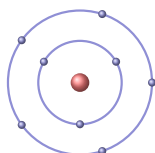


Atomic Structure and Properties

AP Chemistry ■ Unit 1

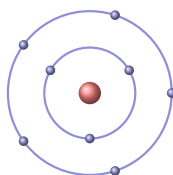
AP Chemistry



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

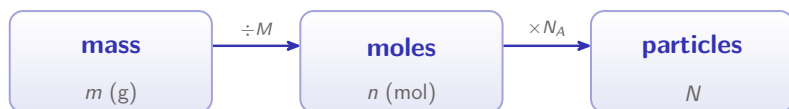


1

Moles

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

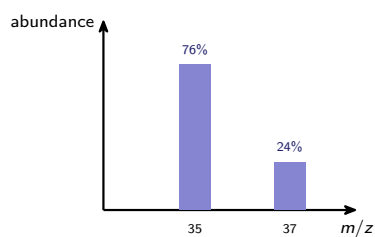
Mass spectra and isotopes

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

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

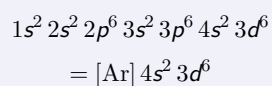
4 Electron configuration

Atomic structure and 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

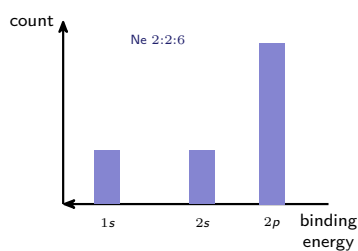
Photoelectron spectroscopy

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

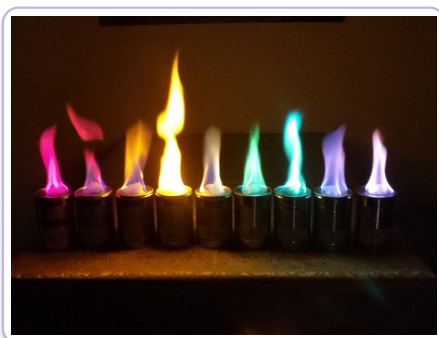
Periodic trends

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

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 ($\text{MgO} \gg \text{NaCl}$).

PERIODIC TABLE OF ELEMENTS

The periodic table is color-coded to show trends in valence electrons and ionic compound formation. Metals (left side) are colored in shades of blue and green, while nonmetals (right side) are colored in shades of yellow and red. The noble gases (Group 18) are colored in shades of purple. The transition metals (Groups 3-10) are colored in shades of blue and green. The lanthanides and actinides are shown at the bottom of the table.

Trends follow the table's structure

8 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

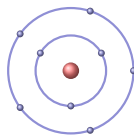
s, p, d, f by Aufbau/Pauli/Hund; valence drives chemistry

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