VOLUME

VOLUME = L × W × H

H m

W m

L m

What are the units of volume in the metric system?

$$VOLUME = (m) \times (m) \times (m)$$

$$= m^3 \text{ (cubic meters)}$$

One "small" problem: The cubic meter is rather large. (A meter is a little more than a yard, so the cubic meter is too big for 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!

(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 ...

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

What are the metric units of DENSITY?

mass unit

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

volume unit

... both kilograms and meters are large compared to lab scale (example: our balances can only weigh up to 0.200 kg without being overloaded)

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

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

A useful density to remember:

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

Measuring density

... of a liquid
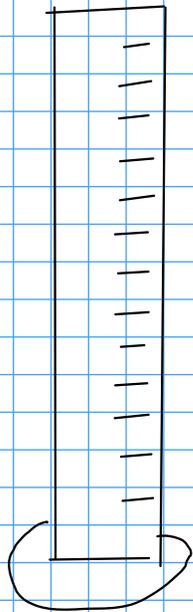
1) Measure mass of empty cylinder

$mass = 97.35\ g$
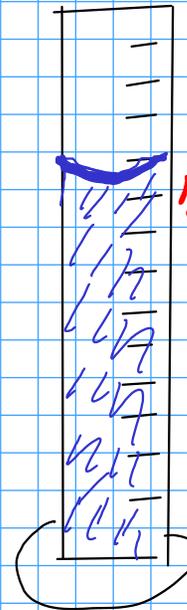
2) Fill cylinder and measure volume of liquid

$volume = 25.3\ mL$

3) Measure mass of filled cylinder

$mass = 130.55\ g$

4) Subtract to find mass of liquid

$$130.55\ g$$
$$-\ 97.35\ g$$
$$\overline{}$$
$$33.20\ g$$

5) Density = mass liquid / volume liquid

$$Density = \frac{33.20\ g}{25.3\ mL}$$
$$= \boxed{1.31\ g/mL}$$

...of an object

1) Measure mass of object

mass = 9.78 g
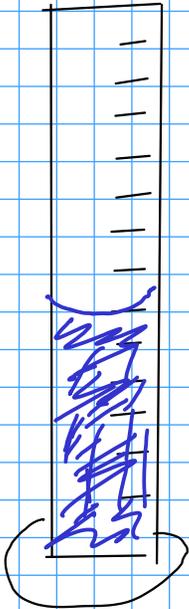
2) Partially fill cylinder with liquid, record volume.

volume = 25.0 mL
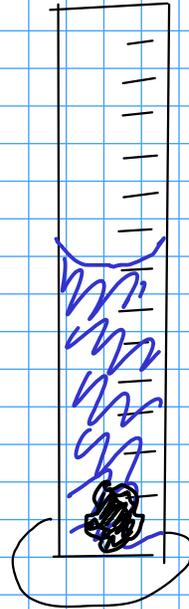
3) Put object into cylinder, record new volume

volume = 26.6 mL

4) Subtract to find volume of object

$$26.6 \text{ mL}$$
$$- 25.0 \text{ mL}$$
$$1.6 \text{ mL}$$

5) Density = mass object / volume object

$$\text{Density} = \frac{9.78 \text{ g}}{1.6 \text{ mL}}$$

$$= 6.1 \text{ g/mL}$$

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 in = 1 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

$$cm = 10^{-2} m$$

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

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

$$kg = 10^{3} g$$

$$0.01893 \, kg \times \frac{10^{3} g}{kg} = \boxed{18.93 \, g}$$

DRAG AND DROP
- Drag the part of the factor that you want to cancel out to the BOTTOM.
- Then, drag the other half of the factor to the TOP

Convert 14500 mg to kg

$$mg = 10^{-3} g \qquad kg = 10^3 g$$

$$14500 \, mg \times \frac{10^{-3} \, g}{mg} \times \frac{kg}{10^3 \, g} = \boxed{0.0145 \, kg}$$

Convert 0.147 cm^2 to m^2

We have to convert both parts of this squared unit, so we apply our conversion factor TWICE!

$$cm^2 = cm \times cm$$

Must convert BOTH!