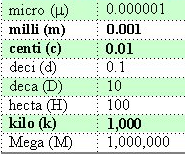
The M\_\_\_\_\_ System

Metric System Versus the English System

* S\_\_\_\_\_
  + The metric system uses \_\_\_\_\_ unit for each category of measurement
  + \_\_\_\_\_ (mass), \_\_\_\_\_ (volume), \_\_\_\_\_ (distance)
  + The English system utilizes \_\_\_\_\_ different names for each major measurement (*units of mass, volume, distance*)
    - * + DISTANCE: Rod, furlong, hand, foot, yard, mile, nautical mile
        + VOLUME: Pinch, gill, teaspoon, tablespoon, ounce, cup, pint, quart, gallon, peck, bushel
        + MASS/WEIGHT: Penny, grain, ounce, pound, short ton, standard ton
* C\_\_\_\_\_
  + All metric units are \_\_\_\_\_ of \_\_\_\_\_ or utilize \_\_\_\_\_ placement
  + The English system has \_\_\_\_\_ consistency between units



Metric & English Common Units

* Vehicle Odometer:
  + \_\_\_ km = \_\_\_ mile or 1 km = 0.625 miles
* Temperature:
  + ºF = \_\_\_ ºC + \_\_\_ or ºC = \_\_\_ (ºF - 32)
* Distance:
  + 1 inch = 2.54 cm or 0.39 inches = 1 cm

Metric \_\_\_\_\_

* Metric prefixes mean the same thing regardless of the quantity being measured; i.e., mass, volume, distance, time.
  + 1 \_\_\_\_\_ \_\_\_\_\_, 1 cc = 1 \_\_\_\_\_, 1 ml
  + \_\_\_\_\_ milliliters = \_\_\_ liter
  + 1 cubic decimeter = 1 liter

Factor labeling … see videos

Mathematics in Science

S\_\_\_\_\_ Notation or E\_\_\_\_\_ Notation

* The system of scientific notation was invented to express very \_\_\_\_\_ or very \_\_\_\_\_ numbers in a very compact and easy-to-calculate way.
* It is also sometimes referred to as "\_\_\_\_\_ of ten" or “exponential notation”, because it takes advantage of the \_\_\_\_\_ nature of our number system.
* Scientific notation always involves raising 10 to some exponential power (“powers of \_\_\_”).

Scientific Notation Conventions

sci not decimals

* use a \_\_\_\_\_ from \_\_\_ to \_\_\_
* \_\_\_\_\_ (power) of \_\_\_\_\_

e.g. 3,600,000,000,000

* + - * assume the decimal follows the last zero & the exponent is 10\_\_ … 3,600,000,000,000. x 100 
        + … You need a \_\_\_\_\_ between \_\_ & \_\_\_ … so move the decimal to the \_\_\_\_\_ 12 places
      * 3.6 x 1012 … Since the \_\_\_\_\_ decreased, you must \_\_\_\_\_ the exponent the same amount of places

sci not decimals 2

e.g. 0.0000000000436

* + - * assume the decimal follows the last zero & the exponent is 100 … 0.0000000000436 x 100 
        + … You need a \_\_\_\_\_ between 1 & 9 … so move the decimal to the \_\_\_\_\_ 11 places
      * 4.36 x 10-11 … Since the number \_\_\_\_\_, you must \_\_\_\_\_ the exponent the same amount of places

Scientific Notation (standard notation to exponential notation)

* Notice when the number \_\_\_\_\_, the exponent \_\_\_\_\_
* Notice when the \_\_\_\_\_ increases, the \_\_\_\_\_ decreases

Scientific Notation

* Inter-converting exponents to decimals
* scientific notation to standard notation

e.g. 6.7 x 104 = \_\_\_\_\_

* + You must decrease the \_\_\_\_\_, and therefore, increase the \_\_\_\_\_,
  + 10\_\_ decreases to 10\_\_
  + \_\_\_\_\_ increases to \_\_\_\_\_

e.g. 3.82 x 10-3 = \_\_\_\_\_

* + You must increase the \_\_\_\_\_, and therefore, \_\_\_\_\_ the number
  + 10\_\_ increases to 10\_\_
  + \_\_\_\_\_ decreases to \_\_\_\_\_
* “Thumb \_\_\_\_\_ / Thumb \_\_\_\_\_” RULE

Mathematical Operations

* When adding, subtracting, multiplying or dividing, one must deal with numbers and exponents separately … this means you cannot add a number to an exponent and vice versa.

