Exothermic Reactions and Endothermic Reactions

EXOTHERMIC REACTIONS

DEFINITION: a reaction in which energy is **lost** so the temperature of the surroundings **increases**.

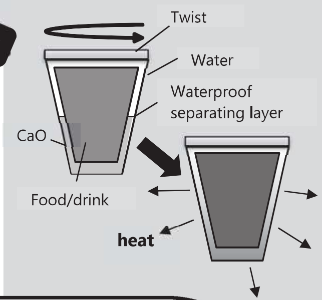
Exothermic processes **heat up** their surroundings by **giving out energy** and can be detected by **an increase in temperature** – the reaction vessel will feel warm. Highly exothermic reactions can even cause reactants to catch fire.

COMMON EXOTHERMIC REACTIONS
- Oxidation (e.g. respiration)
- Combustion (e.g. burning fuels)
- Neutralisation (e.g. acid + base)

EXAMPLE!

EVERYDAY APPLICATIONS: SELF-HEATING CANS

- Inside the can, the food/drink is surrounded by a layer containing the reacting chemicals (e.g. calcium oxide and water).
- When a button is pressed or the cap is twisted, the chemicals mix and react (an exothermic process), releasing thermal energy.
- The energy then warms up the food/drink inside the can.

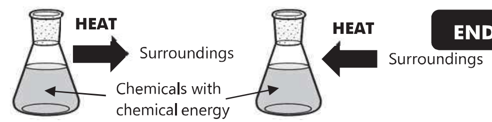


Conservation of Energy

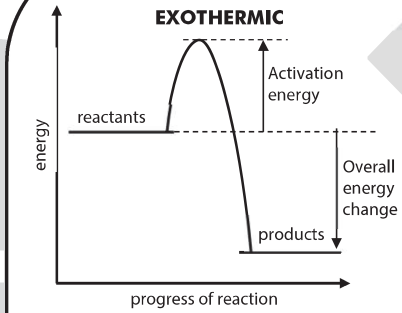
The law of conservation of energy states that:

'the amount of energy in the universe remains the same before and after a change occurs'.

This means that energy **can't be created or destroyed**, just converted and transferred. In a chemical reaction, energy can be **transferred** from the chemicals to the surroundings, or vice versa. This is often done as **thermal energy** (heat).



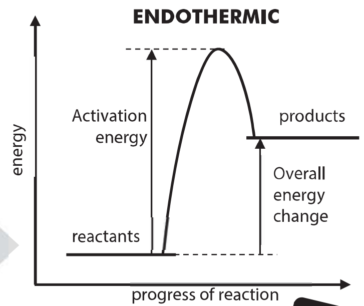
Reaction Profiles



Reaction profiles show the **relative energies** of reactants and products, and the **overall energy change** of the reaction.

Activation energy is **the minimum amount of energy** that reacting atoms/molecules need to collide with for the reaction to be **successful**. The **smaller** the activation energy, the **easier** it is for the reaction to occur.

An overall energy change arrow pointing **downwards** means energy has been **lost** during the reaction (exothermic). An arrow pointing **upwards** means energy has been **gained** (endothermic). The **size** of the arrow indicates **how much** energy has been transferred.

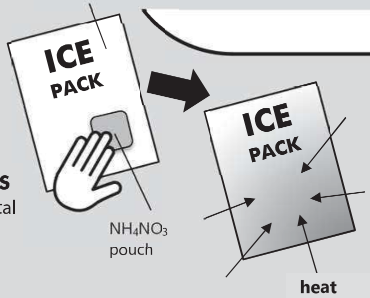


ENDOTHERMIC REACTIONS

DEFINITION: a reaction in which energy is **gained** so the temperature of the surroundings **decreases**.

Endothermic reactions cool down their surroundings by **taking in energy** and can be detected by a **fall in temperature** – the reaction vessel will feel cold.

COMMON ENDOTHERMIC REACTIONS
- Thermal decomposition (e.g. heating metal carbonates)
- Acid + hydrogencarbonate



EXAMPLE!

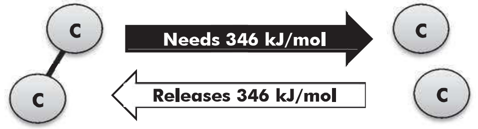
EVERYDAY APPLICATIONS: INJURY PACKS

- The pack is full of water and contains a pouch of a chemical such as ammonium nitrate.
- When the pack is squeezed the pouch bursts and the nitrate dissolves, which is an endothermic process.
- This makes the pack feel cool to the touch and it can be used to treat sprains and bruises.

Bond Energies

HT ONLY

For a chemical reaction to occur, chemical bonds must be broken and new ones must be formed. **Breaking** bonds **requires** energy, whereas **making** them **releases** energy.

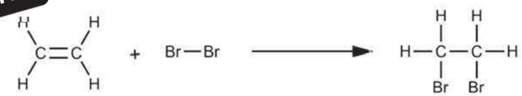


Energy change = energy needed to break bonds – energy released when forming new bonds

If the overall energy change is **positive**, the reaction is **endothermic** (more energy needed to break bonds)

If the overall energy change is **negative**, the reaction is **exothermic** (more energy released on forming bonds)

EXAMPLE!



Bonds broken		Bonds formed	
Br–Br C=C C–H ×4		C–Br ×2 C–C C–H ×4	
Total	193 + 602 + (412 × 4) = **2443 kJ**	**Total**	(276 × 2) + 346 + (412 × 4) = **2546 kJ**
Overall energy change = 2443 – 2546 = **-103 kJ**			

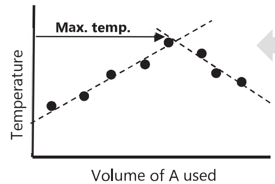
PRACTICAL SKILLS: MEASURING TEMPERATURE CHANGES

VARIABLES

Reactant B is gradually added to reactant A in a neutralisation reaction, and the temperature change is recorded.

Independent variable: amount of reactant A used
Dependent variable: temperature change

Control variables: amount of reactant B, concentration of reactant A/B, equipment used, ambient (room) temperature, identity of reactant A and reactant B



This graph shows data from an **exothermic** reaction – to find the **maximum temperature** reached, draw two lines of best fit and determine the point where they **intersect**