

Chapter 2 Atoms, Molecules, and Ions

1.1 The Atomic Theory of Matter

- Dalton's atomic theory of matter:
 - 1) Each element is composed of extremely small particles called atoms
 - 2) All atoms of a given element are identical; the atoms of different elements are different and have different properties
 - 3) Atoms of an element are not changed into different types of atoms by chemical reactions
 - 4) Compounds are formed when atoms of more than one element combine
- explains the law of constant composition, law of conservation of mass

1.2 The Discovery of Atomic Structure

- **subatomic particles** – what atoms are composed of
- Like charges repel each other; unlike charges attract

1.2.1 Cathode Rays and Electrons

- **cathode rays** – radiation resulting from a high voltage
 - cause certain materials to give off light (fluoresce)
- mass of an electron 9.10939×10^{-28} g
 - 2000 times smaller than hydrogen

1.2.2 Radioactivity

- **radioactivity** – spontaneous emission of radiation
- three types of radiation: alpha (α), beta (β), gamma (γ)
- alpha and beta radiation are affected by an electric field
- beta particles have a charge of 1-
- alpha particles have a charge of 2+
- gamma radiation has no particles and no charge

1.2.3 The Nuclear Atom

- Rutherford determined that there was a nucleus in every atom
- Protons discovered by Rutherford in 1919
- Neutrons discovered by James Chadwick in 1932

1.3 The Modern View of Atomic Structure

- charge of an electron is -1.602×10^{-19}
- charge of a proton is $+1.602 \times 10^{-19}$
- 1.602×10^{-19} is called to **electronic charge**

Particle	Charge	Mass (amu)
Proton	Positive	1.0073
Neutron	None	1.0087
Electron	Negative	5.486×10^{-4}

- **atomic mass unit (amu)** – equals 1.66054×10^{-24} grams
- **angstrom (Å)** – unit of length to measure atomic dimensions
 - 1 angstrom = 10^{-10} m
- atoms have diameters of 1-5 Å
- **nucleus** – diameter of 10^{-4} Å

1.3.1 Isotopes, Atomic Numbers, and Mass Numbers

- all atoms of an element have the same number of protons in the nucleus
- **isotopes** - atoms of the same element that have a different number of neutrons
- **atomic number** – the number of protons in an atom
- **mass number** – number of protons + number of neutrons
- **nuclide** – atom of a specific isotope

1.4 The Periodic Table

- **periodic table** – the arrangement of all the elements by atomic number and similarities into a table
- columns = groups
- **metallic elements** – all elements on the left side and in the middle of the periodic table
- **nonmetallic elements** – elements on the periodic table that are divided by a diagonal steplike line from boron to astatine
- **metalloids** – properties of metals and nonmetals

1.5 Molecules and Molecular Compounds

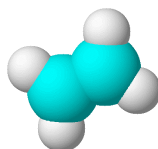
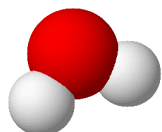
- **molecule** – two or more atoms bonded together

1.5.1 Molecules and Chemical Formulas

- **chemical formula** – way of representing molecules
- **diatomic molecule** – any molecule made up of two atoms
- **molecular compounds** – contains more than one type of atom

1.5.2 Molecular and Empirical Formulas

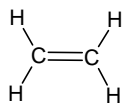
- **molecular formulas** – chemical formulas that indicate the actual number of atoms



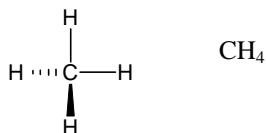
- **empirical formula** – chemical formulas that only give the relative number of atoms

1.5.3 Picturing Molecules

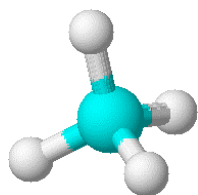
- **structural formulas** – shows which atoms are attached to other atoms



- **perspective drawing** – gives an idea of the three-dimensional shape of a molecule

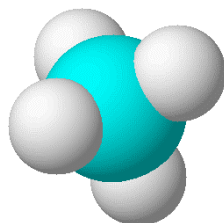


- **ball-and-stick models** – shows atoms as balls bonded by sticks



CH₄

- **space-filling model** – accurate representation of what atoms would look like



CH₄

1.6 Ions and Ionic Compounds

- **ion** – charged particle formed by the removal or addition of an electron
- **cation** – ion with a positive charge
- **anion** – ion with a negative charge
- metal atoms tend to lose electrons
- nonmetal atoms tend to gain electrons
- **polyatomic ions** – joined atoms that have a net positive or negative charge

1.6.1 Predicting Ionic Charges

- alkali metals form 1+ ions
- alkaline earth from 2+ ions
- halogens form 1- ions
- group 6A from 2- ions

1.6.2 Ionic Compounds

- **ionic compound** – a compound that contains positively and negatively charged ions
- ionic compounds are generally combinations of metals and nonmetals
- molecular compounds are generally nonmetals only

1.7 Naming Inorganic Compounds

- **chemical nomenclature** – the naming of substances
- over 10 million known chemical substances
- **organic compounds** – contain carbon
- **inorganic compounds** – everything else

1.7.1 Names and Formulas of Ionic Compounds

- 1) **positive ions**
 - a. cations formed from atoms have the same name as the metal
 - b. if a metal can form cations of differing charges, the positive charge is given by a roman numeral in parentheses following the name of the metal
 - c. cations formed from nonmetal atoms have names that end in **-ium**

2) Negative Ions

- monatomic anions have names formed by dropping the ending of the name of the element and adding the ending **-ide**
- polyatomic anions containing oxygen have names ending in **-ate** or **-ite**
- called **oxyanions**
- anions derived by adding H^+ to an oxyanion are named by adding as a prefix the word hydrogen or dihydrogen, as appropriate

3) Ionic compounds

- names of ionic compounds are the cation name followed by the anion name

1.7.2 Names and formulas of Acids

- acids based on anions whose names end in **-ide** have associated acids that have the hydro- prefix and an **-ic** ending
- acids based on anions whose names end in **-ate** or **-ite**

Anion	Acid
____ide	Hydro____ic acid
____ate	____ic acid
____ite	____ous acid

1.7.3 Names and Formulas of Binary Molecular Compounds

- the name of the element farthest to the left in the periodic table is usually written first
- if elements in same group lower one written first
- name of second element is given an **-ide** ending
- Greek prefixes used to indicate number of atoms of each element
- if prefix ends in a or o and the name of the anion begins with a vowel, the a or o is dropped

Prefix	Meaning
Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10