

Exercise walk-through

Types of Chemical Bonds ■ 2.1

eXercise

You must be able to

- distinguish **ionic** 离子键, **covalent** 共价键, and **metallic** 金属键 bonding
- use **electronegativity difference** 电负性差 to classify a bond as ionic, polar covalent, or nonpolar covalent
- link bond type to the elements involved (metal + nonmetal, nonmetal + nonmetal, metal + metal)

Method — The three bond types

- **Ionic:** electrons **transferred** from a metal to a nonmetal, giving + and – ions that attract (e.g. NaCl).
- **Covalent:** electrons **shared** between nonmetals (e.g. H₂O).
- **Metallic:** metal atoms share a “sea” of delocalized electrons (e.g. copper).

Method — Classifying by electronegativity difference

Let ΔEN be the difference in electronegativity:

- ΔEN large ($\gtrsim 1.7$): **ionic**;
- ΔEN moderate: **polar covalent** 极性共价 (unequal sharing);
- $\Delta\text{EN} \approx 0$: **nonpolar covalent** (equal sharing).

Method — A worked classification

HCl: H (2.1) and Cl (3.0), $\Delta\text{EN} = 0.9$ — a **polar covalent** bond, with Cl slightly negative. Cl_2 : $\Delta\text{EN} = 0$, **nonpolar covalent**.

Method — Bonding continuum

Bonding is a continuum: as ΔEN grows, sharing becomes more unequal, then a full transfer. Use the elements' positions (metal vs nonmetal) as a first guide.

Practice 2.1 ■ 1 mark

State the bond type in KBr (K is a metal, Br a nonmetal).

Solution 2.1

Method: The three bond types

Worked steps

Ionic **B1**.

Practice 2.2 ■ 2 marks

Classify the bond in O_2 as polar or nonpolar covalent, with a reason.

Solution 2.2

Method: A worked classification

Worked steps

Nonpolar covalent — two identical atoms, so $\Delta\text{EN} = 0$ and the electrons are shared equally **M1** **A1**.

Practice 2.3 ■ 1 mark

For a bond between elements with $\Delta\text{EN} = 2.1$, state the likely bond type.

Solution 2.3

Worked steps

Ionic **B1**.

Exam-style 3.1 ■ 1 mark

Which compound is most likely to contain **ionic** bonds?

A CO_2

B CH_4

C MgO

D N_2

Solution 3.1

A CO_2

B CH_4

C MgO



D N_2

Worked steps

C — MgO is a metal + nonmetal, so it is ionic; the others are nonmetal–nonmetal (covalent).

Exam-style 3.2 ■ 2 marks

Consider the bonds in HF and F₂ (electronegativities: H 2.1, F 4.0).

- (a) Find ΔEN for each.
- (b) Classify each bond.

Solution 3.2

Method: A worked classification

Worked steps

(a) HF: $|4.0 - 2.1| = 1.9$; F_2 : 0 **M1** **A1**. (b) HF polar covalent (or borderline ionic); F_2 nonpolar covalent **M1** **A1**.

Exam-style 3.3 ■ 2 marks

Explain, in terms of electrons, how metallic bonding differs from ionic bonding.

Solution 3.3

Method: The three bond types

Worked steps

In metallic bonding the electrons are **delocalized** and shared across all the metal atoms (a “sea”); in ionic bonding electrons are **transferred** to form fixed + and – ions held by electrostatic attraction **M1** **A1**.