Worksheet: Exothermic and Endothermic Reactions

ChemistrySheets

Specification: GCSE Chemistry (AQA 5.5.1.1 / Edexcel SC13 / OCR Gateway C6.1)

Core Concepts:

- **Exothermic reactions** transfer energy *to* the surroundings, usually as heat, causing the temperature of the surroundings to increase.
- **Endothermic reactions** take in energy *from* the surroundings, usually as heat, causing the temperature of the surroundings to decrease.
- Energy is **taken in** to **break bonds** and **released** when **new bonds are formed**.
- The overall energy change of a reaction is the difference between the energy needed to break bonds and the energy released when bonds are formed.

Section A: Key Terms & Concepts

A1. Match the following key terms to their correct definitions by drawing a line between them.

Exothermic	The minimum energy required for a reaction to start.
Endothermic	A reaction that takes in energy from the surroundings.
Activation Energy	The overall energy change of a reaction, often measured as heat.
Enthalpy Change	A reaction that releases energy to the surroundings.

Model Answer:

Exothermic → A reaction that releases energy to the surroundings.
Endothermic → A reaction that takes in energy from the surroundings.
Activation Energy → The minimum energy required for a reaction to start.
Enthalpy Change → The overall energy change of a reaction, often measured as heat.

A2. Complete the following sentences using the words provided. *(Words: released, surroundings, absorbed, decrease, increase, bonds, products, reactants)*

(i) In an exothermic reaction, energy is **released** to the **surroundings**, causing the temperature to **increase**.

(ii) In an endothermic reaction, energy is **absorbed** from the **surroundings**, causing the temperature to **decrease**.

(iii) Energy is always required to break **bonds** in the **reactants**, and energy is always **released** when new bonds are formed in the **products**.

Section B: Core Concepts & Explanations

B1. Explain what an exothermic reaction is, giving one common example.

Model Answer:

An exothermic reaction is a chemical reaction that transfers energy (usually as heat) from the reacting system to its surroundings. This causes the temperature of the surroundings to increase. An example is combustion (e.g., burning fuel) or neutralisation reactions.

B2. Explain what an endothermic reaction is, giving one common example.

Model Answer:

An endothermic reaction is a chemical reaction that takes in energy (usually as heat) from its surroundings. This causes the temperature of the surroundings to decrease. An example is thermal decomposition (e.g., calcium carbonate decomposition) or dissolving ammonium nitrate in water.

B3. Describe the energy changes involved in bond breaking and bond making during a chemical reaction.

Model Answer:
Energy must be supplied (taken in) to break existing bonds in the reactants; this is an endothermic process. Energy is then released when new bonds are formed in the products; this is an exothermic process. The overall energy change of the reaction depends on the balance between these two processes.

B4. How can observing the temperature change of the surroundings help you determine if a reaction is exothermic or endothermic?

Model Answer:
If the temperature of the surroundings increases, it indicates that the reaction is exothermic because energy has been transferred from the reaction to the surroundings. Conversely, if the temperature of the surroundings decreases, it indicates that the reaction is endothermic because energy has been taken in from the surroundings by the reaction.

Section C: Exam Application & Extended Writing

C1. The diagram below shows an energy level profile for a chemical reaction.

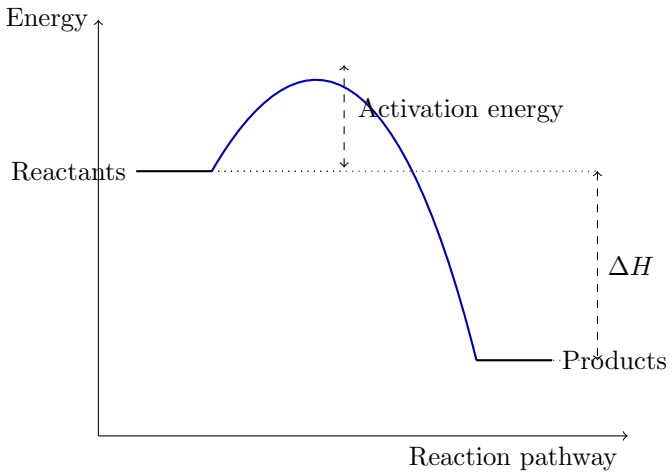

Figure 1: Energy Level Profile

(i) Is the reaction shown in Figure 1 exothermic or endothermic? Justify your answer by referring to the diagram.

Model Answer:
The reaction is **exothermic**. This is because the energy level of the products is lower than the energy level of the reactants. This indicates that energy has been released to the surroundings during the reaction, resulting in a negative enthalpy change (ΔH).

C2. Explain, in detail, the key differences between exothermic and endothermic reactions, including how energy is transferred, the overall energy change, and provide a practical application for each type of reaction. (6 marks)

Model Answer:
Exothermic and endothermic reactions differ fundamentally in how they transfer energy with their surroundings. **Exothermic reactions** release energy, typically as heat, to the surroundings. This causes the temperature of the surroundings to increase. In terms of bond energies, the energy released when new bonds are formed in the products is greater than the energy absorbed to break bonds in the reactants. This results in a net release of energy, meaning the products have lower energy than the reactants (a negative enthalpy change, $\Delta H < 0$). A practical application is combustion, such as burning natural gas in a boiler to heat a home. **Endothermic reactions** absorb energy, typically as heat, from the surroundings. This causes the temperature of the surroundings to decrease. In these reactions, the energy absorbed to break bonds in the reactants is greater than the energy released when new bonds are formed in the products. This results in a net absorption of energy, meaning the products have higher energy than the reactants (a positive enthalpy change, $\Delta H > 0$). A practical application is a chemical cold pack, where dissolving ammonium nitrate in water absorbs heat from the surroundings to provide a cooling effect.