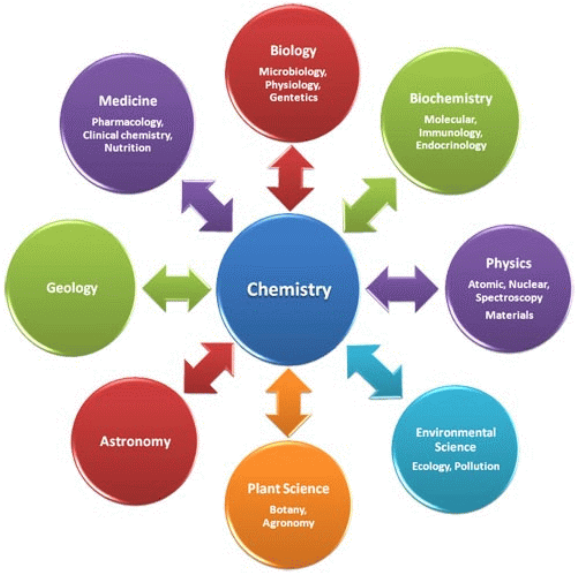
GENERAL CHEMISTRY

Why Study Chemistry?

- learn fundamental physical laws
- develop problem solving skills
- gain technical perspective on current events

The Central Science



Major Divisions

- **biochemistry**
  study of biological compounds

- **organic chemistry**
  carbon based compounds

- **inorganic chemistry**
  all other elements

- **analytical chemistry**
  methods of analysis

- **physical chemistry**
  theory and concepts

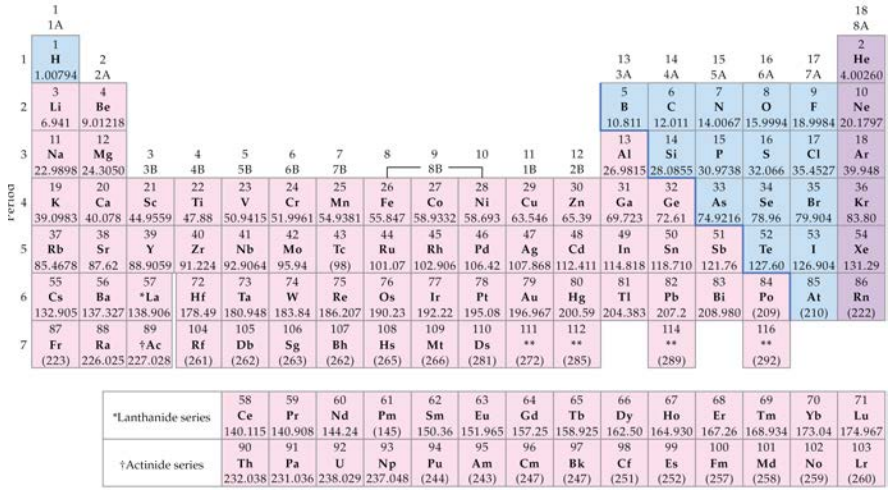
Chemistry .....

the study of matter &
the changes it undergoes

- **These changes are called chemical reactions**

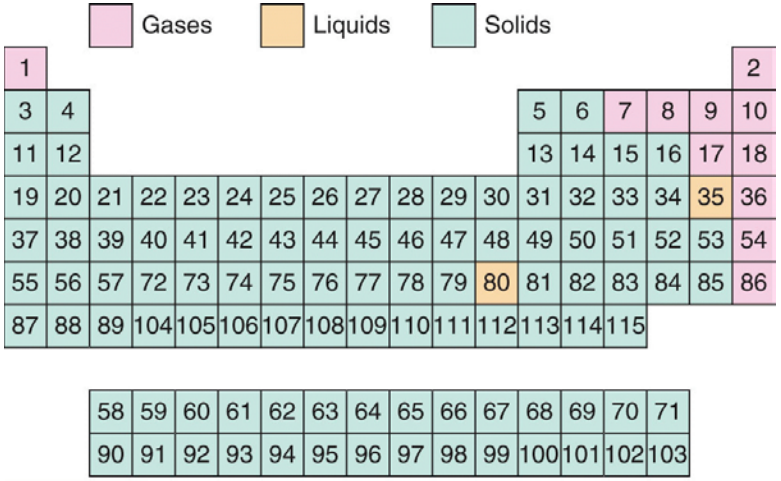
- **Elements: atoms & molecules**
- **Compounds: molecules**

