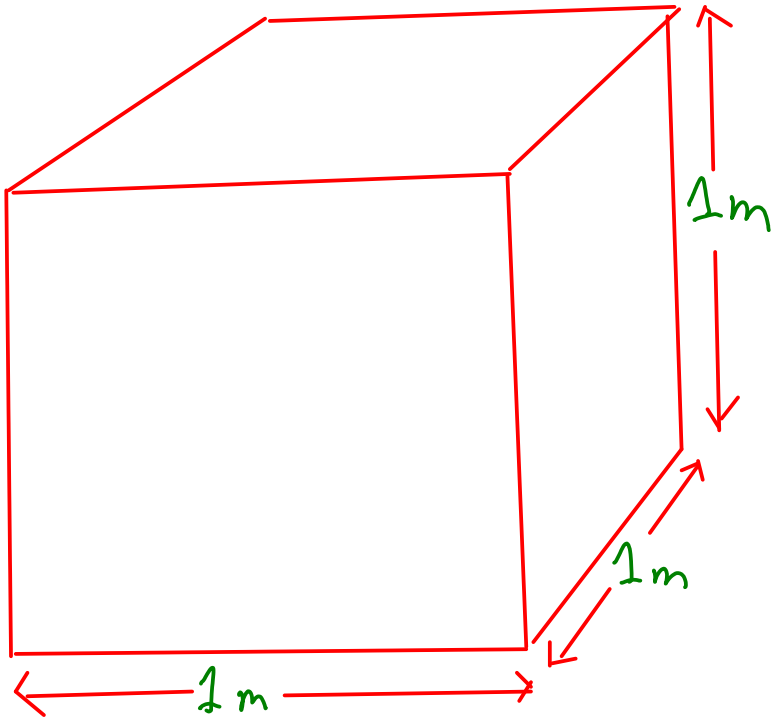
2) DENSITY

VOLUME

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

What are the units of volume in the metric system?

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



The cubic meter is the simplest metric volume unit, BUT it's too big for routine medical and laboratory work.

## 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!  $\text{dm}^3$

(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)

"cc"  
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

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.



9

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

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

A useful density to remember:

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