

# CHM138H1 - Introductory Chemistry

Huzaim Malik

September 29, 2024

## Contents

<b>1</b>	<b>Atomic Structure</b>	<b>2</b>
1.1	Subatomic Particles . . . . .	2
1.2	Isotopes . . . . .	2
<b>2</b>	<b>Quantum Mechanics and Orbitals</b>	<b>2</b>
2.1	Quantum Numbers . . . . .	2
<b>3</b>	<b>Periodic Trends</b>	<b>2</b>
3.1	Atomic Radius . . . . .	2
3.2	Ionization Energy . . . . .	3
<b>4</b>	<b>Chemical Bonding</b>	<b>3</b>
4.1	Ionic Bonding . . . . .	3
4.2	Covalent Bonding . . . . .	3
<b>5</b>	<b>Molecular Geometry</b>	<b>3</b>
5.1	VSEPR Theory . . . . .	3
<b>6</b>	<b>Thermodynamics</b>	<b>3</b>
6.1	First Law of Thermodynamics . . . . .	3
6.2	Enthalpy . . . . .	3
<b>7</b>	<b>Equilibrium</b>	<b>4</b>
7.1	Le Chatelier's Principle . . . . .	4
<b>8</b>	<b>Acids and Bases</b>	<b>4</b>
8.1	pH Scale . . . . .	4
8.2	Buffers . . . . .	4
<b>9</b>	<b>Kinetics</b>	<b>4</b>
9.1	Rate Laws . . . . .	4

<b>10 Electrochemistry</b>	<b>4</b>
10.1 Redox Reactions . . . . .	4
10.2 Galvanic Cells . . . . .	5

## 1 Atomic Structure

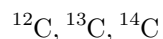
Atoms consist of a nucleus containing protons and neutrons, surrounded by electrons in various energy levels (orbitals).

### 1.1 Subatomic Particles

- **Proton:** Positively charged particle in the nucleus.
- **Neutron:** Neutrally charged particle in the nucleus.
- **Electron:** Negatively charged particle in orbitals around the nucleus.

### 1.2 Isotopes

Isotopes are atoms with the same number of protons but different numbers of neutrons. Example:



## 2 Quantum Mechanics and Orbitals

Electrons occupy orbitals, regions of space where the probability of finding an electron is highest.

### 2.1 Quantum Numbers

- **Principal quantum number  $n$ :** Energy level (shell).
- **Azimuthal quantum number  $l$ :** Orbital shape (subshell).
- **Magnetic quantum number  $m_l$ :** Orientation of the orbital.
- **Spin quantum number  $m_s$ :** Spin direction of the electron.

## 3 Periodic Trends

Elements in the periodic table exhibit trends in properties like atomic radius, ionization energy, and electronegativity.

### 3.1 Atomic Radius

The atomic radius increases down a group and decreases across a period.

### 3.2 Ionization Energy

The energy required to remove an electron. It decreases down a group and increases across a period.

## 4 Chemical Bonding

Atoms form bonds to achieve stable electron configurations.

### 4.1 Ionic Bonding

Occurs between metals and non-metals, involving the transfer of electrons. Example: NaCl.

### 4.2 Covalent Bonding

Involves the sharing of electron pairs between atoms. Example: H<sub>2</sub>O.

## 5 Molecular Geometry

The 3D arrangement of atoms in a molecule is determined by VSEPR (Valence Shell Electron Pair Repulsion) theory.

### 5.1 VSEPR Theory

Predicts molecular shape based on electron pair repulsion. Example shapes:

- Linear: 180° bond angles (CO<sub>2</sub>).
- Trigonal planar: 120° bond angles (BF<sub>3</sub>).
- Tetrahedral: 109.5° bond angles (CH<sub>4</sub>).

## 6 Thermodynamics

The study of energy changes in chemical reactions.

### 6.1 First Law of Thermodynamics

Energy cannot be created or destroyed, only transferred or converted.

### 6.2 Enthalpy

The heat content of a system at constant pressure. The change in enthalpy ( $\Delta H$ ) during a reaction can be exothermic (releases heat) or endothermic (absorbs heat).

## 7 Equilibrium

In a reversible reaction, the system reaches equilibrium when the rates of the forward and reverse reactions are equal.

### 7.1 Le Chatelier's Principle

If a system at equilibrium is disturbed, it will shift to counteract the disturbance.

## 8 Acids and Bases

Acids donate protons ( $\text{H}^+$ ), while bases accept protons.

### 8.1 pH Scale

The pH scale measures the acidity or basicity of a solution:

$$\text{pH} = -\log[\text{H}^+]$$

### 8.2 Buffers

A buffer solution resists changes in pH when small amounts of acid or base are added.

## 9 Kinetics

Chemical kinetics is the study of the rates of chemical reactions.

### 9.1 Rate Laws

The rate of a reaction depends on the concentration of reactants:

$$\text{Rate} = k[\text{A}]^m[\text{B}]^n$$

where  $k$  is the rate constant, and  $m$  and  $n$  are the reaction orders.

## 10 Electrochemistry

Electrochemistry deals with the relationship between electricity and chemical reactions.

### 10.1 Redox Reactions

Reduction involves the gain of electrons, while oxidation involves the loss of electrons.

## 10.2 Galvanic Cells

A galvanic cell generates electrical energy from spontaneous redox reactions.