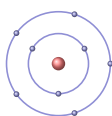


Atomic Structure and Properties

AP Chemistry • Unit 1

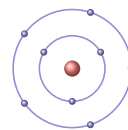
AP Chemistry



Atomic Structure and Properties

What we will cover

- 1 Moles and molar mass
- 2 Mass spectra and isotopes
- 3 Formulas and mixtures
- 4 Electron configuration
- 5 Photoelectron spectroscopy
- 6 Periodic trends
- 7 Ionic compounds



1 Moles

Atomic Structure and Properties

└ Moles

Moles and molar mass

The **mole** 摩尔 bridges grams (what we weigh) and particles (what a reaction sees):



$$N_A = 6.022 \times 10^{23}; \quad n = \frac{m}{M}; \quad 36.0 \text{ g of water} = 2.0 \text{ mol} = 1.2 \times 10^{24} \text{ molecules.}$$

2 Mass spectra

Atomic Structure and Properties

└ Mass spectra

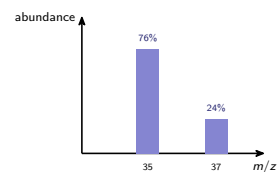
Mass spectra and isotopes

Isotopes 同位素 share protons but differ in neutrons – so in mass. A **mass spectrometer** 质谱仪 sorts them.

Average atomic mass

$$\bar{m} = \sum (\text{mass} \times \text{abundance})$$

Cl: $0.758(35) + 0.242(37) = 35.45$ – the taller bar pulls the average toward it.



3 Formulas & mixtures

Atomic Structure and Properties
└ Formulas & mixtures

Formulas and mixtures

Empirical formula recipe

percent → mass → mole → divide by small → multiply til whole

40% C, 6.7% H, 53.3% O ⇒ 1:2:1 ⇒ **empirical formula** 实验式 CH_2O .

Molecular formula 分子式 = a whole-number multiple of the empirical one.

A **mixture** 混合物 has variable composition; a **compound** 化合物 is fixed.

- **homogeneous** 均相混合物 – uniform (a solution)
- **heterogeneous** 非均相混合物 – visibly different parts

Molarity

$$c = \frac{n}{V} \quad \left(\frac{\text{mol}}{\text{L}} \right)$$

4 Electron configuration

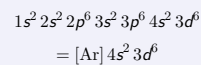
Atomic Structure and Properties
└ Electron configuration

Atomic structure and electron configuration

Electrons fill **subshells** 亚层 s, p, d, f (holding 2, 6, 10, 14) by three rules:

- **Aufbau** 构造原理 – lowest energy first
- **Pauli** 泡利不相容原理 – 2 per orbital, opposite spin
- **Hund** 洪特规则 – spread out singly before pairing

Iron, $Z = 26$



The outer **valence electrons** 价电子 drive bonding – so a column shares chemistry.

5 PES

Atomic Structure and Properties
└ PES

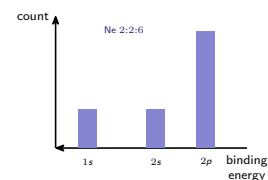
Photoelectron spectroscopy

PES 光电子能谱 measures how tightly each electron is held:

Binding energy

$$\text{BE} = \text{photon} - KE_{\text{electron}}$$

- each peak = one subshell (left = held tightest)
- peak height = number of electrons



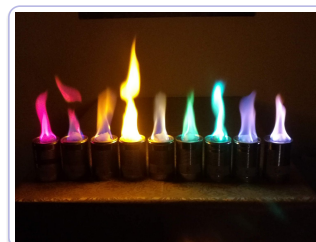
6 Periodic trends

Atomic Structure and Properties
└ Periodic trends

Periodic trends

Trends trace a tug-of-war: **effective nuclear charge** 有效核电荷 vs **shielding** 屏蔽.

- **atomic radius** 原子半径: down across, up a group
- **ionization energy** 电离能: up across, down a group
- **electronegativity** 电负性: up across (F is highest)



Flame colors reveal electron structure

7 Ionic compounds

Atomic Structure and Properties
└ Ionic compounds

Valence electrons and ionic compounds

Main-group atoms chase a full **octet** 八隅规则:

- **metals** 金属 **lose** electrons → cations
- **nonmetals** 非金属 **gain** them → anions

An **ionic bond** 离子键 is the **Coulomb** 库仑定律 pull; higher charge + smaller ions ⇒ stronger **lattice energy** 晶格能 ($\text{MgO} \gg \text{NaCl}$).

Trends follow the table's structure

8 Recap

Atomic Structure and Properties
└ Recap

Unit 1 – key takeaways

1 Moles

$$N_A = 6.022 \times 10^{23}; n = m/M; c = n/V$$

2 Spectra

isotopes give a weighted-average mass; PES: peak = subshell

3 Configuration

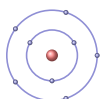
s, p, d, f by Aufbau/Pauli/Hund; valence drives chemistry

4 Trends

radius down across, IE/EN up; ionic bonds by Coulomb

Check yourself

- 1 How many moles are in 18 g of water ($M = 18$)?
- 2 In a PES spectrum, what does a peak's height tell you?
- 3 Across a period, does atomic radius rise or fall?
- 4 Na^+ and O^{2-} – what is the formula of the compound?



Answers 1. 1.0 mol 2. the number of electrons in that subshell 3. it falls 4. Na_2O