CHM1011 – Exam Summary

Lecture 2 – Atomic Orbitals & Quantum Numbers

Electrons and orbitals

- Electrons have **wave–particle duality**.
- Electrons do **not** travel in fixed circular orbits around the nucleus.
- An **atomic orbital** is described mathematically by a wavefunction (Ψ).
- **Ψ^2** relates to the probability density of finding an electron at a particular location.
- Orbital diagrams commonly show the region containing approximately **95% probability** of finding the electron.

Quantum numbers

Quantum number	Symbol	Describes
Principal	**n**	Energy level/shell
Angular momentum	**l**	Orbital shape/subshell
Magnetic	**m_l**	Orbital orientation
Spin	**m_s**	Electron spin (+½ or −½)

Subshells:

- l = 0 → **s**
- l = 1 → **p**
- l = 2 → **d**
- l = 3 → **f**

Penetration and shielding

Penetration = ability of an electron to approach the nucleus.

Within the same principal shell:

s > p > d > f penetration

Greater penetration → stronger attraction to nucleus → generally **lower energy/more stable**.

Shielding = inner/core electrons reduce the nuclear attraction experienced by outer electrons.

This affects **effective nuclear charge (Zeff)** and periodic trends.

Lecture 3 – Electron Configuration & Periodic Trends

Electron configuration

Three essential rules:

Aufbau principle

Electrons fill the **lowest-energy orbitals first**.

Hund's rule

Within degenerate orbitals:

- Fill each orbital singly before pairing.
- Unpaired electrons have **parallel spins**.

Pauli exclusion principle

Each orbital can contain a maximum of **2 electrons with opposite spins**.

Subshell capacities

Subshell	Maximum electrons
s	2
p	6
d	10
f	14

Absorption vs emission

Absorption
→ electron absorbs energy → moves to a **higher energy level**.

Emission
→ electron moves to a lower energy level → releases energy as a **photon**.

Periodic trends

Atomic radius

Generally:

- **↓ across a period**

- **↑ down a group**

Across a period, increasing Zeff pulls electrons closer to the nucleus.

Ionisation energy

Energy required to remove an electron.

Generally:

- **↑ across a period**
- **↓ down a group**

A large jump in successive ionisation energies indicates that all **valence electrons** have been removed and a core electron would be removed next.

Lecture 4 – Respiration & Physics of Gases

Pressure and breathing

Air moves because of **pressure differences**.

The pressure relationship across the lung helps keep it expanded.

If the pleural space is opened, as in a **pneumothorax**, the normal pressure relationship is lost and the lung can collapse.

Kinetic theory of gases

Gas molecules:

- Move randomly.
- Possess kinetic energy.
- Have average kinetic energy proportional to **absolute temperature**.
- Are highly compressible.

Gas laws

Boyle's law

At constant temperature:

$$P \propto \frac{1}{V}$$