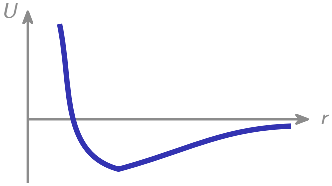
Compound Structure and Properties

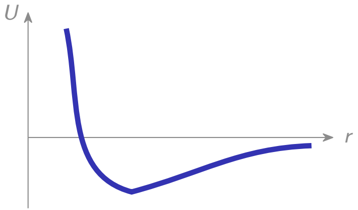
AP Chemistry ▪ Unit 2

AP Chemistry



What we will cover

1. Types of chemical bonds
2. Bond energy and length
3. Ionic solids
4. Metals and alloys
5. Lewis diagrams and resonance
6. VSEPR and hybridization



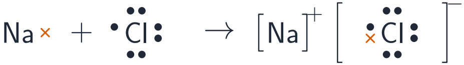
Types of chemical bonds

A **chemical bond** 化学键 forms by what atoms do with valence electrons:

- **ionic** 离子键 – metal transfers to nonmetal
- **covalent** 共价键 – two nonmetals share
- **metallic** 金属键 – a shared electron sea

Network solids bond in giant lattices

Types of chemical bonds



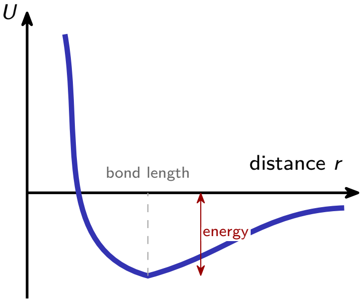
sodium gives its outer electron (×) to chlorine

Bond energy and length

As two atoms approach, potential energy dips to a well:

- **bond length** 键长 – the distance at the minimum
- **bond energy** 键能 – the depth of the well

> Higher **bond order** 键级 (single→double→triple) ⇒ shorter and stronger.



Ionic solids

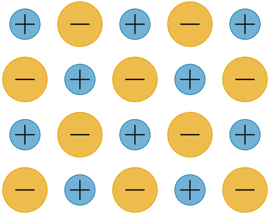
Ions pack into a repeating **crystal lattice** 晶格, glued by **Coulombic attraction** 库仑吸引.

- higher charges + smaller ions ⇒ bigger **lattice energy** 晶格能
- high melting points; **brittle** 脆性 (a shifted layer repels)

MgO $(2+/2-)$ melts far hotter than NaCl $(1+/1-)$.

Ionic solids form ordered lattices

Ionic solids



Cl^- ion

Na^+ ion

a regular, repeating 3-D pattern of alternating + and − ions

Metals and alloys

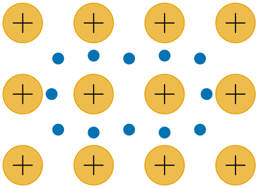
The **sea of electrons** 电子海: fixed + ions in a sea of **delocalized electrons** 离域电子. This explains:

- conductivity (electrons drift)
- **malleability** 延展性 (layers slide)
- **luster** 光泽 (electrons reflect light)

Alloys 合金: substitutional (brass) or interstitial (steel) – both harder.

Metals share a sea of delocalised electrons

Metals and alloys



'sea' of **delocalised electrons**, free to move and carry charge

positive metal ions in a fixed lattice

Lewis diagrams and resonance

A **Lewis diagram** 路易斯结构式 shows shared **bonds** 共价键 (lines) and **lone pairs** 孤对电子, aiming for an **octet** 八隅规则.

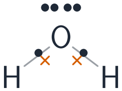
Formal charge picks the best

$$\mathrm{FC} = V - (\text{lone}) - (\text{bonds})$$

Resonance 共振: when several equal structures exist, the real bonds are an average (delocalized).

O=C=O (linear)

Lewis diagrams and resonance



H_2O: 2 bonding pairs
+ 2 lone pairs

N_2: triple bond
(3 shared pairs)

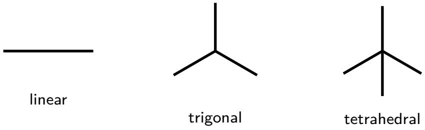
- • electron from one atom
- × electron from the other

VSEPR and hybridization

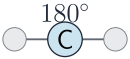
VSEPR 价层电子对互斥理论: electron domains push as far apart as possible.

- 2 domains – *sp* – linear
- 3 – sp^2 – trigonal planar
- 4 – sp^3 – tetrahedral

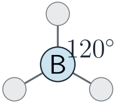
Lone pairs bend the shape; geometry decides **polarity** 分子极性.



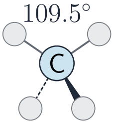
VSEPR and hybridization



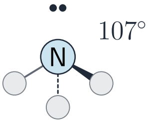
linear
CO_2



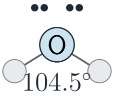
trigonal planar
BF_3



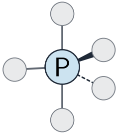
tetrahedral
CH_4



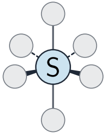
pyramidal
NH_3



bent
H_2O



trig. bipyramidal
PF_5, $120°$ & $90°$



octahedral
SF_6, $90°$

Unit 2 – key takeaways

1 Bond types

ΔEN sets ionic / polar / nonpolar covalent

2 Bond well

depth = energy, minimum = length; order shortens it

3 Structures

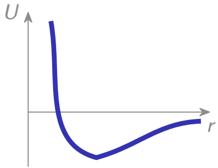
ionic lattice; metals a sea of delocalized electrons

4 Shape

VSEPR: 2/3/4 domains $\rightarrow$ linear/trigonal/tetrahedral

Check yourself

1. A large electronegativity difference gives which bond type?
2. Going single $\rightarrow$ double $\rightarrow$ triple, how does bond length change?
3. Why do metals conduct electricity?
4. A central atom with 4 electron domains has what shape?



Answers **1.** ionic **2.** it shortens **3.** delocalized electrons drift **4.** tetrahedral