Periodic table of elements



	1 1A																18 8A
1	1 H 1.00794	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.00260
2	3 Li 6.941	4 Be 9.01218											5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
3	11 Na 22.9898	12 Mg 24.3050	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9381	26 Fe 55.847	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.76	52 Te 127.60	53 I 126.904	54 Xe 131.29
6	55 Cs 132.905	56 Ba 137.327	57 *La 138.906	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.025	89 †Ac 227.028	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 ** (272)	112 ** (285)		114 ** (289)		116 ** (292)		

*Lanthanide series	58 Ce 140.115	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
†Actinide series	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)



- **Most elements are solids at normal temperatures**

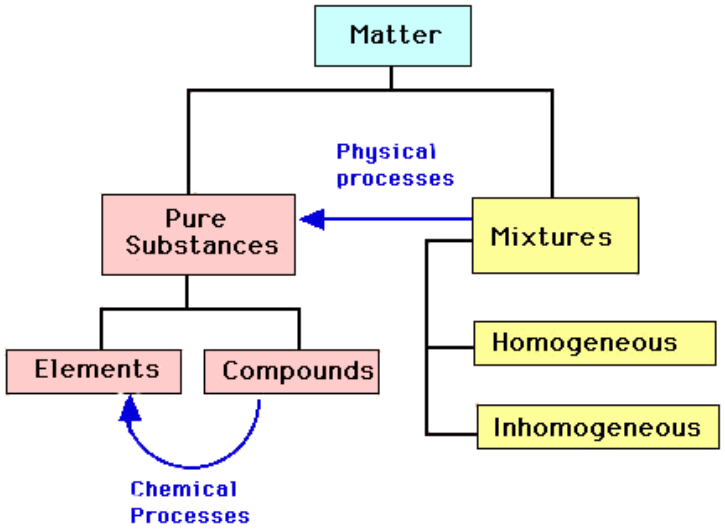
➢ **1 oz silver dollar coin contains**
160,000,000,000,000,000,000,000 atoms of silver

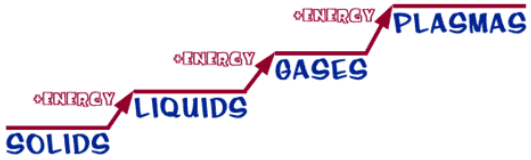
What are atoms made of?

Matter & Energy

Matter ◆ **Anything that occupies space and has mass**

Mass ◆ **Measures the amount of matter an object contains**





States of matter

Math Review (append 3)

1. **Exponents/Scientific noatation**
2. **Ratios and Proportions**
3. **Percentage (%)**

Read this link – required reading:

