Introduction to Chemistry

Chapters 1 & 3

Introductory Chemistry 1

The Basics

- **Chemistry** is the study of **matter**, its interactions and reactions, and the **energy** associated with those processes.

- **Matter** is substance that has mass and volume – all of the objects around us.

- **Energy** is the potential or capacity to move or change matter.

Alchemy

- Alchemy was the earliest attempts to practice chemistry as a “science”.
- Alchemists attempted to change cheap metals into gold, among other things.

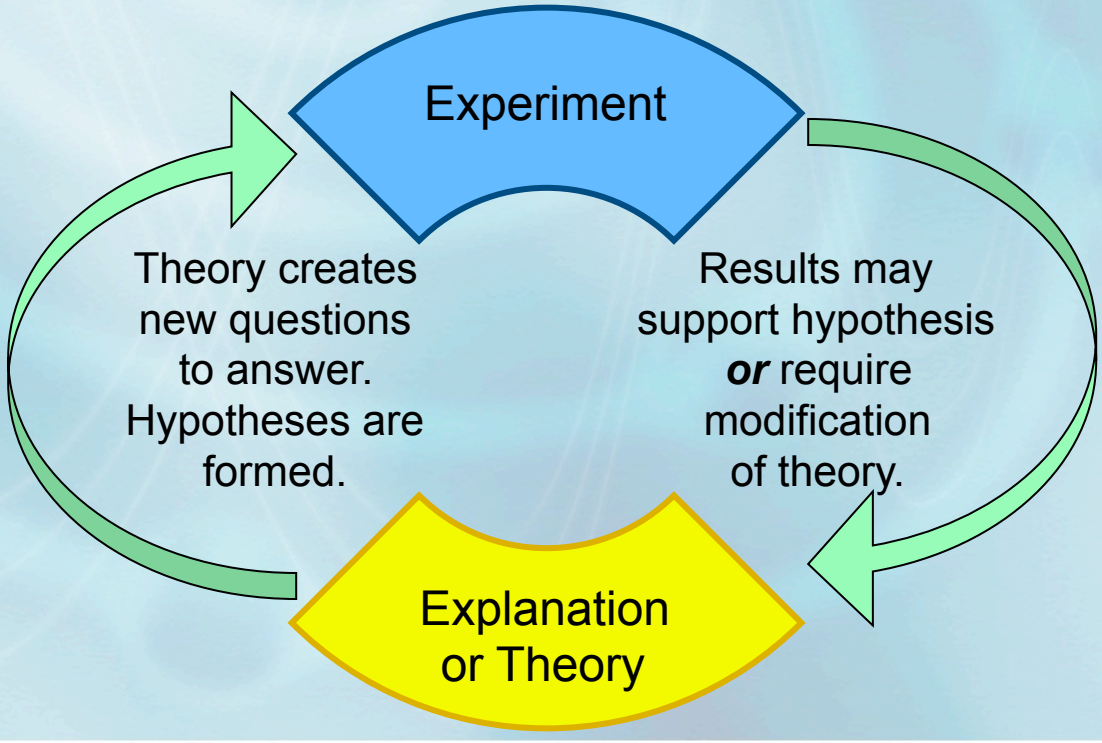
Modern Chemistry

- Modern Chemistry is generally considered to have begun with the work of Antoine Lavoisier in the late 18th Century.
- Lavoisier was one of the first chemists to use **quantitative measurements** in chemistry.
- Lavoisier was an **experimentalist** – testing his theories in the physical world, rather than simply arguing them philosophically.

Scientific Method

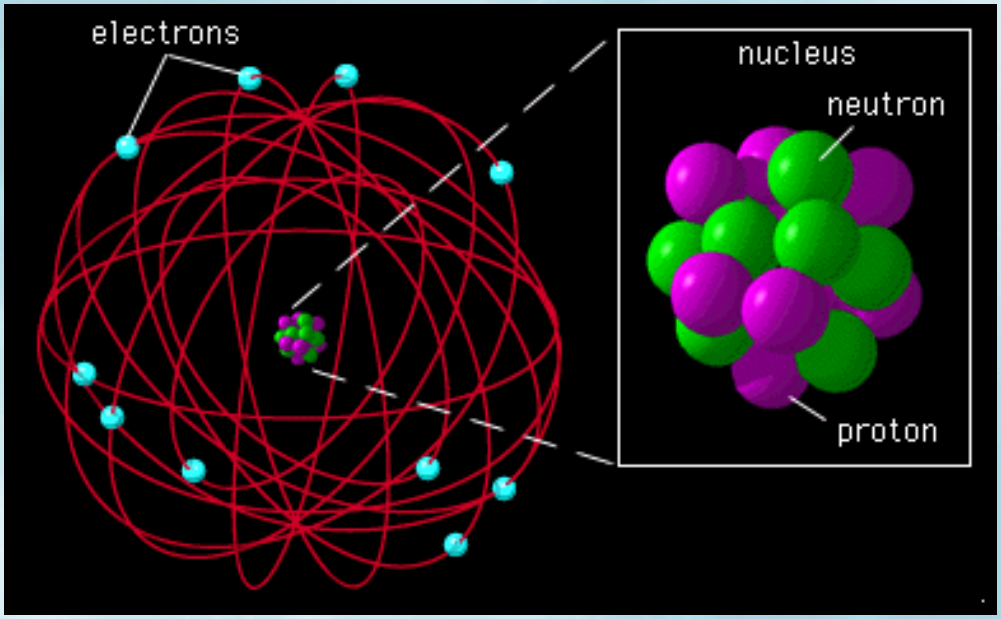
- Lavoisier was one of the first chemists to apply a modern **Scientific Method** to his work.
- The scientific method is a cyclical process of **experimentation** - controlled observation and explanation to increase understanding about the universe:

Scientific Method:



