Units and Measurement

Scientific Notation

Scientific notation is used to write very large or very small numbers.

A decimal from 1 to less than 10 is written in from followed by a power of ten.

The power of ten comes from how far the decimal is moved from the original number to create the decimal.

Each time the decimal is moved left, your power of 10 goes up.

Each time the decimal is moved right, your power of 10 goes down.

Ex. $2300 = 2.3 \times 10^3$ Decimal moved left 3 spaces.

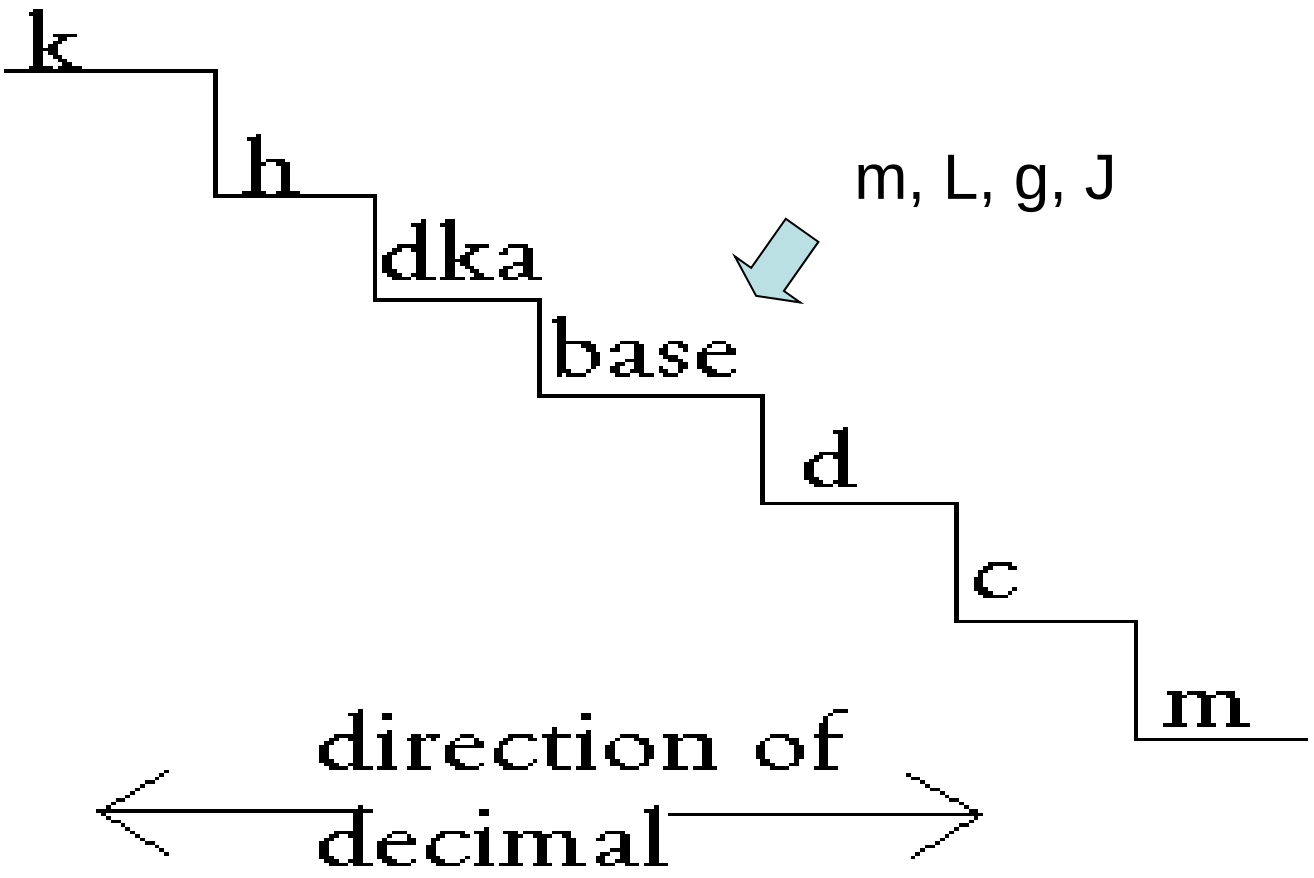
Math with Scientific Notation

- Adding and subtracting – must convert all numbers to the same power of ten before doing the operation.
- Ex $3x10^2 + 2x10^3 = 0.3x10^3 + 2x10^3 = 2.3x10^3$
- Multiplying and dividing – do normal math with the decimals out in front. If multiplying add powers of 10, when dividing subtract.
- Ex $3x10^2 + 2x10^3 = 6x10^5$

Metric System

- Used by most of the world
- Based on powers of 10
- Same prefixes for all measurements.
- Base units
  - Length – meter
  - Volume – Liter
  - Mass – grams
  - Energy – Joules
- Prefixes – milli, centi, deci, deka, hecto, kilo

Metric Ladder



Metric conversions

- Pick one of the larger unit and move the decimal one place for each step on the ladder.
- Ex 2.5hm = ?dm
- $2.5\text{hm} \times \frac{1000\text{dm}}{1\text{hm}} = 2500\text{dm}$
- 3 steps down the ladder from h to d, move decimal 3 steps to the right from 1 hm.

