Molecules, Compounds and Mixtures

Crystallized Alexa Fluor organic fluorescent dye compound. Image was taken with 10x objective with a TRITC filter.
Objectives

• Name the two atomic models cited in the chapter and note the differences between them.
• Describe the important quantum –mechanical principal that relate to electron energies.
• Schematically plot attractive, repulsive, and net energies vs. interatomic separation for two atoms or ions. Identify equilibrium separation and bonding energy.
• Briefly describe ionic, covalent, metallic, hydrogen and van der Waals bonding. Give examples of materials that exhibit each bond.
Molecules: A group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction.

Chemical bonds: the inter-atomic forces that bind atoms together. There are three primary bonds: Ionic, Covalent, and metallic.

Mixture: Two or more substances physically combined. Example sugar in water, iron beads mixed with plastic beads.

Compound: Two or more elements bonded together in fixed proportion that results in a substance that has different chemical and physical properties.
What is the difference between a compound and a molecule?

A molecule is formed when two or more atoms join together chemically. A compound is a molecule that contains at least two different elements. All compounds are molecules but not all molecules are compounds.

Is water a molecule, compound or a mixture?

Water is a molecule because it is made from atoms that have been chemically combined. It is also a compound because the atoms that make water are not all the same - some are oxygen and some are hydrogen.
Primary Bonding

\( \nu \) hydrogen atoms are close together

\( \nu \) hydrogen atoms are far apart

Potential energy

-104 kcal/mol

0.74 Å

104 kcal/mol bond dissociation energy

Internuclear distance
Ionic Bonds

Characteristics of Ionic Compounds

1. Crystalline solids at room temperature
2. Have higher melting points and boiling points compared to co-valent compounds
3. Conduct electrical current in molten or solution state
4. Are extremely polar bonds
5. Most are soluble in water but not soluble in non-polar solvents
Covalent Bonds

What are some characteristics of a covalent bond?

1. Covalent bonds have definite and predictable shapes.
2. Very strong
3. Low melting and boiling points
Metallic Bonding

- The metal ions are bonded but some of the electrons are delocalized.
- Therefore metals are opaque and shiny
- Good conductors
Secondary Bonds

- **Hydrogen Bonding** – permanent dipole bonding
- **van der Waals Bonding** – inducted dipole bonding
Atomic Models

• Bohr atomic model
  – Electron revolve around nucleus like planets
  – Each shell/orbital is well defined (position)
  – Electron energies are quantized (energy)
Atomic Models

• Wave-Mechanical Model
  - Electrons spin around the positively charged nucleus
  - Quantum Mechanics tells us there is a probability that the electrons will be in a certain space (orbital) most of the time.
  - These orbital also have unique shapes which help to determine the chemistry of the atom.
Some Rules

- **Exclusion Principle**
  - Electrons and protons are part of a fundamental class of particles called Fermions. These particles are characterized by an intrinsic spin of $\frac{1}{2}$ and cannot share the exact same space. This well observed principle is called the Pauli Exclusion Principle.
Quantum numbers

- Principal QN, n: specifies the shell energy of the electron
- Azimuthal QN, l: specifies the sub shell and shape of the orbital
- Magnetic QN, M_l: specifies the orbital and labels the different orbital of a given subshell
- Spin QN, M_s: specifies the direction of spin of the two electrons within an orbital

http://www.westga.edu/~chem/courses/chem1211d/lecture/Chapter7/sld033.htm
Shapes of the Orbital
Shapes of the Orbitals
Example of Covalent Bonding

Methane - a gas at room temperature
# Periodic Table of the Elements

![Periodic Table of the Elements](image.png)
Periodic Table of the Elements

- **s-block**
  - 1A
  - 1s, 2s, 3s, 4s, 5s, 6s, 7s

- **p-block**
  - 2A
  - 3A, 4A, 5A, 6A, 7A, 8A
  - 1s, 2p, 3p, 4p, 5p, 6p

- **d-block**
  - 3B, 4B, 5B, 6B, 7B
  - 3d, 4d, 5d, 6d

- **f-block**
  - Inner-transition elements
  - 4f, 5f
Review

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References

- [http://www.accd.edu/spc/natsci/chemistry/common/imagepage.htm](http://www.accd.edu/spc/natsci/chemistry/common/imagepage.htm)
- [wps.prenhall.com/.../ Text_Images/FG05_17.JPG](http://wps.prenhall.com/.../ Text_Images/FG05_17.JPG)