Addition 65 x 10-1 + 8.3 x 101

* Convert numbers to a \_\_\_\_\_ exponent (choose the \_\_\_\_\_ exponent)
* The \_\_\_\_\_ of the exponents must be the \_\_\_\_\_ to add or subtract numbers

0.65 x 101 + 8.3 x 101

* Add \_\_\_\_\_ to \_\_\_\_\_ … add 0.65 + 8.3 = 8.95 8.95 x 101

Subtraction 47 x 10-1 - 7.1 x 101

* Convert numbers to a \_\_\_\_\_ exponent (choose the larger exponent)
* The superscripts of the exponents must be the same to add or subtract numbers

0.47 x 101 - 7.1 x 101

* Subtract \_\_\_\_\_ from \_\_\_\_\_ … subtract 0.47 - 7.1 = -6.63 -6.63 x 101

Multiplication 12 x 10-2 x 3 x 104

* Multiply \_\_\_\_\_ by \_\_\_\_\_ 12 x 3 = 36
* \_\_\_\_\_ the superscripts of the \_\_\_\_\_ 10-2 x 104 … add (-2) + 4 = 2 … = 102

36 x 102 … 3.6 x 103

Division 9 x 104 / 3 x 10-2

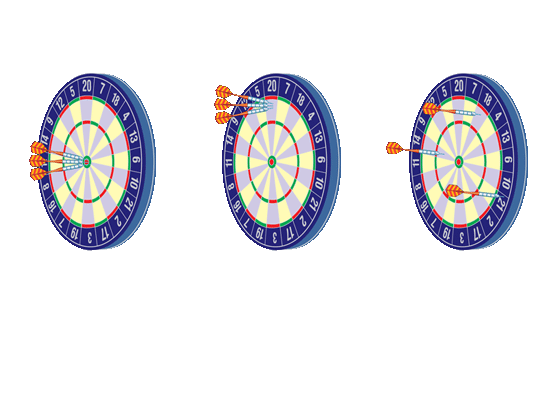
* Divide \_\_\_\_\_ by \_\_\_\_\_ 9 / 3 = 3
* \_\_\_\_\_ the superscripts of the \_\_\_\_\_ 104 x 10-2 … subtract … 4 - (-2) = 6 … = 106 🡪 3 x 106

Uncertainty in Measurement

* Uncertainty in measurement depends on the \_\_\_\_\_ and \_\_\_\_\_ of the \_\_\_\_\_ and the limitations of the \_\_\_\_\_
* We certainly want our dentists, doctors, mechanics, pharmacists, nurses, chefs, and other service providers to be \_\_\_\_\_ and \_\_\_\_\_ in their care

Accuracy, Precision, and Error

* Darts on a dartboard illustrate the difference between accuracy and precision.
* Label each target related to accuracy and precision:



* The \_\_\_\_\_ of a dart to the bull’s-eye corresponds to the degree of \_\_\_\_\_. The closeness of several darts to one \_\_\_\_\_ corresponds to the degree of \_\_\_\_\_.
  + Example: TroubleShooting and Q & A’s
* \_\_\_\_\_ is the identification or diagnosis of "trouble" in a system based on a lack of accuracy and/or precision.

\_\_\_\_\_: deals with ‘common’ errors or failures (experienced \_\_\_\_\_); “\_\_\_\_\_”.

* + *E.g. Students forgot to put units on their measurements, lowering the average grade on the test.*

\_\_\_\_\_: deals with “\_\_\_\_\_” in the system.

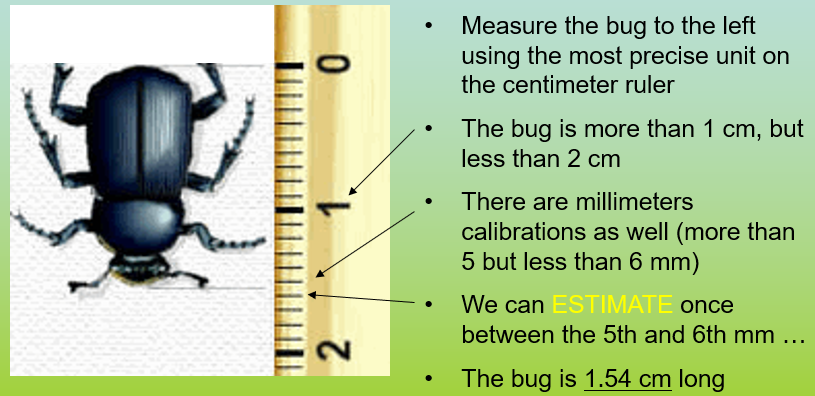
* + *E.g. A student misread the question and got it incorrect.*

Precision

* + Usually refers to \_\_\_\_\_
  + Indicates the \_\_\_\_\_, reproducibility or consistency of a measurement.

