2.1 Elements, Compounds and Mixtures

- **Element**: consists of only one kind of atom, a pure substance, whose composition is fixed. Elements have names (oxygen, carbon, silicon).
- **Molecule**: individual elements that come together to form molecules, independent structural units chemically bonded together.
- **Compound**: matter composed of two or more different elements that are chemically bonded together. Compounds have different properties than the elements that make them up.
- **Mixture**: a group of two or more substances (elements and/or compounds) that are physically intermingled. The components in a mixture can vary in their parts by mass, unlike compounds. Mixtures retain the physical properties of its components.

2.2. The Atomic View of Matter

A. **Mass Conservation**: the total mass of substances does not change during a chemical reaction.

B. **Definite Composition**: no matter what its source, a particular chemical compound is composed of the same elements in the same parts (fractions) by mass. (i.e. mass fraction)

C. **Multiple Proportions**: if elements A and B react to form two compounds, the different masses of B that combine with a fixed mass of A can be expressed as a ratio of small whole numbers.

2.5 Atomic Theory

- **Atomic number**: for an element, the number of protons in the nucleus of its atom.
- **Mass number**: the total number of protons and neutrons of an atom (i.e. $^{12}$C, with 6 protons + 6 neutrons)
- **Atomic symbol**: the elemental symbol designation (i.e. carbon is C, oxygen O).
- **Isotopes**: for an element, are atoms that have different numbers of neutrons and therefore different mass number. (i.e. $^{12}$C, $^{13}$C, $^{14}$C, all have 6 protons and 6 electrons)
• Atomic mass: the average of the masses of an element containing all naturally occurring isotopes weighted according to their abundances in nature.

2.6 The Periodic Table
1. Each element has a box that contains its atomic number, atomic symbol, and atomic mass, increasing in atomic number as you move left to right.
2. The table is arranged in periods (across) and groups (up and down). Groups are numbered 1-8, periods are numbered 1-7.
3. The eight A groups contain the main group elements. The ten B groups contain the transition elements. The lanthanides, or inner transition elements, are below the table.

2.7 Introduction to bonding
The electrons of the atoms of interacting element are involved in compound formation.
1. Transferring electrons from the atoms of one element to those of another forms ionic compounds.
2. Sharing electrons between atoms of different elements forms covalent compounds.

• Ionic compounds are composed of ions, or charged particles, that gain or lose electrons.
• Ionic compounds are neutral, possessing no NET charge.
• In general, metals lose electrons and nonmetals gain electrons to form ions with the same number of electrons are its nearest noble gas.

• Covalent compounds form when elements share electrons, usually between nonmetals, in which a pair of electrons is mutually attracted to two nuclei.
• Most covalent substances consist of molecules; no molecules exist in a sample of an ionic compound.
• Polyatomic atoms: ionic compounds that have two or more atoms covalently bonded with a net negative or positive charge.
2.8 Chemical Formulas, Names and Masses

In a chemical formula, element symbols and numerical subscripts show the type and number of each atom present in the smallest unit of a substance. There are 3 types of chemical formula:

1. An **empirical formula** is the relative number of atoms of each element in a compound, derived from the masses of the component elements.
2. A **molecular formula** shows the actual number of atoms of each element in a molecule of the compound.
3. A structural formula shows the bonding structure of the atoms in a molecule (connections to other atoms in the molecule).

**Example:**
Hydrogen peroxide is 1 part hydrogen and 16 parts oxygen. Its empirical formula is HO, its chemical formula is H₂O₂ and it’s structural formula is H-O-O-H.

**Naming compounds:**
1. The name of the **cation** is the same as the name of the metal. Many metals end in −ium. (e.g. chromium, zinc)
2. The name of the **anion** takes the root of the nonmetal name and adds the suffix −ide. (e.g. bromide, chloride)
3. The suffix −ous for the ion with the lower charge. (ferrous for Fe³⁺)
4. The suffix −ic for the ion with the higher charge. (ferric for Fe²⁺)
5. The ion with more O atoms take the nonmetal root and the suffix −ate.
6. The ion with fewer O atoms take the nonmetal root and the suffix −ite.
7. The ion with the most O atoms has the prefix per-, the nonmetal root, and the suffix −ate.
8. The ion with the least O atoms (three fewer) has the prefix hypo-, the nonmetal root, and the suffix −ite.
Example:
ClO₄⁻ is perchlorate; ClO₃⁻ is chlorate, ClO₂⁻ is chlorite, ClO⁻ is hypochlorite, Cl⁻ is chloride.

Naming acids:
1. Binary acids: change –ide to –ic. (e.g. hydrochloric acid for HCl)
2. Oxoacids: -ate becomes –ic and –ite becomes –ous. The prefix hypo- and per- remain. (e.g. BrO₄⁻ is perbromate, HBrO₄ is hydrobromic acid)

Molecular Mass: The sum of the atomic masses in a compound.

Example: Molecular mass of water, H₂O
Molecular mass = sum of atomic mass for H₂O
= (2 x atomic mass of H) + (1 x atomic mass of O)
= (2 x 1.008 amu) + (1 x 16.00 amu)
= 18.02 amu

2.9 Mixtures
• heterogeneous mixture: has one or more visible boundaries between the components (not uniform throughout). (e.g. rocks)
• homogeneous mixture: has no visible boundaries because the components are mixed as individual atoms, ions and molecules. (e.g. aqueous solutions like sugar in water).