Exercise walk-through

12.1
Calorimetry and chemical energy

International Baccalaureate · IB Diploma · Chemistry · HL

INTERNATIONAL BACCALAUREATE · IB DIPLOMA · CHEMISTRY · HL • EXERCISE SHEET

12.1 Calorimetry and chemical energy

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS enthalpy change • exothermic

Objective

Calorimetry and chemical energy. Original classroom practice for IB HL; not an official IB paper.

1 Key knowledge and worked examples

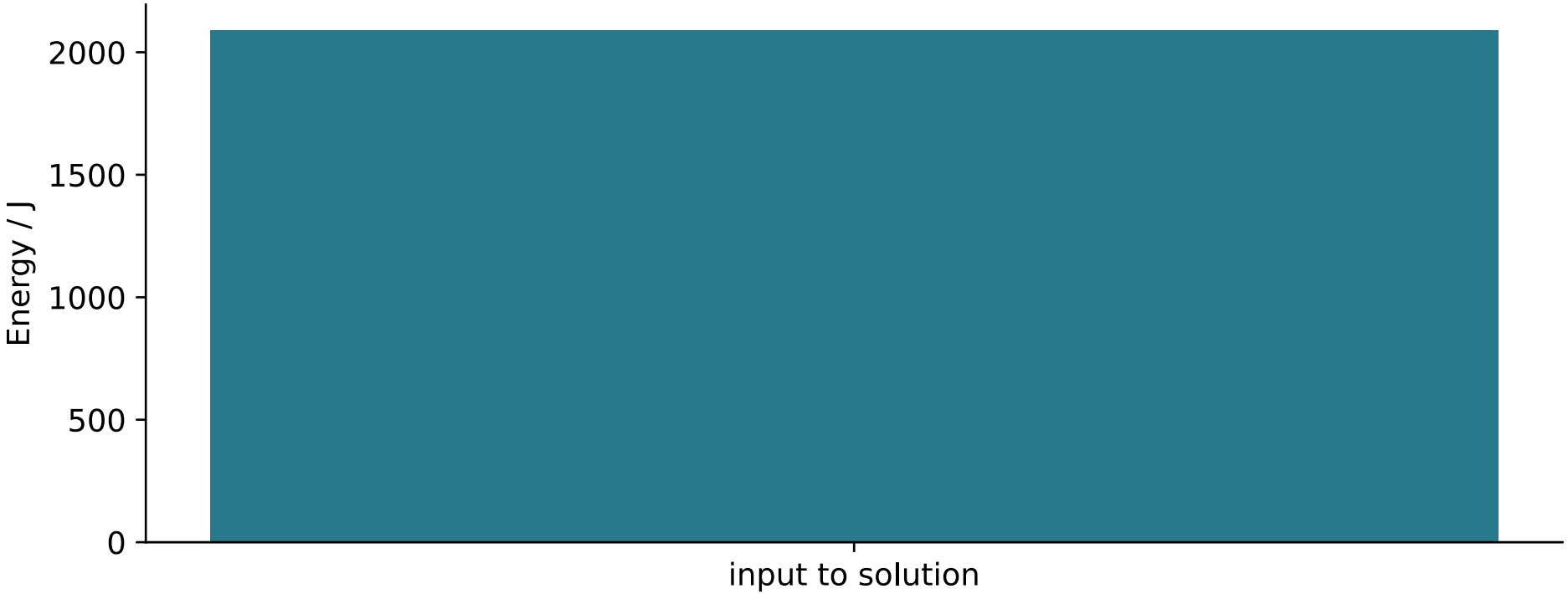
■ What would explain this observation?

- A cup warms when two solutions react. The temperature rise measures energy transferred to the surroundings; it does not directly equal the **enthalpy change** .

Build the model

- **Exothermic** reactions transfer energy to surroundings.
- Endothermic reactions take energy from surroundings.
- Bond breaking requires energy; bond formation releases energy.