The Modern Model of the Atom

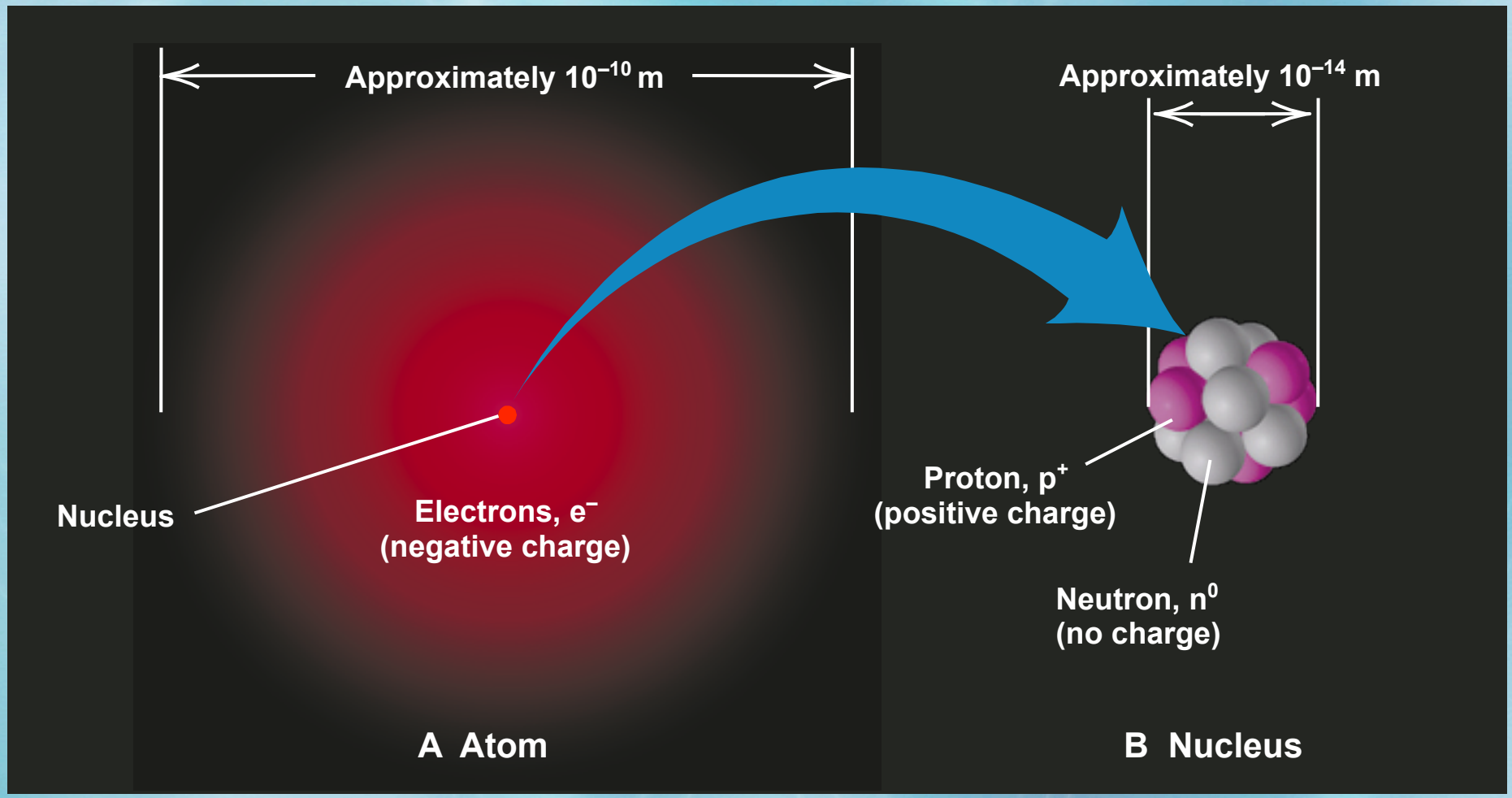
Particle	Mass
Electron	9.11×10^{-31} kg
Proton	1.67×10^{-27} kg
Neutron	1.67×10^{-27} kg



Atoms are made up of three subatomic particles:

Proton (p^+):	Positively charged subatomic particle found in the nucleus of the atom.
Neutron (n^0):	Neutral subatomic particle found in the nucleus of the atom.
Electron (e^-):	Negatively charged subatomic particle found outside the nucleus.

