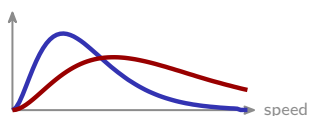


Properties of Substances and Mixtures

AP Chemistry ■ Unit 3

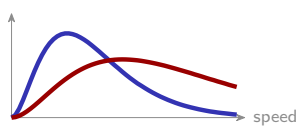
AP Chemistry



Properties of Substances and Mixtures

What we will cover

- 1 Intermolecular forces
- 2 Types of solids
- 3 States of matter and the gas law
- 4 Kinetic molecular theory
- 5 Solutions and solubility
- 6 Separation methods
- 7 Spectroscopy and Beer-Lambert



1

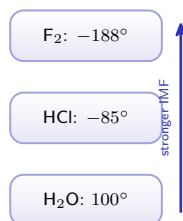
IMFs

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

Properties of Substances and Mixtures

└ 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: $P_{\text{tot}} = \sum P_i$, with $P_i = x_i P_{\text{tot}}$.



*Gases fill
volume; solids hold shape*

4 KMT

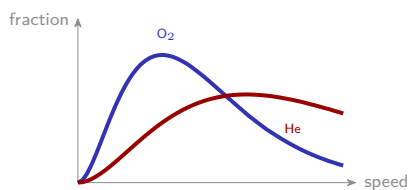
Kinetic molecular theory

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

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

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

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

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



Solute and solvent make a solution

6 Separation

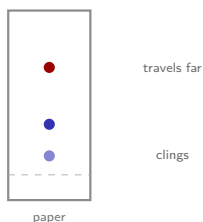
Properties of Substances and Mixtures

└ 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

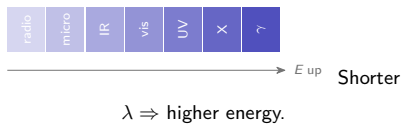
Spectroscopy and the EM spectrum

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



The Beer-Lambert law

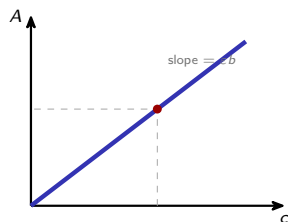
A coloured solution's **absorbance** 吸光度 is proportional to its concentration:

Beer-Lambert

$$A = \epsilon bc$$

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 $M_1 V_1 = M_2 V_2$; like dissolves like

4 Light

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

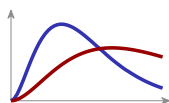
Check yourself

1 Which IMF gives water its unusually high boiling point?

2 At the same temperature, does He or O₂ 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