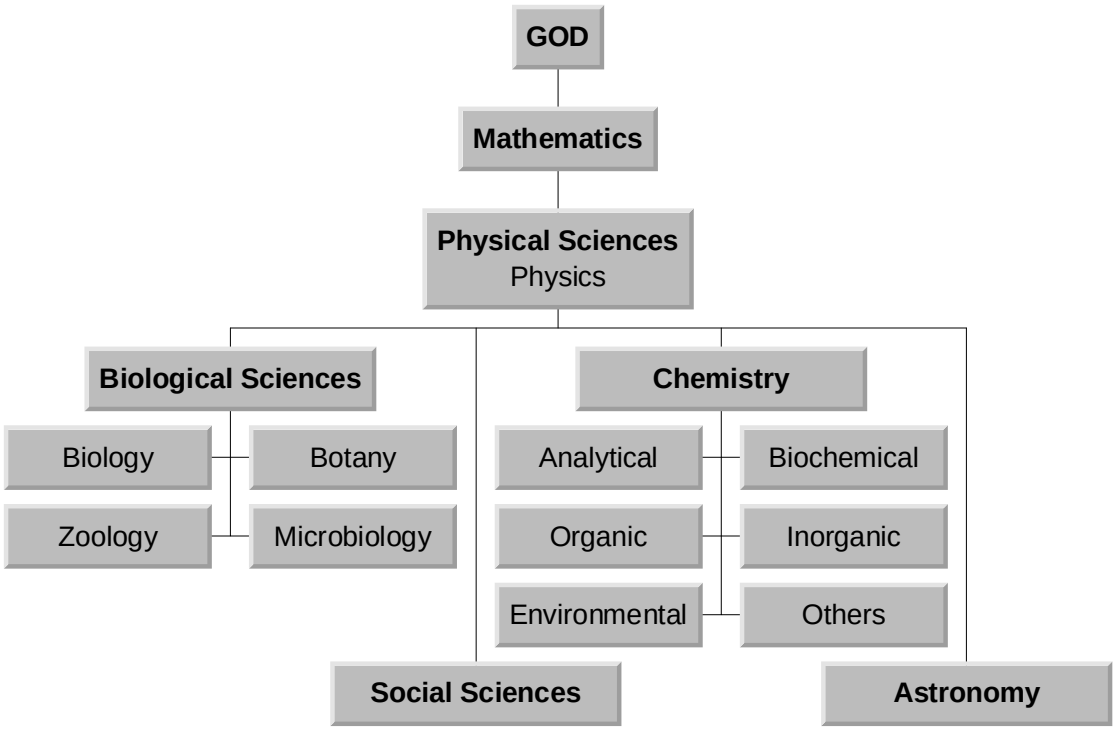
Chapter 1

Introduction to Chemistry

The Higharchy of Life



Science and the Scientific Method

Hypothesis - an educated guess

Theory - a widely tested and accepted hypothesis

Law - a summary of what is consistantly observed in nature

Scientific Method:

- ✓ **Pose a question about nature**
- ✓ **Gather information; do experiments**
- ✓ **Analyze information and/or data from experiments**
- ✓ **Formalize a hypothesis or law**
- ✓ **If hypothesis, repeatedly test for validity; may become a theory and eventually a law**

Uses and Limitations

Example Uses - physicians, meteorologists, pharmacuetical reserachers, forensic pathologists, chemical researchers, crime detectives.

Limitations - since science deals with the physical world, it is limited by the physical world.

Senses, logical thinking, communication abilities, objectivity, biases.

Problem:

Inability to deal with nonmaterial concepts.

What is love? **What happens after death?**

Is there a soul and if so, what is it?

Does God exist? **When does life begin?**

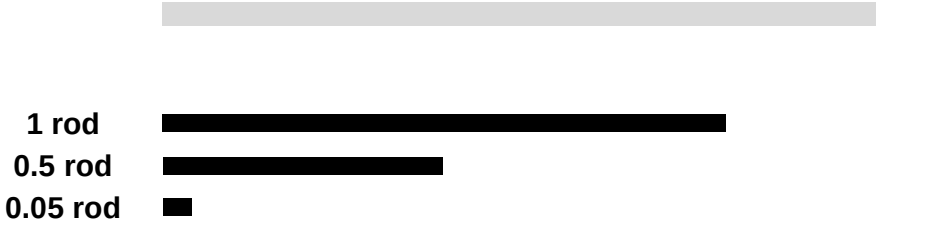
Is euthanasia acceptable under certain circumstances?