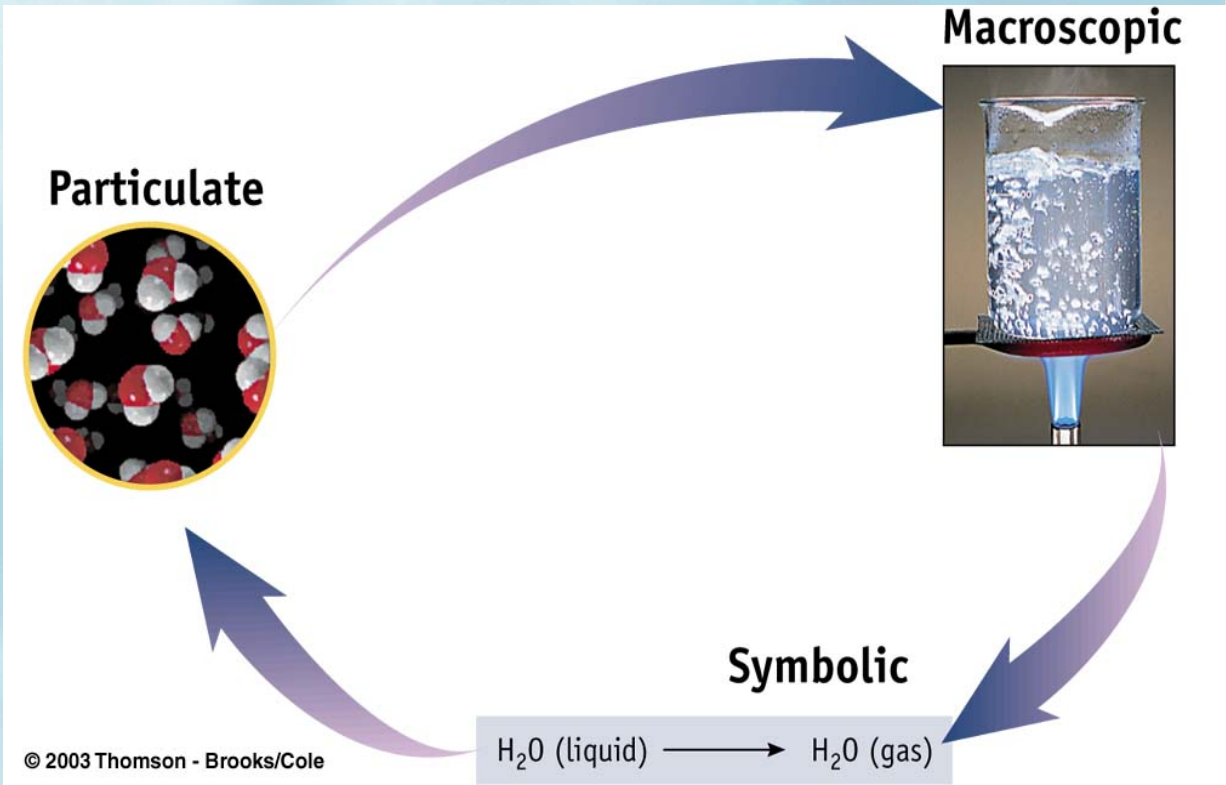
The Modern Model of the Atom



Macroscopic vs. Microscopic vs. Particulate

- **Macroscopic:** large scale, amounts generally seen with the naked eye. This is how we usually observe natural phenomena.
- **Microscopic:** small scale, amounts or sizes that cannot be seen without some sort of magnification aid (Biology / Electronics).

- **Particulate:** Atoms, molecules, and ions. Cannot be visualized with a light microscope. Generally represented with models.



Periodic Table of the Elements

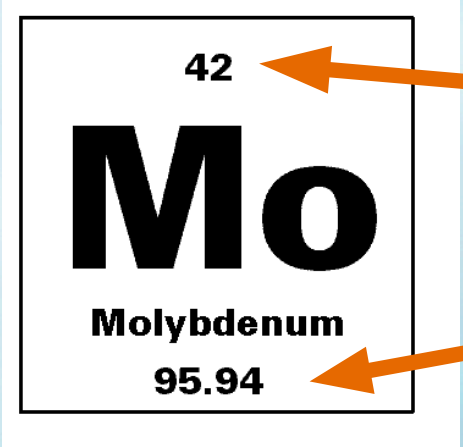
1 IA 11A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 168.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Lanthanide Series	57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Periodic Table

- The **periodic table** organizes the **elements**, by their atomic number (Z) and by repeating, or periodic, properties.
- Elements in the same family or group (column) share similar properties.
- Now, between 114 & 118 elements are known, 90 of which are naturally occurring. The rest have been prepared in a laboratory.

Interpreting an Element Box on the Periodic Table



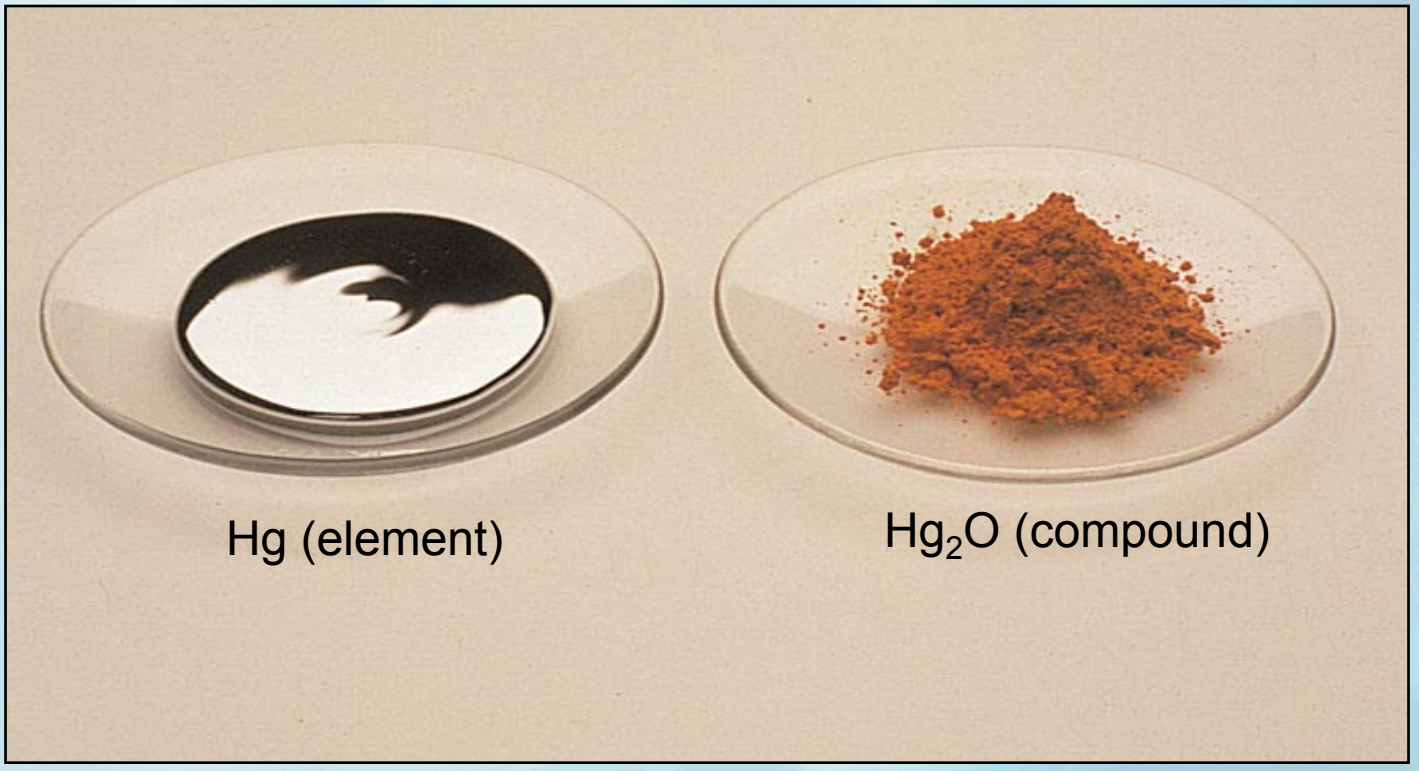
Atomic Number (Z = # protons)