www.shodor.org/unchem/math/index.html

Origins of Chemistry

technological (or factual)
philosophical (or theoretical) **Ancient Greeks**

First to formulate theories explaining behavior of matter principles

first humans, antiquity

⇨ **chemical changes such as Cook food, baked pottery,,smelted ores**

Others ⇨ **fermentation, dyes, drugs from plants**

All possible without knowing scientific principles

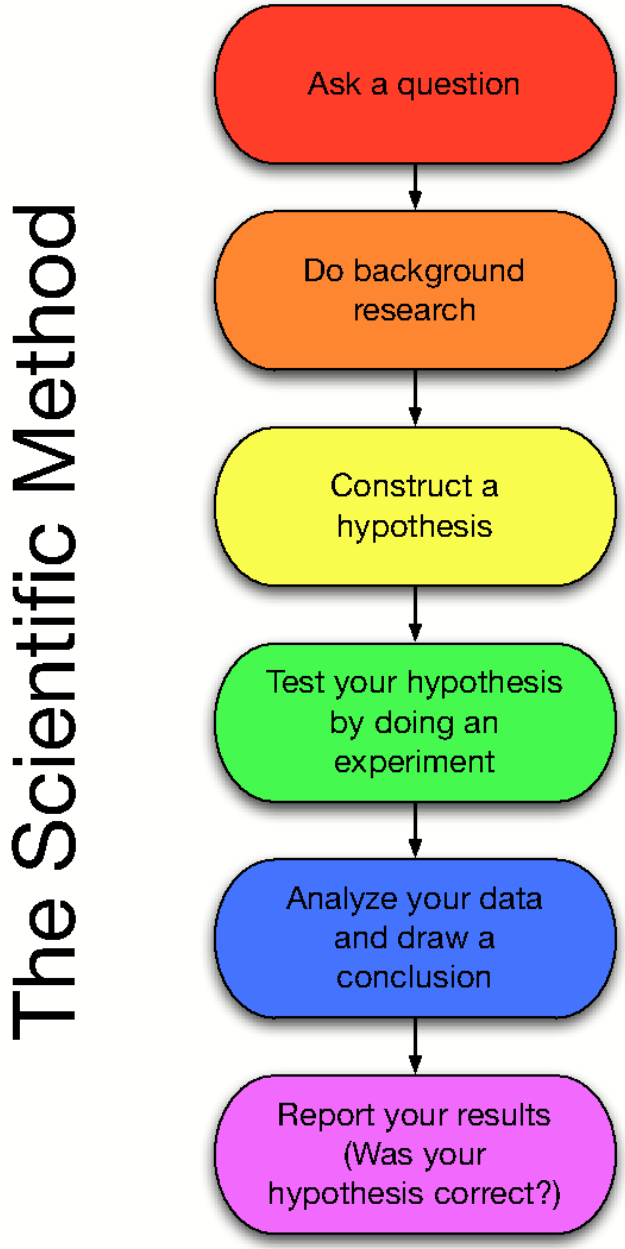
Objectives of alchemy

Alchemy
⇓
New discoveries
⇓
Modern science

- **To find the panacea**
  - medicine to cure illness & diseases
- **To find the elixir of life**
  - immortality
- **Transmutation**
  - convert "base metals" to gold

The Scientific Method

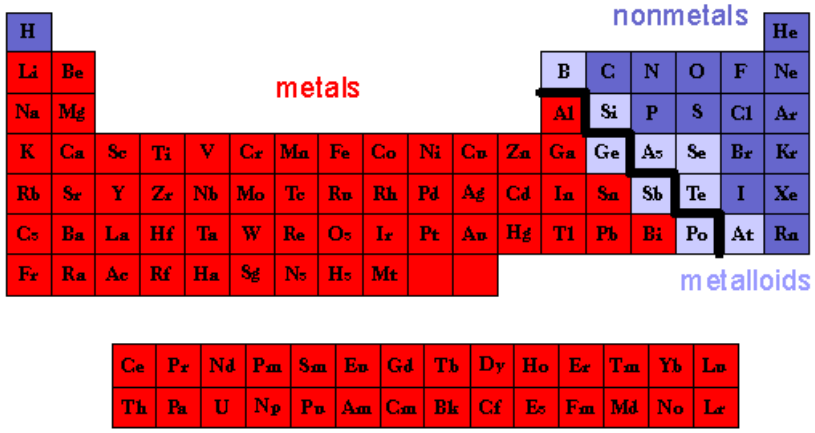
Process used to develop laws and theories



Elements arranged in Periodic Table

- May be metals, nonmetals, metalloids

Pure substances that can't be broken down in simpler substances



- Each element assigned a unique symbol
- Each is 1-2 letter; first letter capitalized
- Symbol may not match name;
  May be based on different name

Know symbols for first 36 elements; plus others we discuss

Also see table 1.1 page 6

Measurements, Units, Significant Figures

English System
Metric System

Metric (Decimal) System

French Revolution (1800)

meter ⇨
“one-ten-millionth the distance from the equator to North Pole”

Volume ⇨ liter
Mass ⇨ kilogram
Time ⇨ second

In science:
use SI units
(mostly metric)

Metric units:
1 base unit for each measurement type

Use prefixes to change size of units

Metric/SI units table 1.2

Type	Name	Symbol
Mass	gram	g
Length	meter	m
Volume	liter	L
Energy	joule	J
Temp	Celsius	°C
Amount	Mole	mol