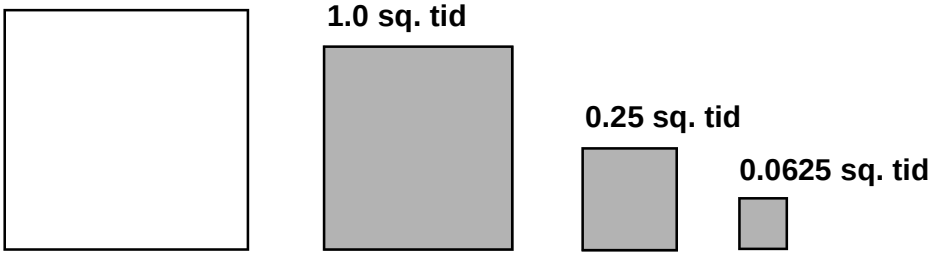
If and when is abortion acceptable?

What is right and wrong?

Significant Figures (Digits)

Sig Figs: has to do with how accurately you can measure something with a particular instrument or tool.





Rules for sig figs:

1) All nonzero numbers are significant

2) zeros are significant <u>EXCEPT</u> when

a) precede (before) the first nonzero number

e.g. 009126 4 sig figs 0.000123 3 sig figs

b) follow the last nonzero number and no decimal point is present

e.g. 912600 4 sig figs 0.00012300 5 sig figs

3) Other exception - <u>EXACT</u> numbers (usually when converting from one unit to another within a given unit system (e.g., within the metric system or within the English system)

example: 1 m = 100 cm

$$439.3\ \cancel{\text{cm}}\left(\frac{1\ \text{m}}{100\ \cancel{\text{cm}}}\right) = 4.393\ \text{m}$$

Rules (continued):

Addition and Subtraction

Limited to the least accurate measurement (fewest places to right of the decimal point).

417.28|916
+ 3.21|___
420.49|916 = 420.50

417.28 916
- 3.21|___
414.07|916 = 414.08

246.37|000
- 5.08|179
241.28|821 = 241.29

246.37 000
- 5.08|821
241.28|179 = 241.28

Multiplication and Division

Limited by term with least number of sig figs.

2.00 x 4.0 = 8.0 2 sig figs 8.00 ÷ 2.00000 = 4.00 3 sig figs

Rules (continued):

Rounding

1) If numbers to right of last sig fig place are > 5, round up (like normal).

e.g., 5.32 59 = 5.33

2) If numbers to right of last sig fig palce are < 5, round down (like normal).

e.g., 5.32 26 = 5.32

3) If numbers to right of last sig fig place are = 5, round to nearest even number (not like normal).

e.g. 5.32 50 = 5.32 5.31 50 = 5.32

Exponents and Scientific Notation

Any number can be expressed as a decimal times ten raised to an exponent (raised to a power).

e.g. $123 = 1.23 \times 10^2$ (same as 1.23×100)
$4{,}671{,}898 = 4.671898 \times 10^6$ ($4.671898 \times 1{,}000{,}000$)

If the exponent is > 0, then number in standard form is > 1. (exp indicates number of spaces decimal moved to left)

If the exponent is < 0, then number in standard form is < 1. (exp indicates number of spaces decimal moved to right)

e.g. $0.123 = 1.23 \times 10^{-1}$ (1.23×0.1)
$0.000123 = 1.23 \times 10^{-4}$ (1.23×0.0001)

Scientific notation is accurate way to show sig figs.

e.g. 47,500 4.75×10^4 4.7500×10^4

Rules for sig figs also apply to the decimal portion of numbers in scientific notation.