Average Atomic Mass
(amu or g/mol)

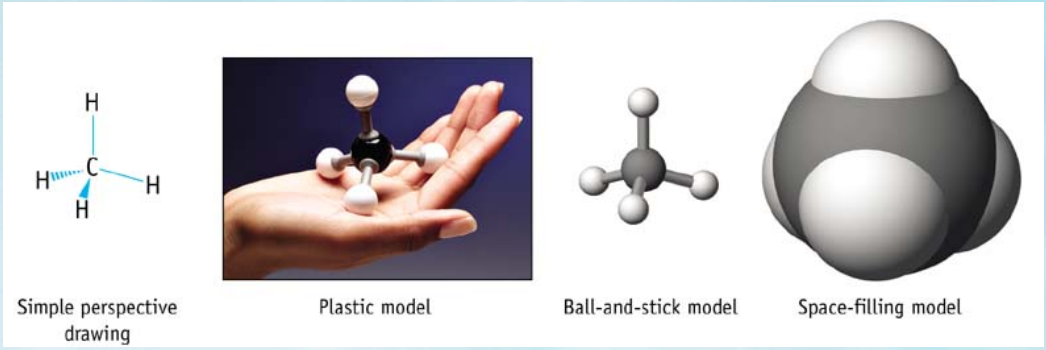
Elements

Compound formation

When elemental mercury is heated in air - where oxygen gas is present - Mercury (I) oxide is formed.

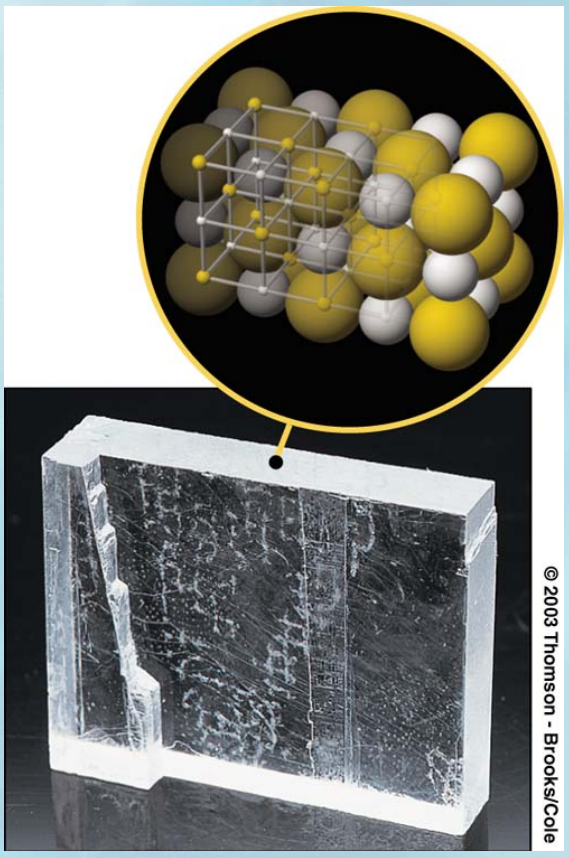


Methane (CH_4) molecule

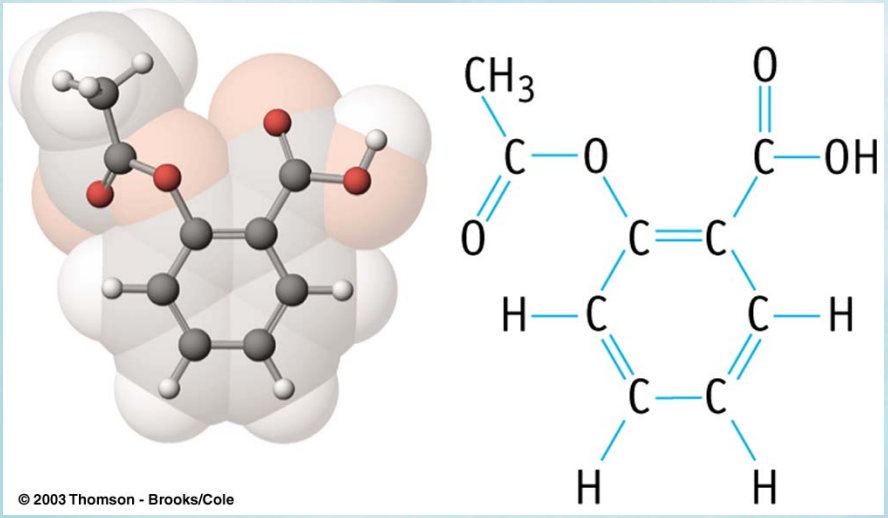


NaCl crystal

- There are no molecules of NaCl.
- The formula unit NaCl is the smallest ratio of Na^+ and Cl^- ions

