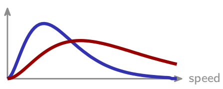
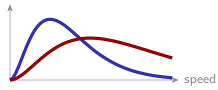
Properties of Substances and Mixtures

AP Chemistry ▪ Unit 3

AP Chemistry



What we will cover



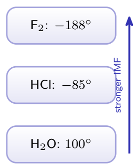
1 IMFs

Intermolecular forces

IMFs 分子间作用力 are weak attractions *between* molecules – they set boiling points:

- **London dispersion** 伦敦色散力 – all molecules; grows with size
- **dipole-dipole** 偶极-偶极 – polar molecules
- **hydrogen bonding** 氢键 – H bonded to N, O, F

> H-bond > dipole > dispersion – but compare the total.



2 Solids

Types of solids

A solid's properties follow from its particles and the force holding them:

- **Ionic** 离子型: high melt, brittle, conducts molten
- **Covalent network** 共价网状: very high melt, hard (diamond)
- **Metallic** 金属型: conducts, malleable
- **Molecular** 分子型: low melt, soft (ice)

> Network solids melt highest – you must break covalent bonds, not just weak IMFs.

3 Gas law

States of matter and the gas law

A balance of **kinetic energy** 动能 vs IMFs sets the state:

Ideal gas law

$$PV = nRT \quad (T \text{ in kelvin})$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Dalton 道尔顿分压定律: $P_{tot} = \sum P_i$, with $P_i = x_i P_{tot}$.

Gases fill volume; solids hold shape

4 KMT

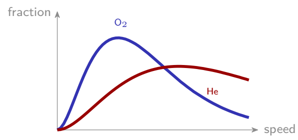
Kinetic molecular theory

KMT 分子运动论: gas particles are tiny points, in constant random motion, with elastic collisions and no attractions.

Temperature is average KE

$$\overline{KE} = \tfrac{3}{2} k_B T = \tfrac{1}{2} m v^2$$

Same T: lighter particles move faster. Real gases stray at high P, low T.



5 Solutions

Solutions and solubility

A **solution** 溶液: **solute** 溶质 dissolved in **solvent** 溶剂.

Molarity and dilution

$$M = \frac{n}{V}, \qquad M_1 V_1 = M_2 V_2$$

"Like dissolves like": polar in polar, nonpolar in nonpolar.

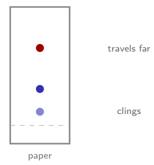
Solute and solvent make a solution

6 Separation

Separation methods

Mixtures separate by physical differences:

- **chromatography** 色谱法 – different pull between a stationary and mobile phase
- **distillation** 蒸馏 – different boiling points
- filtration – different particle sizes



7 Spectroscopy

Spectroscopy and the EM spectrum

Absorbed light matches an energy gap:

Photon energy

$$E = h\nu = \frac{hc}{\lambda}$$

- microwave – **rotational** 转动
- **infrared** 红外 – **vibrational** 振动
- UV/visible – **electronic** 电子跃迁

Shorter

$\lambda \Rightarrow$ higher energy.

The Beer-Lambert law

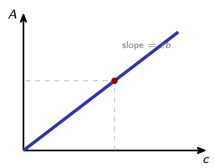
A coloured solution's **absorbance** 吸光度 is proportional to its concentration:

Beer-Lambert

$$A = \varepsilon bc$$

ε = **molar absorptivity** 摩尔吸光系数, b = **path length** 光程.

A **calibration curve** 校准曲线 of A vs c is a straight line – read an unknown off it.



8 Recap

Unit 3 – key takeaways

1 IMFs

H-bond > dipole > dispersion; they set boiling points

2 Gases

$PV = nRT$; KMT – lighter particles move faster

3 Solutions

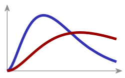
$M = n/V$; dilution $M_1V_1 = M_2V_2$; like dissolves like

4 Light

$E = hc/\lambda$; Beer-Lambert $A = \varepsilon bc$

Check yourself

1. Which IMF gives water its unusually high boiling point?
2. At the same temperature, does He or O_2 move faster?
3. Dilute a solution – do the moles of solute change?
4. In Beer-Lambert, absorbance is proportional to what?



Answers **1.** hydrogen bonding **2.** He (lighter) **3.** no (only concentration) **4.** concentration