Exponent math:(understanding what the calculator is doing)
Multiplication and Division

$(3.6 \times 10^3)(4.0 \times 10^{-1}) = 1.440 \times 10^3$ (correct is 1.4×10^3)

1) take decimal parts and multiply together
$3.6 \times 4.0 = 14.40$ (same as 1.440×10^1)

2) add the exponents together
$(10^3 \times 10^{-1}) \equiv (3 + (-1)) = 2 \equiv 10^2$ or 1×10^2 (exact #)

3) multiply the results of 1 & 2 and use correct sig figs
$(1.4 \times 10^1)(1 \times 10^2) = 1.4 \times 10^3$ (same as 1400)

Multiplication and Division (continued)

$(3.6 \times 10^3) \div (4.0 \times 10^{-1}) = 9.0 \times 10^3$

1) take decimal parts and divide
$3.6 \div 4.0 = 0.90$ (same as 9.0×10^{-1})

2) subtract the exponents from each other
$(10^3 \div 10^{-1}) \equiv (3 - (-1)) = 4 \equiv 10^4$ or 1×10^4 (exact #)

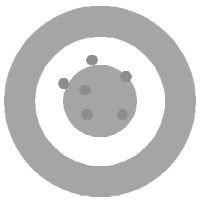
3) multiply the results of 1 & 2 and use correct sig figs
$(9.0 \times 10^{-1})(1 \times 10^4) = 9.0 \times 10^3$ (same as 9000)

Addition and Subtraction
Do it long hand or let the calculator do it.

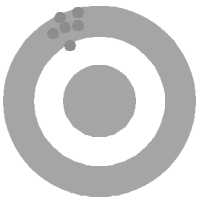
Accuracy and Precision

Accuracy - how close a measurement is to the true value.

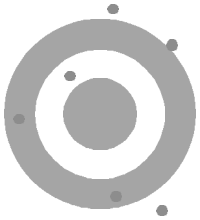
Precision - how closely you can reproduce a measurement.



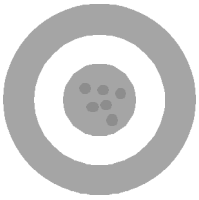
Good Accuracy
Poor Precision



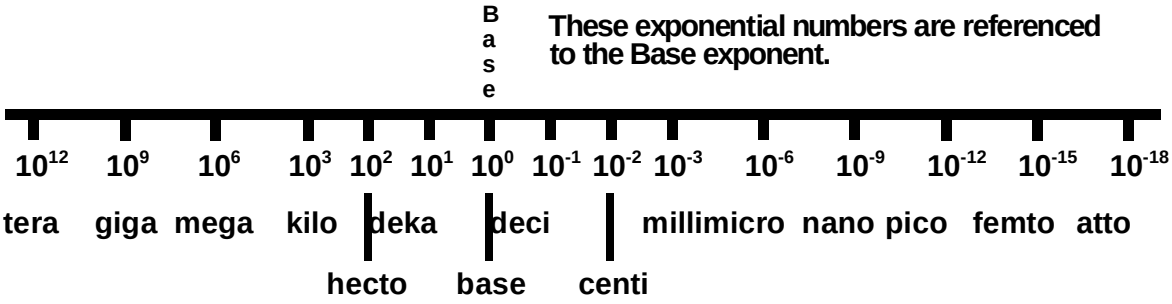
Poor Accuracy
Good Precision



Poor Accuracy
Poor Precision



Good Accuracy
Good Precision



Conversion Equalities (conversion factors) -

Examples:

1 kilometer (km) = 10^3 meters (m) (1 km = 1000 m)

1 millimeter (mm) = 10^{-3} m (1 mm = 0.001 m)

same as saying 1 mm is 1/1000 th of a meter

Can also express as 10^3 mm = 1 meter (1000 mm = 1 m)

$$1000 \cdot 1\ \text{mm} = \frac{1}{\cancel{1000}}\ \text{m} \cdot \cancel{1000}$$

$$1000\ \text{mm} = 1\ \text{m}$$

Converting Units

Factor - Label Method (or Unit Analysis)

- Identify initial units
- Identify desired final units
- Determine conversion factor needed to change from initial to final units or to an interim unit(s) then final unit
  - Generate a unit map to show sequence of conversions
  - Make sure you know a conversion factor for each step
- Write down initial value then multiply by appropriate conversion factor(s) to change to desired units
- Calculate the answer making sure the units and significant figures are correct

Make sure units work out first then numbers!