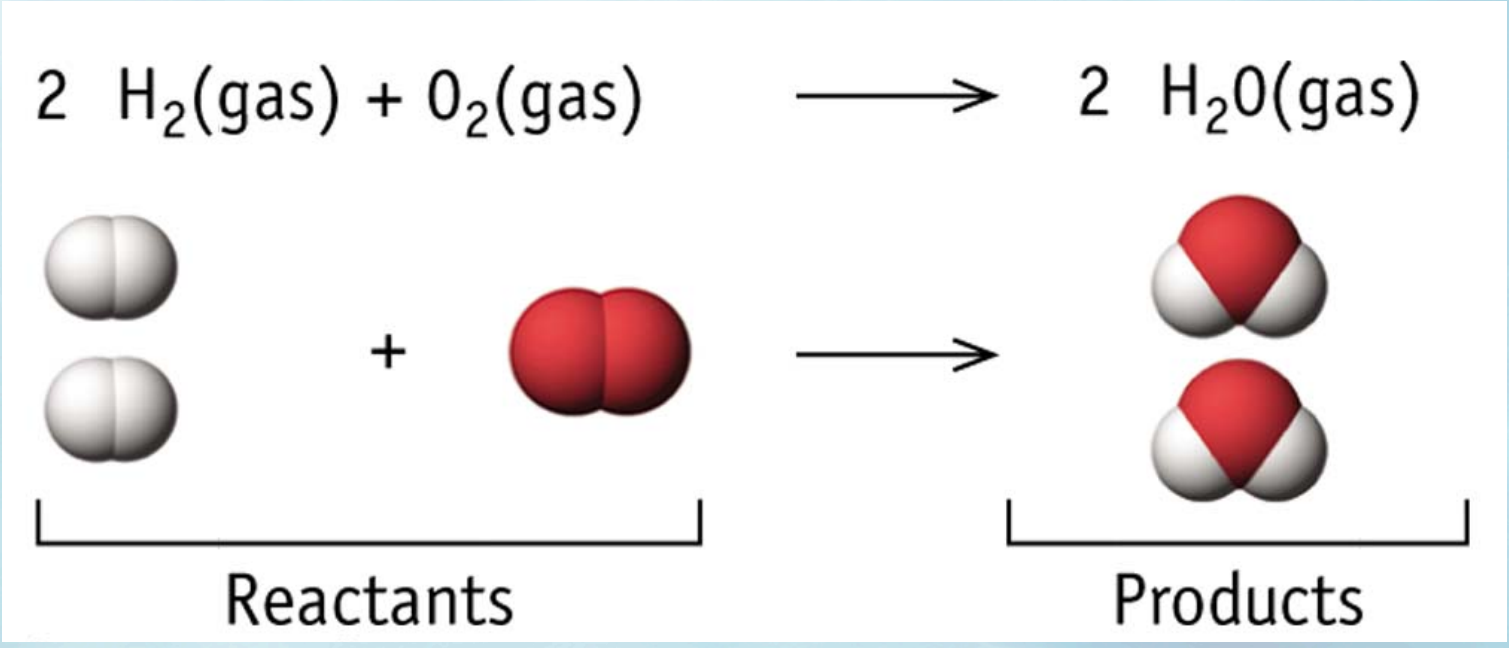


Aspirin ($C_9H_8O_4$) molecule

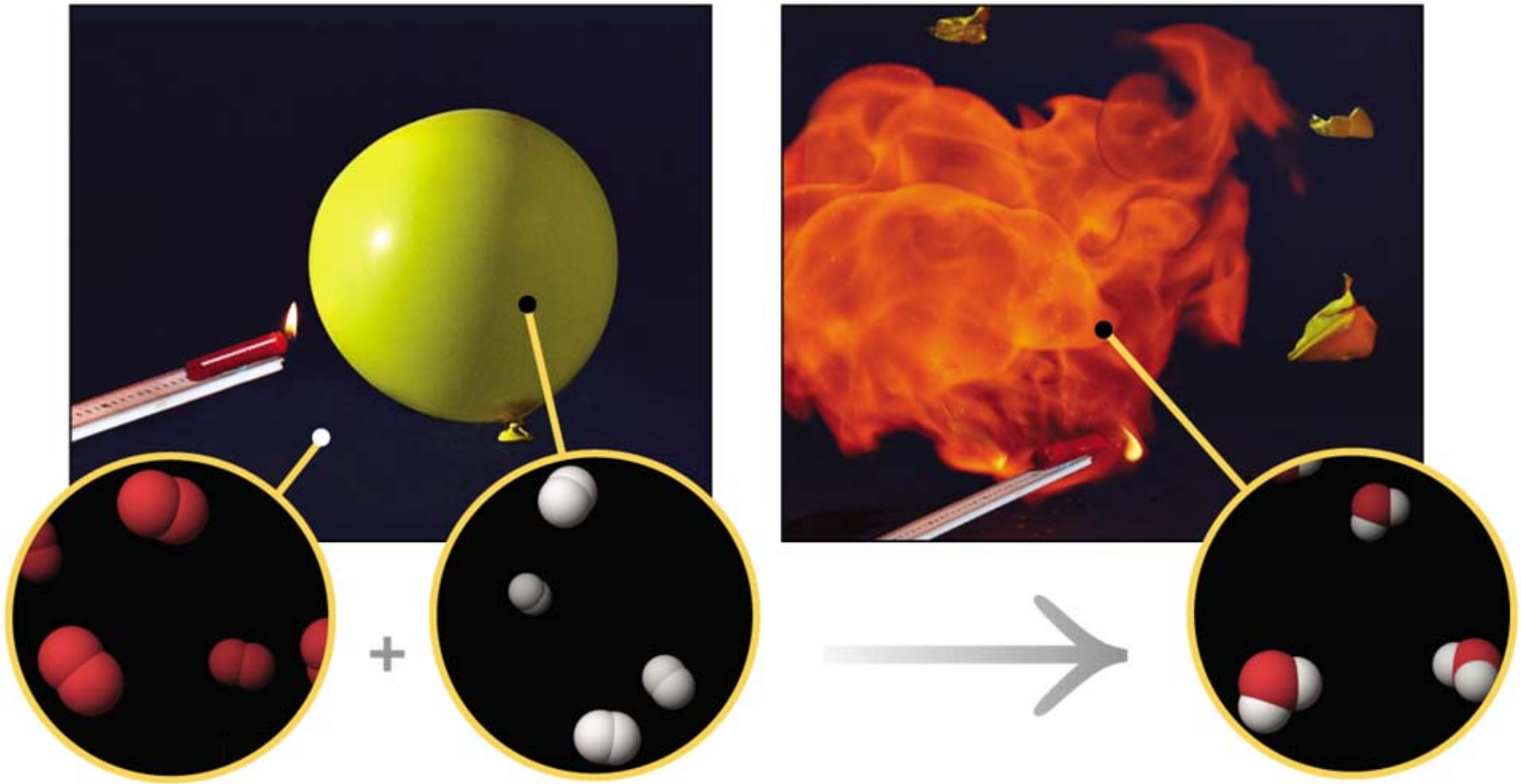


Chemical Reaction: Formation of Water

- Two hydrogen molecules and one oxygen molecule combine to make two water molecules.
- In their elemental diatomic forms, hydrogen is an explosive gas and oxygen supports combustion.
- However, as a compound, water is relatively non-reactive.
- https://www.youtube.com/watch?v=nLuOM9aOWvk