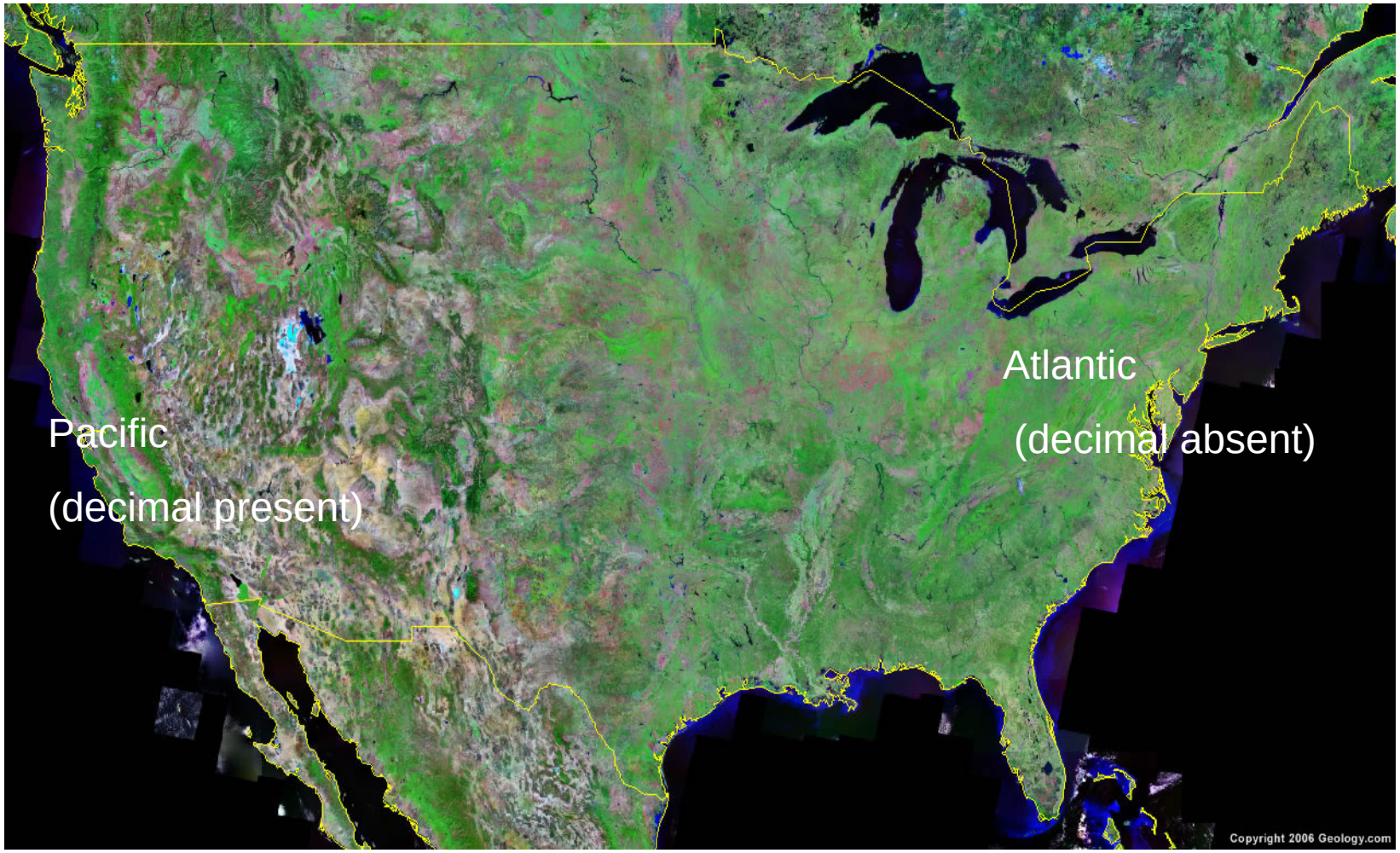
Dimensional Analysis

- Set up the math by looking at the units.
- Analyze the problem first.
  - Determine what unit and type you are starting with.
  - Figure out what unit you need to end with.
  - Think about what conversions will be necessary to get to final unit.
- Ex. 6.25 dm = ? ft
- Decimeters are metric units for length, feet is US unit for length (conversion is 2.54cm = 1in)
- $\frac{6.25\text{dm}}{1} \times \frac{10\text{cm}}{1\text{dm}} \times \frac{1\text{in}}{2.54\text{cm}} \times \frac{1\text{ft}}{12\text{in}} = 2.05\text{ft}$

Significant digits

- When you measure, you always estimate one decimal place past the scale.
- If your scale on your instrument goes to the ones place, then your measurement goes to the tenths place.
- That’s called the uncertainty.
- All numbers in your measurement are significant including the uncertain digit.
- Sig figs are necessary because they show how good you measurements and answers are.

Atlantic and Pacific Rule



Determining sig figs

- If a number has a decimal (present) start from the Pacific side of the number and don't count until you see the first non-zero number, then count everything after that (including zeros) until you reach the Atlantic side.
- 0.030507 = 5 sig figs (the 30507 part)
- If a number does not have a decimal written (absent) start from the Atlantic side and don't count until you hit your first non-zero number, then count everything after that until you reach the Pacific.
- 103000 = 3 sig figs (the 103 part)
- Conversion factors and exact counts have infinite sig figs.

Math with Sig Figs

- Addition and Subtraction – Your answer cannot have more decimal places then your number with the largest uncertainty.
- 3.25 + 4.689 + 1.2 = 9.139
- Largest decimal place is the 10ths place (1.2) so the answer is rounded to 9.1
- Multiplication and Division – Your answer cannot have more sig figs than the smallest number of sig figs in your measurements.
- 6.12 x 42.356 x 3.5 = 907.26552
- Least is 2 sig figs (3.5) so the answer is 910

Accuracy and Precision

- Accuracy is how close to the accepted value your measurements are (could be the average of your measurements if you have several)
- Precision is how close to each other your measurements are (whether you are getting the same thing every time)

Density

- Density is the relationship between mass and volume of a substance.
- It is a physical property that can be used to identify substances.
- Usually measured in grams per 1mL(g/mL).
- Substances with a lower density will float on substances with a higher density.
- Density is constant at a constant temperature regardless of how big your sample is.
- Density is a conversion factor to convert from mass to volume, so it can be flipped when doing dimensional analysis.