Factor - Label (continued)

Examples:

Convert 15.6 miles to kilometers.

***Initial Units*: miles**

***Final Units*: km**

***Conversion Factor(s)*: 1.61 km = 1 mile**

Will use in one of two forms dependent on initial units -

$$\frac{1.61\ \text{km}}{1\ \text{mile}} \quad \text{or} \quad \frac{1\ \text{mile}}{1.61\ \text{km}}$$

***Map out conversion*: miles km**

***Write intial units and perform conversion(s)*:**

$$\frac{15.6\ \text{miles} \mid 1\ \text{mile}}{\mid 1.61\ \text{km}} \quad \text{or} \quad \frac{15.6\ \cancel{\text{miles}} \mid 1.61\ \text{km}}{\mid \cancel{1\ \text{mile}}}$$

***Calculate answer*: 15.6 x 1.61 km = 25.116 km 25.1 km**

Make sure units work out first then numbers!

Factor - Label (continued)

Examples:

Convert 15.6 mi to meters.

***Initial Units*: mi**

***Final Units*: m**

***Conversion Factor(s)*: 1.61 km = 1 mi; 1 km = 10^3 m**

***Map out conversion*: miles km m**

***Write intial units and perform conversion(s)*:**

$$\frac{15.6\ \cancel{mi} \mid 1.61\ \cancel{km} \mid 1000\ m}{\quad\quad\ \ 1\ \cancel{mi} \quad\ \ 1\ \cancel{km}}$$

***Calculate answer*: 15.6 x 1.61 x 1000 m = 25116 <u>25100</u> m**

✪ **Let's do some more:**

1) 345 g to micrograms (*μ*g) **2) 9056 J to kJ**

3) 6.3 x 10^{-2} L to quarts **4) 3 cups to nanoliters (nL)**

Specific Units of Measurements

Mass

Mass is the amount of matter in an object, <u>NOT</u> the weight of the object. Weight deals with gravitational attraction.

Metric system - grams

Length

Metric system - meters

Volume

Related to length cubed, e.g., m^3

Metric system - liters (note: 1 mL = 1 cm^3 or cc)

✪ **How many cc in one m^3?**

Density

The amount of mass of an object divided by its volume.

Density = mass / volume

Metric system - g/mL (liquids) or g/cm^3 (solids)

Units (continued)

Table 2.3 Densities	
mercury	13.6 g/mL
lead	11.3 g/cm^3
iron	7.86 g/cm^3
iodine	4.93 g/cm^3
diamond	3.52 g/cm^3
table salt	2.17 g/cm^3
bone	1.80 g/cm^3
chloroform	1.48 g/mL
whole blood	1.06 g/mL
water	1.00 g/mL
ethyl alcohol	0.79 g/mL
ethyl ether	0.71 g/mL
octane	0.70 g/mL

Specific Gravity
Density of a substance divided by the density of water

$$\frac{\text{density of a substance}}{\text{density of water}}$$

What units?

Energy
Energy is the ability to do work. It is absorbed or given off during motion of or changes in matter. Heat is what is felt when energy flows from a hot object to a cooler one.

Two types of energy: kinetic and potential
- **Kinetic energy is the energy of motion. Potential energy is the energy stored in a substance or object.**
- **Metric system - Joule (J), also used is calorie (cal)**
  - **<u>Not</u> the calorie you are thinking of, that would be dietary <u>C</u>alories (big C calories or Cal).**

1 cal = 4.184 J 1 kilocalorie (kcal) = 1 Cal = 1000 cal

✪ **Three Chips Ahoy Cookies contain 164 Cal. What is the energy expressed in Joules?**

Basal Metabolic Rate (BMR)
BMR is the energy expenditure required for normal metabolic function.