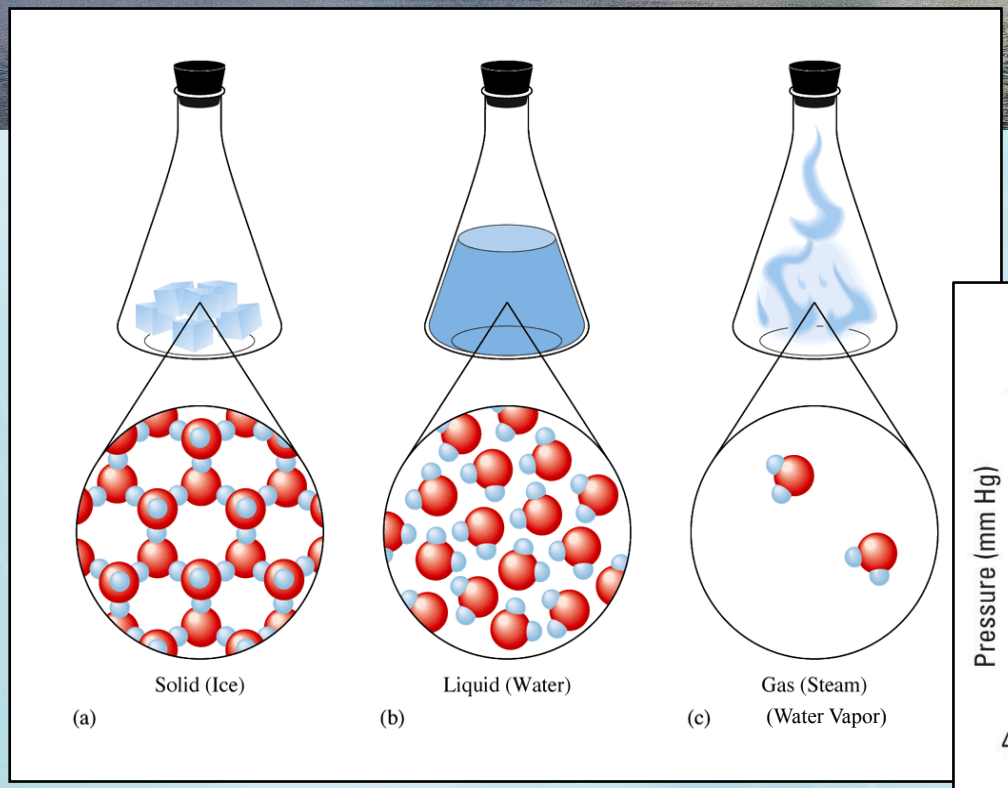
Chemical Reaction: Formation of Water



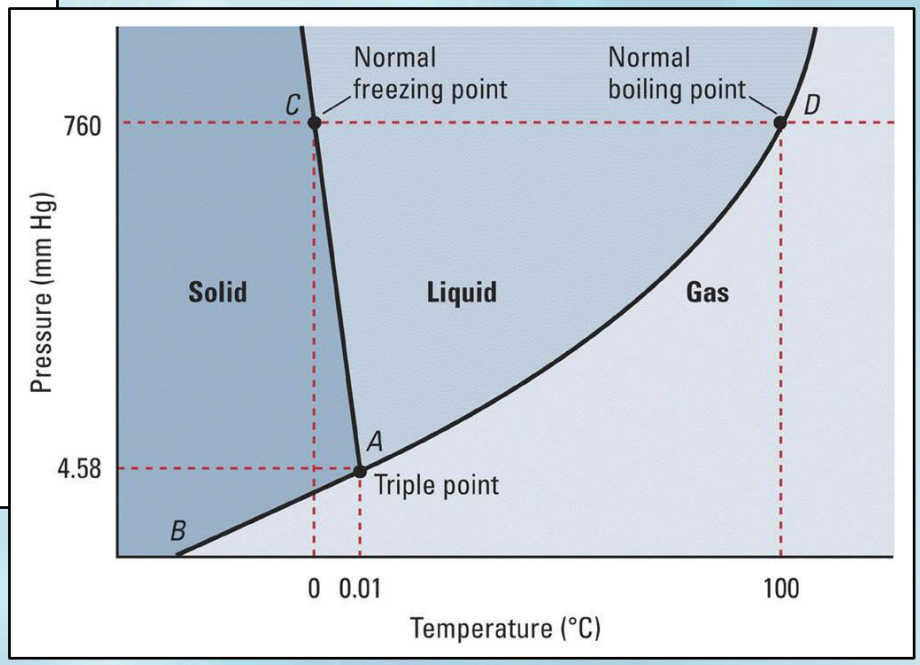
O_2 (gas) + H_2 (gas)

