CHEM100 Lecture Summary

Module 1

Elements

A substance that cannot be broken down into simpler substances by chemical or physical means.

a) Single atom of an element
b) Molecules of an element
c) Atoms of an element present in some form

Made of atoms, all of which are identical (except isotopes of elements).

Compound

A distinct substance that is composed of the atoms of two or more different elements. Always contains exactly the same relative masses of those elements.

Atoms

Contain negatively charged electrons balanced by protons- overall zero charge. Nucleus is small, dense and makes up most of atoms mass. All atoms are composed of the same components, chemical properties change based on number/arrangement of electrons.

Dalton's Atomic Theory-Law of Constant Composition

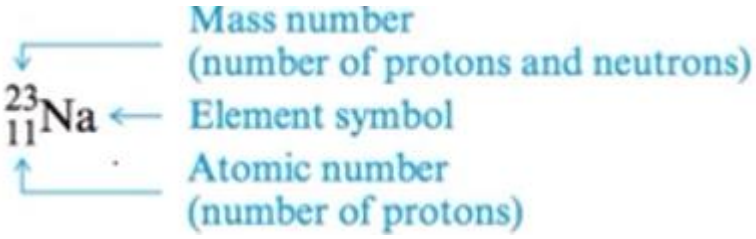
1. Most natural materials are mixtures of pure substances
2. Pure substances are either elements or combinations of elements called compounds
3. A given compound always contains the same proportions (by mass) of the elements

Isotopes

Atom with different number of neutrons, meaning not all atoms of the same element are identical. Show almost identical chemical properties.

Atomic Mass and Atomic Number

Atomic mass equals to the number of protons (atomic number) plus the number of neutrons. Atomic number tells number of protons and electrons (they are equal).



Metals

Good conductors of heat and electricity. Malleable. Ductile. Lustrous appearance.

Nonmetals

Lack properties of metals. Variation in properties. Can be solid, liquid or gas.

Metalloids

Have some metal and some nonmetal properties.

States: Liquid

Atoms are packed together but able to slightly move. Liquid bromine and mercury are only elements liquid at room temperature.

States: Solid

Atoms are tightly packed, little to no movement.

States: Gases

Atoms are freely moving.

Allotropes

Different forms of the same element. Non-metallic solids may have different structures thus have different properties, e.g. solid carbon can be diamond, graphite and buckminsterfullerene.

Ions

Neutral atom has zero charge. Atoms form ions by losing/gaining electrons. Physical size decreases with loss of electrons. Ions are formed when metallic elements combine with non-metallic elements.

Positive Ion (Cation)

Formed when electrons are lost, thus the atom has more protons than electrons giving a positive charge. Always metals. Transitional metals form cations with various charges. Cation is named from parent atom.

Negative Ion (Anion)

Formed when electrons are gained, thus the atoms have less protons than electrons giving a negative charge. Always nonmetals. Anion is named from root of parent atom name plus -ide.

Ionic Compounds

Contain ions held together by electrostatic forces called ionic bonding. High melting point (strong attraction between + and – charges). Hard as ions are firmly held together by attractions to oppositely charged surrounding ions. Conduct electricity as charged ions carry electric current.

Metal cations and nonmetal anions form neutral ionic compounds. Charge sum must be zero.

Modern Atomic Theory

Differences in behaviour between element groups due to electron arrangement.

Nuclear Model of Atom

Electrons are arranged around nucleus in regular geometric patterns as opposed to poling on top of one another.

Electromagnetic Radiation

Radiant energy travels through space in waves at the speed of light.

$$E = \frac{hc}{\lambda}$$

Wavelength (λ): distance between two consecutive wave peaks.

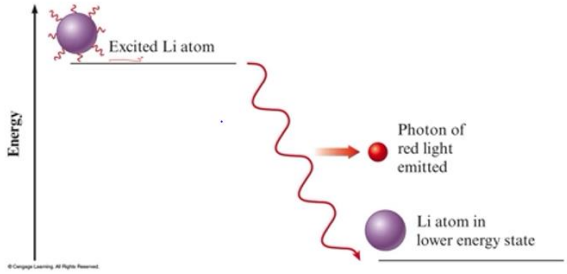
Frequency (υ): indicates how many peaks pass a certain point per given time period.

Speed (c): indicates how fast a given peak travels.

Light travels in a stream of tiny packets of energy call photons (particle of electromagnetic radiation). The longer the wavelength the lower the energy of its photons.

Atom Emission of Energy

Atoms release energy by emitting visible light of specific wavelengths. A particular colour (wavelength) of light carries a particular amount of energy per photon, which corresponds to the change in energy that the atom experiences going from excited to lower ground state of energy. Energy levels of atoms are quantized energy level- only certain energy values are allowed.

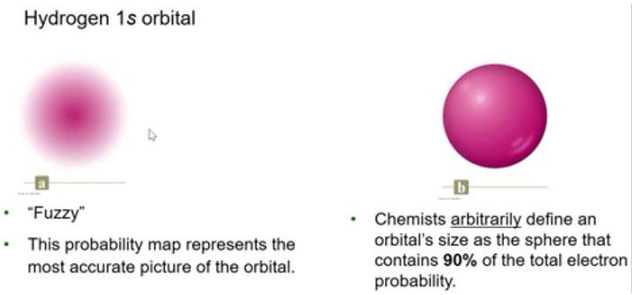


Bohr Model of Atom (PROVEN INCORRECT)

Electrons are assumed to travel around the nucleus in circular orbits corresponding to various allowed energy levels. Discarded are its properties did not correspond closely to experimental measurements.

Wave Mechanical Model of Atom

Electron might exhibit both wave and particle characteristics and electron states are described by orbitals (distinct regions around the nucleus that each electron traces out). Can be applied to all atoms. Each electron has a spin, represented as an arrow, which allows the arrangement of electrons to be determined.



Hydrogen Orbitals

Probability map for hydrogen electron is called an orbital. An *orbit* represents a define, exact circular pathway. An *orbital* represents a region of space where there is a high probability of finding the electron. Discrete energy levels of atoms are called *principle energy levels*. In the wave mechanical model, the higher energy states correspond to different kinds of orbitals with different shapes. Four principle energy levels in the hydrogen atom with each level assigned an integer, *n*. Hydrogen atom has only one electron but possesses a set of orbitals. Other orbitals serve as excited states of the atom. Higher the *n* the farther away from the nucleus is the electron.