

## CHEMISTRY LECTURE #1: UNITS OF MEASUREMENT.

- Length
- Volume
- Mass
- Metric Prefixes

Chemistry is the study of the properties of matter.

Some properties include length, volume, and mass.

In chemistry, we use the metric system to measure length. The unit of length is the meter (m).

The meter is a tiny bit larger than a yard. (3 feet).

The meter is good for measuring moderately large distances. For example, a football field is 91.44 meters.

But what if we need to measure short lengths, like the length of a pencil? It's cumbersome to use a big meter stick to measure a short length. We need a shorter unit of measurement.

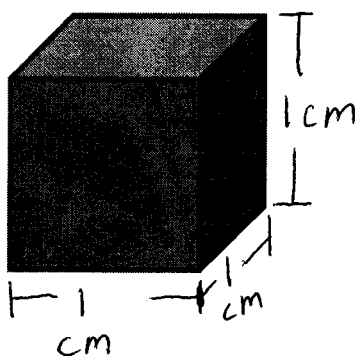
If we take a meter stick and slice it into 100 pieces, one of those little pieces would be a *centimeter* (cm). The prefix "centi-" means "1/100." One centimeter is 1/100 of a meter. Or,  $1 \text{ cm} = 0.01 \text{ m}$ , or  $1 \times 10^{-2} \text{ m}$ . It takes 100 cm to make 1 meter ( $100 \text{ cm} = 1 \text{ m}$ ). A nickel is about 2 cm in diameter.

If we take a meter stick and slice it into 10 pieces, we have a *decimeter* (dm). The prefix "deci-" means "1/10." So, one

decimeter = 1/10 of a meter. Or,  $1 \text{ dm} = 0.1 \text{ m}$ , or  $1 \text{ dm} = 1 \times 10^{-1} \text{ m}$ .  
A coffee mug is about 1 dm tall (approximately 4 inches).

We use length measurements to determine the *volume* of an object. Volume is the amount of space occupied by an object.

Suppose we want to measure the volume of a small amount of water. We can build a tiny box that is 1 cm long, 1 cm wide, and 1 cm tall. The volume of a box is length x width x height, so the volume of our little box is  $1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm} = 1 \text{ cm}^3$ . Or, our box has a volume of 1 cubic centimeter. Sometimes "cubic centimeters" is abbreviated as "cc" instead of " $\text{cm}^3$ ." Also,  $1 \text{ cm}^3$  is the same as 1 milliliter (or  $1 \text{ cm}^3 = 1 \text{ mL}$ ). So cc,  $\text{cm}^3$ , and mL all mean the same thing. Most of the time we use mL to measure volume in chemistry.



$$V = l \times w \times h$$

$$V = 1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm}$$

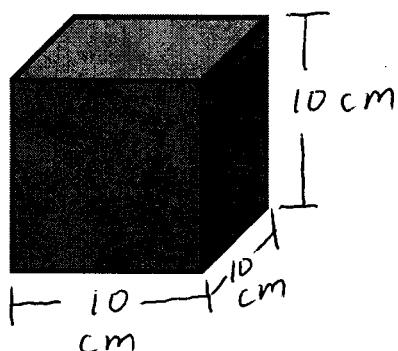
$$V = 1 \text{ cm}^3 = 1 \text{ cc} = 1 \text{ mL}$$

A soda can has a volume of about 355 mL.

To measure larger volumes, we use *liters* (L). One liter is about the size of 3 soda cans. A box with a volume of 1 liter would be 10 cm long, 10 cm wide, and 10 cm tall or  $10 \text{ cm} \times 10 \text{ cm} \times 10 = 1000 \text{ cm}^3$ . Thus, one liter =  $1000 \text{ cm}^3 = 1000 \text{ mL}$ .

Also, our one liter box would measure  $1 \text{ dm} \times 1 \text{ dm} \times 1 \text{ dm}$ , so its volume could also be expressed as one  $\text{dm}^3$ . Cubic decimeters is sometimes used in chemistry texts, so you have to be aware of what it means.

$$10 \text{ cm} = 1 \text{ dm}$$



$$V = 10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm} = 1000 \text{ cm}^3$$

$$V = 1 \text{ dm} \times 1 \text{ dm} \times 1 \text{ dm} = 1 \text{ dm}^3$$

$$1000 \text{ cm}^3 = 1 \text{ dm}^3 = 1 \text{ liter}$$

↓  
mL

or 1 L

If  $1 \text{ liter} = 1000 \text{ mL}$ , then  $1 \text{ mL} = 1/1000$  of a liter. The prefix "milli-" means "1/1000." So,  $1 \text{ mL} = 0.001 \text{ L}$  or  $1 \times 10^{-3} \text{ L}$ .

We use volume measurements to establish measurements for *mass*. Mass is a measure of the amount of material you have. We usually judge the mass of an object by its weight or how heavy it feels. Weight and mass are not the same thing, but for right now, let's just say that we measure the mass of an object on Earth by measuring its weight (you'll have to take physics to get the real definition of mass and weight - sorry!).

In chemistry, mass is measured in *grams (g)*. If you take a tiny little box that is  $1 \text{ cm}^3$  in volume and fill it with water, the mass of the water would be one gram. A penny has a mass of about 2.5 grams.

To measure very small amounts of mass, we use *milligrams* (mg). Remember that the prefix "milli-" means  $1/1000$ , so one mg =  $1/1000$  of a gram or 0.001 grams. A single grain of rice is about 1 milligram. Low dose aspirin tablets are 81 mg.

To measure large amounts of mass, we use the *kilogram* (kg). The prefix "kilo-" means "thousand." Thus, 1 kg = 1000 g, 2 kg = 2000 g, and so on. 3 cans of Coke have a mass of about 1.1 kg.

The prefixes kilo, deci, centi, and milli are used quite a bit in science, so you should memorize their meanings. The chart below should be of help.

Prefix	meaning	sample conversion
milli (m)	$1/1000$ or $10^{-3}$	$32 \text{ mL} = 32 \times 10^{-3} \text{ L}$
centi (c)	$1/100$ or $10^{-2}$	$85 \text{ cm} = 85 \times 10^{-2} \text{ m}$
deci (d)	$1/10$ or $10^{-1}$	$4 \text{ dm} = 4 \times 10^{-1} \text{ m}$
kilo (k)	1000 or $10^3$	$6.3 \text{ kg} = 6.3 \times 10^3 \text{ g}$