$2\ H_2(g) + O_2(g) \longrightarrow 2\ H_2O(g)$

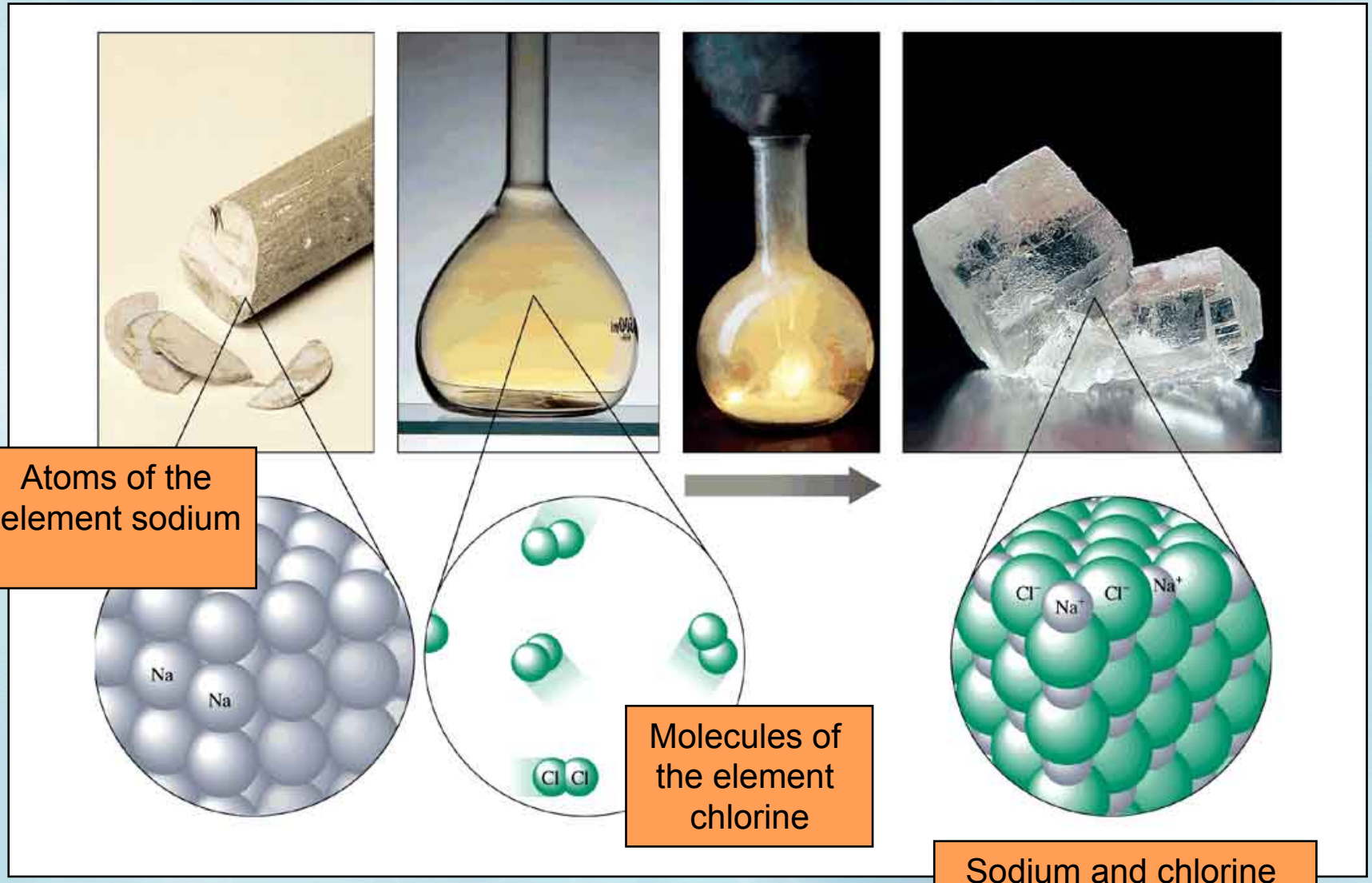
The three states of water



Phase Diagram:

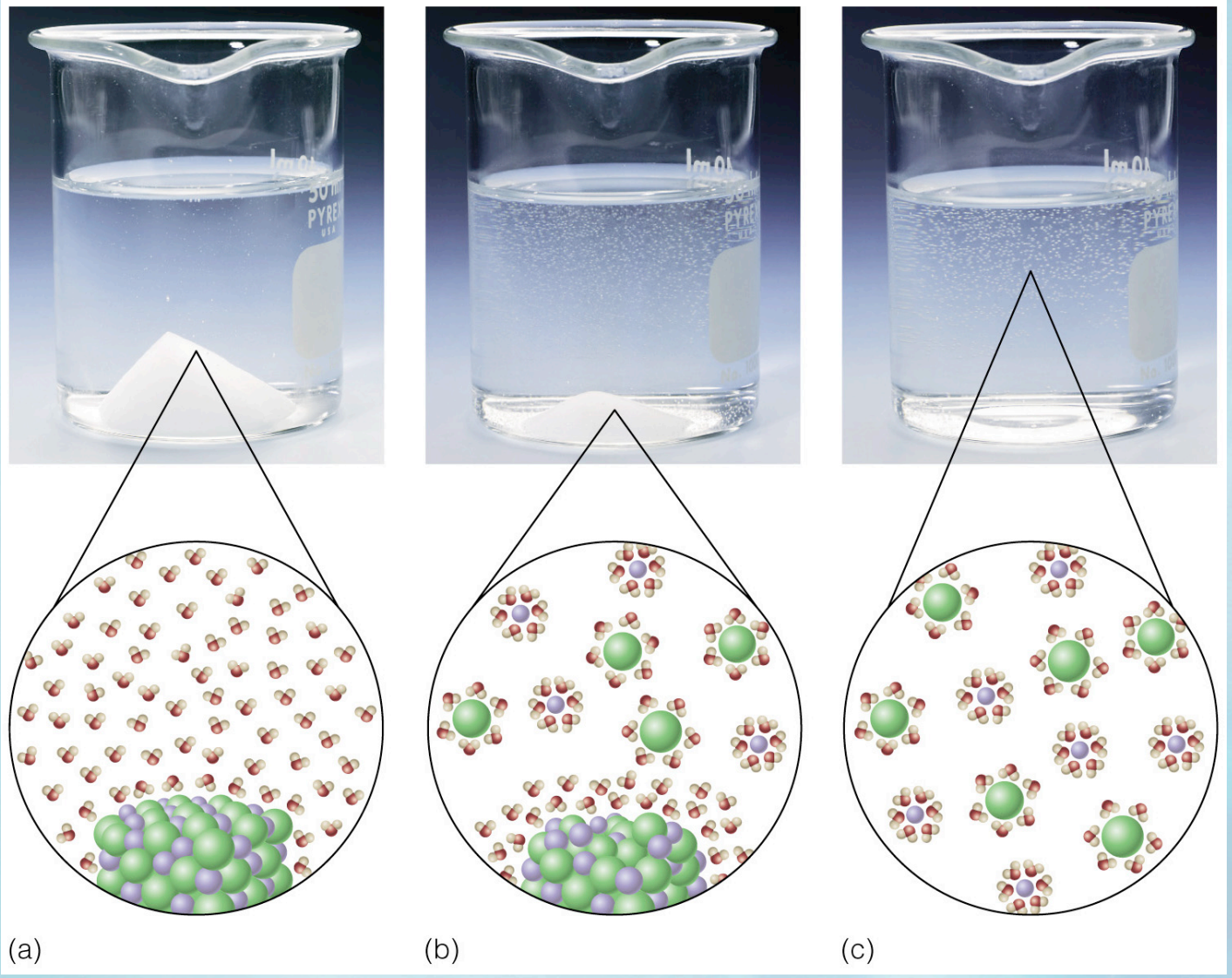


Elements and an ionic compound

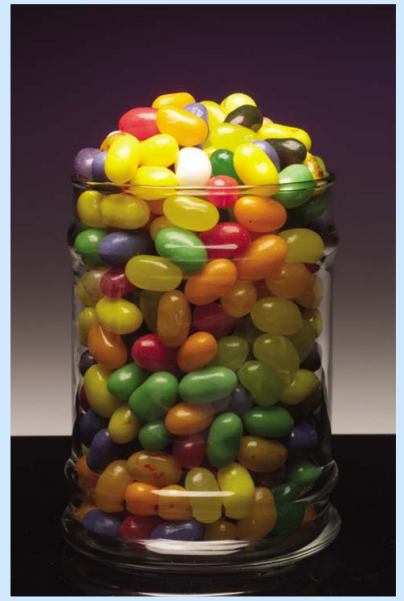
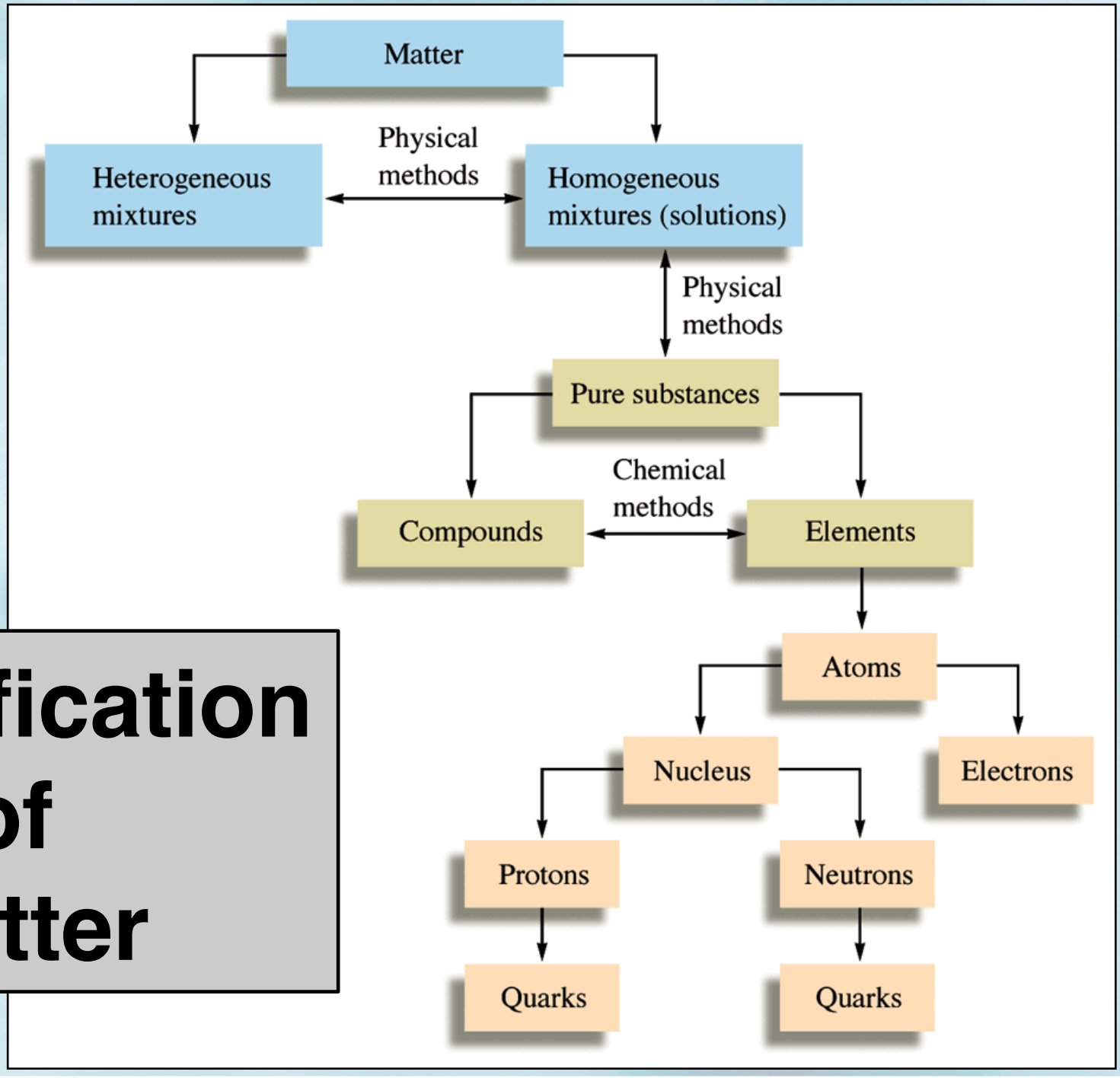


Mixtures

Saltwater: **Homogeneous Mixture**, also called a **Solution**.



Jar of jelly beans: **Heterogeneous Mixture**



Classification of Matter