Metric/SI system

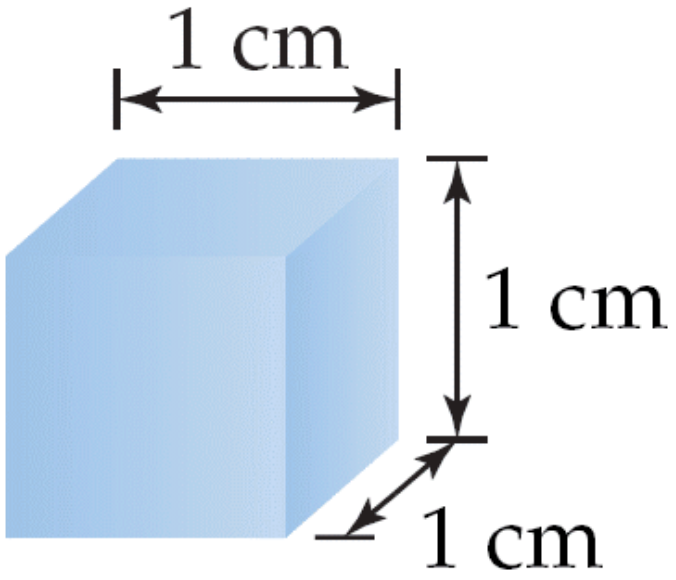
Prefix	Symbol	Factor
mega	M	10^{6}
kilo	k	10^{3}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

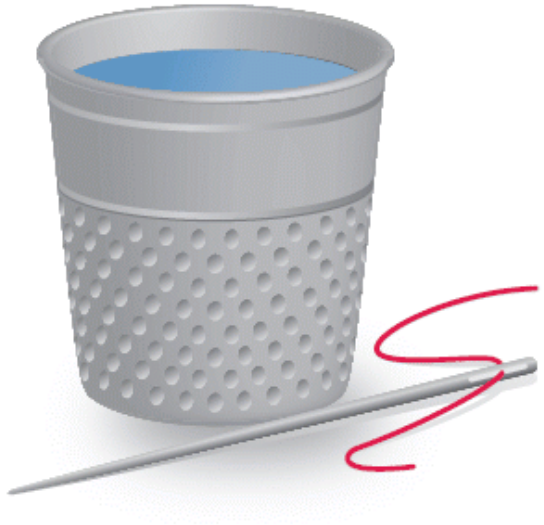
Also tera-, giga-, pico-

see table 1.3, p10

Volume tricky

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





Converting between units

English ⇔ English
English ⇔ Metric
Metric ⇔ Metric

Dimensional Analysis

How many miles in 50 kilometers?

Need conversion factor

0.62 miles = 1 kilometer

There are 0.62 miles per 1 km or.....

$$\frac{0.62 \text{ miles}}{1 \text{ km}}$$

To convert: multiply given quantity by conversion factor

$$\text{Miles} = 50 \text{ km} \times \frac{0.62 \text{ miles}}{1 \text{ km}}$$

$$= 31 \text{ miles}$$

Make sure end up with right units

How much is gold worth?
Mass = 290 kg
$1,200 per oz

kg → lb → oz → $

$$290\ \text{kg} \times \frac{1\ \text{lb}}{0.45\ \text{kg}} \times \frac{16\ \text{oz}}{1\ \text{lb}} \times \frac{1{,}200\ \text{dollars}}{1\ \text{oz}}$$

= 12,373,330 dollars

≈$12 million

Significant Figures

Read: Section 1.6

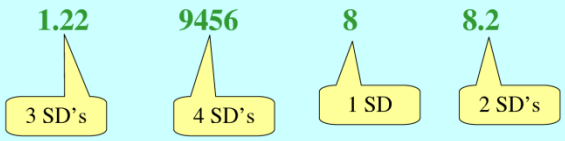
- **Numbers important in science**
- **Used in measurements or counting objects**
- **Measured - measurement tool gives level of significance or accuracy**
- **Counted - all digits are significant**

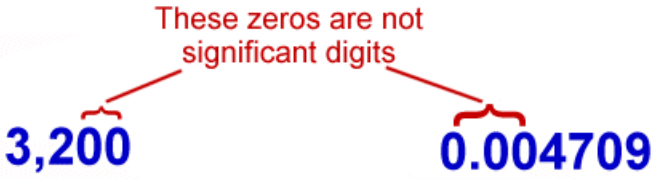
- **Example Area of rectangle 10.5 inch long & 6.401 inch wide**
  - **Answer 67.2105 inch^2**
- **Can't get answer more accurate than the numbers used in measurement**
  - **Correct Answer 67.2 inch^2**
- **This is Rounding off**

Last digit uncertain, but significant

Significant Digits

All non-zero digits are significant





Scientific Notation

- $123{,}000{,}000 = 1.23 \times 10^{8}$

mantissa x base^{power}

Scientific Notation

- **$123{,}000{,}000 = 1.23 \times 10^{8}$**

  mantissa x base^{power}

  mantissa: >1 and <10

Calculators

Most calculators use scientific notation for large or small numbers
Know how to use your calculator!!