For men = 1 Cal / (kg bodyweight x hr)
For women = 0.95 Cal / (kg bodyweight x hr)

✪ **How many Calories does a 185 lb man need per day?**

For a person to maintain their present bodyweight, their activity level must be considered. If sedentary, add 30% more Calories. If active, add 40%. If very active, add 50%.

Daily Caloric Intake = BMR (Cal / day) x 1.30 (1.40 or 1.50)

From above, Caloric intake for an active man is

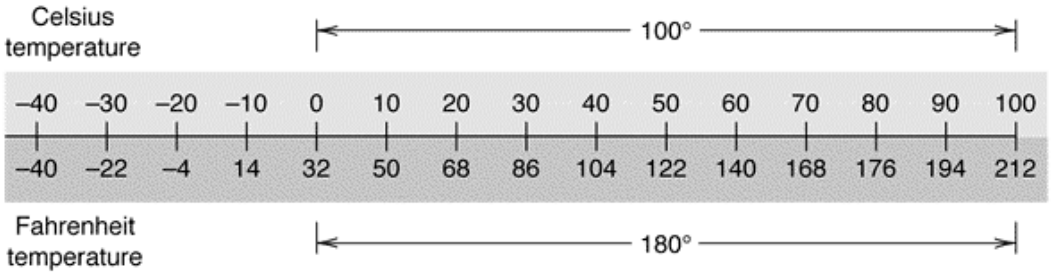
Eating Disorders
bulimia - binge eating followed by purging (vomiting)
subtype: exercise bulimia - eat then perform excessive exercise to compensate for Calories eaten.

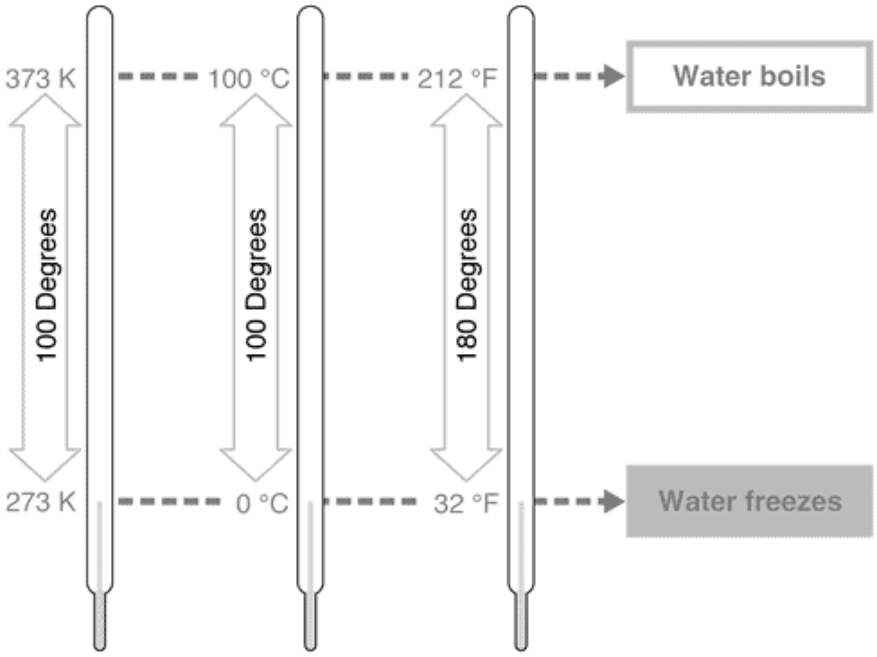
anorexia nervosa - psychological disorder based on a phobia (or fear) of gaining weight. This disorder is characterized by avoidance of eating and purging if they do eat.

Temperature
Temperature is a measure of the average kinetic energy of a system or substance. It is a measure of <u>intensity</u> of the energy. A change in temperature is a measure of energy (or heat) flow between two systems or objects.
Metric system - Celsius (centigrade) (C)
Absolute scale - Kelvin (K)
English system - Fahrenheit (F)

C + 273 = Kelvin C = (F -32)/1.8 F = (C x 1.8)+32

✪ What is normal body temperature in Celsius?





✪ A patient has a fever of 103.4 F. What is this expressed in Celsius and Kelvin?

Time
Standard unit in all unit systems is seconds (s)