AP CHEMISTRY • EXERCISE SHEET

6.7 Bond Enthalpies

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS exothermic 放热 • endothermic 吸热

Objective

Build the skills to answer exam questions on **bond enthalpies**.

You must be able to:

- use $\Delta H \approx \Sigma(\text{bonds broken}) - \Sigma(\text{bonds formed})$
- calculate a reaction enthalpy from bond energies
- explain the sign from bond breaking vs forming

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 bond-enthalpy method

$$\Delta H \approx \sum(\text{bond enthalpies of bonds broken}) - \sum(\text{bond enthalpies of bonds formed}).$$

Breaking bonds costs energy (+); forming bonds releases energy (−).

■ A worked calculation

For $H_2 + Cl_2 \rightarrow 2HCl$: bonds broken = H–H (436) + Cl–Cl (242) = 678; bonds formed = 2×H–Cl ($2 \times 431 = 862$). So $\Delta H = 678 - 862 = -184$ kJ (exothermic).

■ The sign logic

If the bonds **formed** are stronger (release more) than those **broken**, ΔH is negative (exothermic). If breaking costs more than forming releases, it is endothermic.

■ An estimate, not exact

Bond enthalpies are **averages**, so this method gives an approximate ΔH — good for gases where all species have well-defined bonds.

2 Practice

Now apply the methods above.

2.1 Write the bond-enthalpy formula for ΔH. [1]

2.2 Breaking bonds — does it absorb or release energy? [1]

2.3 If bonds formed release 900 kJ and bonds broken cost 700 kJ, find ΔH. [2]

3 Exam-style questions

3.1 A reaction is exothermic when the bonds formed are [1]

- **A** weaker than the bonds broken
- **B** stronger than the bonds broken
- **C** equal to the bonds broken
- **D** all single bonds

3.2 For $H_2 + Br_2 \rightarrow 2HBr$: H–H = 436, Br–Br = 193, H–Br = 366 kJ/mol.

(a) Find the total energy to break the reactant bonds. [1]

(b) Find the total energy released forming the product bonds. [1]

(c) Find ΔH and classify it. [2]

3.3 Explain why bond-enthalpy calculations give only an approximate ΔH. [2]

Solutions

2.1 $\Delta H \approx \Sigma(\text{bonds broken}) - \Sigma(\text{bonds formed})$.

2.2 Absorbs energy.

2.3 $\Delta H = 700 - 900 = -200$ kJ.

3.1 B — stronger bonds formed release more energy, giving a negative ΔH.

3.2 (a) $436 + 193 = 629$ kJ. (b) $2 \times 366 = 732$ kJ. (c) $\Delta H = 629 - 732 = -103$ kJ, exothermic.

3.3 Bond enthalpies are **average** values over many molecules, so the actual bond strengths differ slightly, making the result approximate.