- **Display varies with model**
  May be x 10^n or with an E
- **Usually have a button to enter exponent**

Temperature

Measure of heat energy
Three common scales used

Fahrenheit to Celsius formula

$$F = C \cdot \frac{9}{5} + 32$$

Celsius to Fahrenheit formula

$$C = (F - 32) \cdot \frac{5}{9}$$

Kelvin Scale

SI unit K = °C + 273

°C = K − 273

Density

- **Density = $\frac{\text{Mass}}{\text{Volume}}$**

- **Lead is a "heavy" metal**
  Aluminum is a "light" metal

Density is a characteristic property of a substance.

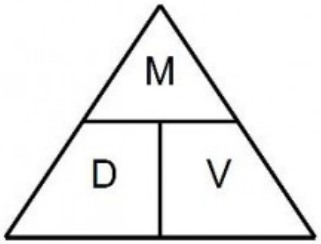
Common units are g / cm^3 or g / ml. (cm^3 = ml)

Material	Density (g/cm^3)
gold	19.3
mercury	13.6
lead	11.3
silver	10.5
aluminum	2.7
rubber	1.1
water	1.0
cork	0.24
air	0.0013

$$D = \frac{M}{V}$$

$$M = D \times V$$

$$V = \frac{M}{D}$$



Density

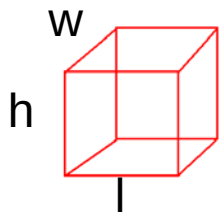
What is the density of 5.00 mL of salt water if it has a mass of 5.23 grams?

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{density} = \frac{5.23\ \text{g}}{5.00\ \text{mL}}$$

density = 1.05 g/mL

How do you determine the volume of a regular object..... a cube?



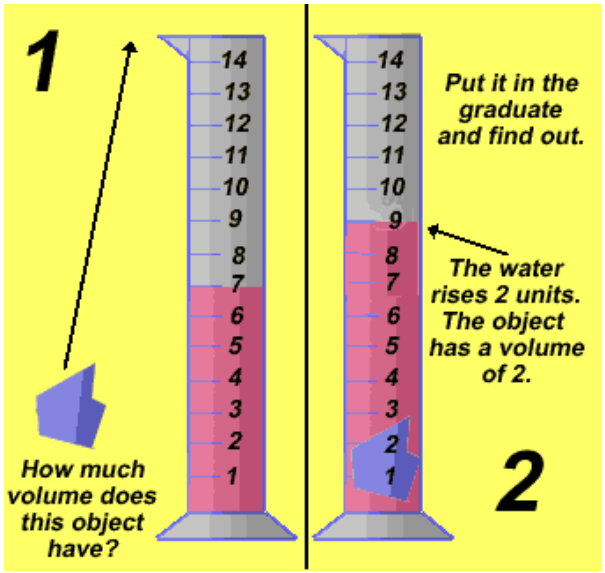
If l = w = h = 2 cm

volume = 20 cm x 20 cm x 20 cm

= 8000 cm^3

Measuring the density of irregular objects - a rock?

Use water displacement



Properties of Matter

Extensive properties: Eg Mass

Depends on how much matter present

Intensive properties: Eg Bp

Does not depends on how much matter present

Physical Properties

Characteristics that can be evaluated without changing the composition of a material

Examples

Color **Taste** **Odor** **Feel**

Density **Melting/boiling point** **Compressibility**

Mp 1063 °C
Density 19.3 g/cm^3

Chemical Properties

Characteristics that result in a change in the composition of a material

This is called a chemical reaction

And produces a chemical change Eg rusting, combustion

Chemical reactions are described with chemical equations

$H_2 + O_2 \Rightarrow H_2O + heat$

Wood + oxygen ⇨ carbon dioxide + heat + smoke

Reactants ⇨ products

Reactants and products can be very different

No change in composition
Chemical nature of components unchanged
Examples melting, boiling, cutting, bending

Ask: Has the composition of the substance changed?
Are these chemical or physical changes – or both?
milk turning sour, making wine, ice melting, Coke going flat, sugar dissolved in water, water boils