

2.1 Types of Chemical Bonds

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS ionic 离子键 • covalent 共价键 • polar covalent 极性共价 • metallic 金属键 • electronegativity difference 电负性差

Objective

Build the skills to answer exam questions on **types of chemical bonds** — deciding whether a bond is ionic, covalent, or metallic.

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)

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ 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).

■ Classifying by electronegativity difference

Let ΔEN be the difference in electronegativity:

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

■ A worked classification

HCl: H (2.1) and Cl (3.0), $\Delta\text{EN} = 0.9$ — a **polar covalent** bond, with Cl slightly negative. Cl₂: $\Delta\text{EN} = 0$, **nonpolar covalent**.

■ 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.

2 Practice

Now apply the methods above.

2.1 State the bond type in KBr (K is a metal, Br a nonmetal). [1]

2.2 Classify the bond in O_2 as polar or nonpolar covalent, with a reason. [2]

2.3 For a bond between elements with $\Delta\text{EN} = 2.1$, state the likely bond type. [1]

3 Exam-style questions

3.1 Which compound is most likely to contain **ionic** bonds? [1]

- **A** CO_2
- **B** CH_4
- **C** MgO
- **D** N_2

3.2 Consider the bonds in HF and F_2 (electronegativities: H 2.1, F 4.0).

(a) Find ΔEN for each. [2]

(b) Classify each bond. [2]

3.3 Explain, in terms of electrons, how metallic bonding differs from ionic bonding. [2]

Solutions

2.1 Ionic.

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

2.3 Ionic.

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

3.2 (a) HF: $|4.0 - 2.1| = 1.9$; F₂: 0. (b) HF polar covalent (or borderline ionic); F₂ nonpolar covalent.

3.3 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.