- exothermic: Transferring energy to the surroundings.
- enthalpy change: Heat change at constant pressure for a stated process.



Choose evidence that can test it

- Use energy transferred = mass × specific heat capacity × temperature change.
- Convert joules to kilojoules before dividing by reaction amount.
- An exothermic molar enthalpy change has a negative sign.

In the lab: Use insulation and a lid, measure starting temperatures consistently, stir, and record a temperature-time series. Estimate the reaction temperature from an appropriate extrapolation rather than ignoring cooling during measurement.

Work from known quantities

- Known: 100 g solution rises by 5.0 °C; specific heat capacity is 4.18 J per gram per degree. $q = mc\Delta T$. $q = 100 \times 4.18 \times 5.0 = 2{,}090$ J = 2.09 kJ.

- If 0.050 mol reacts, $\Delta H = -q/n = -2.09/0.050 = -41.8$ kJ per mole.

Your turn: 50 g water rises 4 °C. Use c = 4.2 J per gram per degree to find q.

■ Check the conclusion and its limits

- Heat loss usually lowers the observed temperature rise.
- The solution gaining heat and the reaction losing heat have opposite signs.

Not true: Bond breaking releases energy. Bond breaking is endothermic - it requires energy. Bond forming releases energy. Confusing the two reverses the sign of every energy calculation.

Key:

- Exothermic reactions transfer energy to surroundings.
- Use energy transferred = mass × specific heat capacity × temperature change.
- Watch for: heat loss usually lowers the observed temperature rise.

■ Write from 756 J and minus 37.8 kJ per mole

- 60 g of solution rises by 3 degrees. Use c = 4.2 J per gram per degree. 0.020 mol reacts.
- Find q and the enthalpy change per mole. Bond breaking requires energy.

Exercises 2.1·2.3

2.1 Which process requires energy? Choose one answer.

- **A** Breaking a covalent bond
- **B** Forming every chemical bond
- **C** Cooling a hot solution [1]

2.2 50 g water rises 4 °C. Use c = 4.2 J per gram per degree to find q. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: Bond breaking is endothermic - it requires energy. [2]

Exercises 2.1·2.3

2.1 Which process requires energy? Choose one answer.

- **A** Breaking a covalent bond
- **B** Forming every chemical bond
- **C** Cooling a hot solution [1]

2.1 A Breaking a bond always requires energy input to separate the atoms; forming a bond releases energy. A reaction is exothermic overall only when the energy released in bond formation exceeds the energy taken in for bond breaking.

2.2 50 g water rises 4 °C. Use c = 4.2 J per gram per degree to find q. Show the relation, substitution and units. [2]

2.2 $q = mc\Delta T = (50\ g) \times (4.2\ J/(g\ K)) \times (4\ K) = 840\ J$.

2.3 Decide whether this claim is true and justify: Bond breaking is endothermic - it requires energy. [2]

2.3 True. True. Bond breaking is endothermic - it requires energy. Bond forming releases energy. Confusing the two reverses the sign of every energy calculation.

Exercises 2.4·3.1

2.4 Transferring energy to the surroundings: write the technical term. [1]

3.1 Fictional solution gains1.5 kJ when0.030 mol reacts. Find molar reaction enthalpy using the stated heat-transfer model, and explain the sign and effect of uncorrected heat loss. [4]

Exercises 2.4·3.1

2.4 Transferring energy to the surroundings: write the technical term. [1]

2.4 exothermic. exothermic means Transferring energy to the surroundings.

3.1 Fictional solution gains1.5 kJ when0.030 mol reacts. Find molar reaction enthalpy using the stated heat-transfer model, and explain the sign and effect of uncorrected heat loss. [4]

3.1 $\Delta H = -q/n = -1.5/0.030 = -50$ kJ/mol. Solution gains heat, reaction loses it. Uncorrected loss usually underestimates magnitude. Include container heat if relevant.