Examples

* + The following measurements on a thermometer [91.9 C, 92.0 C, 92.0 C, 91.9 C] show \_\_\_\_\_ and high \_\_\_\_\_ and, therefore, the thermometer readings are considered \_\_\_\_\_.



A\_\_\_\_\_

* + Usually refers to people and inaccurate measuring OR to an instrument that may be measuring precisely, but is not accurate
  + Indicates how \_\_\_\_\_ a measurement is to the \_\_\_\_\_ value

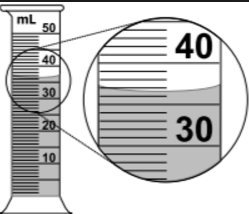
Example

* + The values of temperature [91.9 C, 92.0 C, 92.0 C, 91.9 C] for the boiling point of water are \_\_\_\_\_ … the accepted value at sea level is 100.0 C (student probably used an *“immersion thermometer” rather than non-immersion thermometer*)

How do we designate precision and accuracy in measurements?

* + We use \_\_\_\_\_ figures … also called significant \_\_\_\_\_ … which are numbers that are significant in the \_\_\_\_\_.
  + A scientist uses significant figures for several reasons
    - to \_\_\_\_\_ the amount of numbers used
    - to indicate the \_\_\_\_\_ of measurements obtained
    - to indicate the \_\_\_\_\_ of the measuring tool used

Significant Figures



* The bottom line …
  + significant figures are used to show that \_\_\_\_\_ are both accurate and precise
  + accurate based on the \_\_\_\_\_ measuring and the instrument is \_\_\_\_\_ to \_\_\_\_\_ standards
  + precise based on the measuring \_\_\_\_\_ used
* A precise measurement could be \_\_\_\_\_ ml
* All \_\_\_\_\_ digits are significant as part of the measurement.

Significant Figures when \_\_\_\_\_ …

* You are allowed \_\_\_\_\_ estimate

RULES for determining which numbers in a measurement are significant.

* The \_\_\_\_\_ significant figure or digit in a measurement can be an \_\_\_\_\_.
* Unless instructed otherwise, one should use all the precision possible on a measuring device plus \_\_\_\_\_ estimate (*one decimal place*).
* All of measurement numbers are considered \_\_\_\_\_ (*including the ONE* \_\_\_\_\_).

RULES for determining which numbers in a measurement are significant.

* All digits (*INTEGERS*) except zero are \_\_\_\_\_ considered to be \_\_\_\_\_ in a measurement
  + 433 🡪 \_\_\_ sig figs .1746 🡪 \_\_\_ sig figs
* Zeros are significant if they:
  + exist \_\_\_\_\_ two integers
    - 502 🡪 \_\_\_ sig figs .12304 🡪 \_\_\_ sig figs
  + \_\_\_\_\_ a number containing a \_\_\_\_\_
    - 20. 🡪 \_\_\_ sig figs .7000 🡪 \_\_\_ sig figs

Mathematical Operations 🡪 Addition & Subtraction

* Use the number of significant figures in the \_\_\_\_\_ precise measurement for the total.
* 1520 + 0.1 - 0.001 = 1520.099
* Which of our values is **least precise**? 1520, which has its last significant digit in the \_\_\_\_\_ place. Thus, our answer must be rounded to the tens place: \_\_\_\_\_.

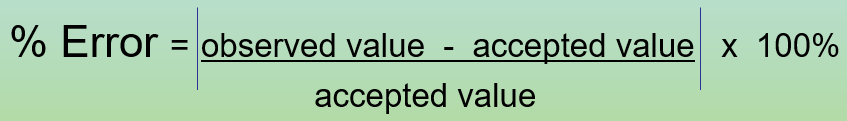
Mathematical Operations 🡪 Multiplication & Division

* When multiplying or dividing two or more numbers, count the significant figures in each of the original numbers.
* Take the smallest of the numbers of significant figures.
* The product or quotient will have that minimum number of significant figures.
* 0.048 m × 32.97 m = 1.58256 m2
  + Round to two significant figures because 0.048 has two: **1.6 m2** .
* 14570 kg ÷ 5.81 L = 0.19719 kg/L
  + Round to three significant figures because 5.81 has three. **0.197 kg/L**

How do we assess precision and accuracy in measurements?

