# Chapter 7: Energy changes

## Knowledge organiser

### Energy changes

During a chemical reaction, energy transfers occur.

Energy can be transferred:

- to the surroundings – **exothermic**
- from the surroundings – **endothermic**

This energy transfer can cause a temperature change.

Energy is always conserved in chemical reactions.

This means that there is the same amount of energy in the Universe at the start of a chemical reaction as at the end of the chemical reaction.

### The surroundings

When chemists say energy is transferred from or to "the *surroundings*" they mean "everything that isn't the reaction".

For example, imagine you have a reaction mixture in a test tube. If you measure the temperature in the test tube using a thermometer, the thermometer is then part of the surroundings.

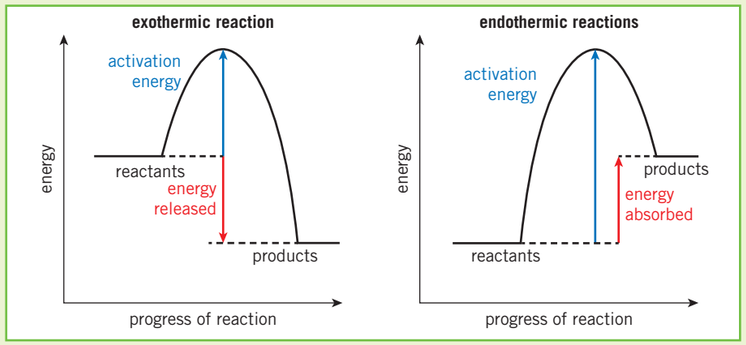
- If the thermometer records an increase in temperature, the reaction in the test tube is exothermic.
- If the thermometer records a decrease in temperature, the reaction in the test tube is endothermic.

| Reaction | Energy transfer | Temperature change | Example | Everyday use | Bonds |
|---|---|---|---|---|---|
| exothermic | to the surroundings | temperature of the surroundings increases | • **oxidation**<br>• **combustion**<br>• **neutralisation** | • self-heating cans<br>• hand warmers | more energy released when making bonds than required to break bonds |
| endothermic | from the surroundings | temperature of the surroundings decreases | • **thermal decomposition**<br>• citric acid and sodium hydrogen carbonate | • sports injury packs | less energy released when making bonds than required to break bonds |

### Reaction profiles

A **reaction profile** shows whether a reaction is exothermic or endothermic.

The **activation energy** is the minimum amount of energy that particles must have to react when they collide.




### Bonds (HT only)

Atoms are held together by strong chemical bonds. In a reaction, those bonds are broken and new ones are made between different atoms.

- Breaking a bond requires energy so is endothermic.
- Making a bond releases energy so is exothermic.

#### Breaking bonds

If a lot of energy is released when making the bonds and only a little energy is required to break them, then overall energy is released and the reaction as a whole is exothermic.

#### Making bonds

If a little energy is released when making the bonds and a lot is required to break them, then overall energy is taken in and the reaction as a whole is endothermic.

### Bond calculations

Different bonds require different amounts of energy to be broken (their **bond energies**). To work out the overall energy change of a reaction, you need to:

1. work out how much energy is required to break all the bonds in the reactants
2. work out how much energy is released when making all the bonds in the products.

*overall energy transferred = energy required to break bonds – energy required to make bonds*

- A positive number means an endothermic reaction.
- A negative number means an exothermic number.

### Key terms

**Make sure you can write a definition for these key terms.**

*activation energy* *battery* *bond energy* *combustion* *endothermic* *exothermic* *neutralisation* *oxidation* *reaction profile* *thermal decomposition*

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## Retrieval questions

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

| | C7 questions | Answers |
|---|---|---|
| 1 | What is an exothermic energy transfer? | transfer to the surroundings |
| 2 | What is an endothermic energy transfer? | transfer from the surroundings |
| 3 | What is a reaction profile? | diagram showing how the energy changes in a reaction |
| 4 | What is the activation energy? | minimum amount of energy required before a collision will result in a reaction |
| 5 | What is bond energy? | the energy required to break a bond or the energy released when a bond is formed |
| 6 | In terms of bond breaking and making, what is an exothermic reaction? | less energy is required to break the bonds than is released when making the bonds |
| 7 | In terms of bond breaking and making, what is an endothermic reaction? | more energy is required to break the bonds than is released when making the bonds |

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