We use \_\_\_\_\_ error

Percent error is a mathematical way of showing \_\_\_\_\_ and \_\_\_\_\_



3B Units of Measurement

V\_\_\_\_\_

* Volume is the amount of \_\_\_\_\_ a substance occupies.
* \_\_\_3 is used to find the volume of a \_\_\_\_\_ shaped solid
* \_\_\_\_\_
  + 1 L = 1000 ml
  + ↓ ↑ liters are the \_\_\_\_\_ unit and have a smaller \_\_\_\_\_
  + ↑ ↓ milliliters are the smaller \_\_\_\_\_ and have a \_\_\_\_\_ number
* W\_\_\_\_\_ d\_\_\_\_\_ can be used to find volume of \_\_\_\_\_ shaped objects.

Name three ways to measure volume

* \_\_\_\_\_ shaped objects … \_\_\_3
* \_\_\_\_\_ … \_\_\_
* \_\_\_\_\_ shaped objects … water \_\_\_\_\_ (\_\_\_)

M\_\_\_\_\_

* The mass of an object is the amount of \_\_\_\_\_ an object contains. A typical classroom uses a \_\_\_\_\_ beam \_\_\_\_\_ to measure mass in \_\_\_\_\_.
* 1 \_\_\_\_\_ (kg) is the basic SI unit of mass.

E\_\_\_\_\_

* The capacity to do \_\_\_\_\_ or to produce \_\_\_\_\_ is called energy.
* The SI unit of energy is the \_\_\_\_\_ (J)
* One \_\_\_\_\_ (cal) is the quantity of heat that raises the temperature of 1 g of pure water by 1°C.
* Conversions between joules and calories can be carried out using the following relationships.
  + 1 J = 0.2390 cal [see reference table 1]
  + 1 cal = 4.184 J
  + 1 \_\_\_\_\_ (KJ) = \_\_\_\_\_ joules
  + 1 kilocalorie (Kcal) = 1000 calories … “food calorie”

T\_\_\_\_\_

* A measure of the \_\_\_\_\_ \_\_\_\_\_ energy (\_\_\_\_\_) of molecules in a substance.
* Most people equate temperature with how “hot” or “cold” an object is. *But an Alaskan or an Egyptian would define hot and cold differently than you and I.*
* Most substances \_\_\_\_\_ with an \_\_\_\_\_ in temperature and \_\_\_\_\_ as the temperature \_\_\_\_\_. (e.g. sidewalks in winter versus summer).
* This explains how thermometers work (*the liquid inside expands & contracts*).

The SI (Metric) unit of temperature is the \_\_\_\_\_ scale, K, also known as the \_\_\_\_\_ temperature scale because it begins at \_\_\_\_\_ … equal to –273.15°C.

CONVERSIONS: \_\_\_ = º\_\_\_ + \_\_\_\_\_ º\_\_\_ = \_\_\_ - 273.15

º\_\_\_ = \_\_\_ º\_\_\_ + \_\_\_ ºC = 5/9(ºF-32)

D\_\_\_\_\_

* A measure of how tightly \_\_\_\_\_ matter is;
* Defined as an object's mass divided by its volume.

ρ = \_\_\_\_\_ 🡪 “d” is also fine

* Density and volume are \_\_\_\_\_ proportional: ↑ ↓
* If one keeps the mass the same, as the density \_\_\_\_\_, the volume the substance occupies \_\_\_\_\_.
* Density is an \_\_\_\_\_ property that depends only on the composition of a substance, not the size of the sample.
* The most dense substance (sinks/floats).



Calculating Density

***\_***

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*\_*

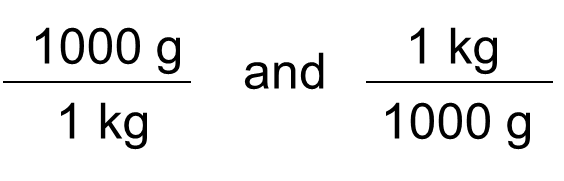
p =

m =

V =

You have been using dimensional analysis or f\_\_\_\_\_ l\_\_\_\_\_.

* We are constantly converting measurements according to units.
  + 1 U.S. dollars = 0.89 euros. For money we call it “exchange rate”.
* To convert units, we need to \_\_\_\_\_ out the unit we do not want, and leave the desired unit.



* We begin with \_\_\_\_\_. E.g. \_\_\_\_\_ g = \_\_\_ kg
* Create \_\_\_\_\_ Factors.

Conversion Factors

* Allow us to convert units
* Use equalities as a \_\_\_\_\_ of equivalent measurements
* The measurement in the numerator is \_\_\_\_\_ to the measurement in the denominator.
* Are \_\_\_\_\_ by “\_\_\_\_\_”

*Convert 2.4 kg to g*

2.4 ~~kg~~ x 103 g/~~1 kg~~ = 2.4 x 103 g