4.5 Revision Checklist : Energy

Conservation of Energy
Energy is conserved in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place.

If a reaction transfers energy to the surroundings the product molecules must have less energy than the reactants, by the amount transferred.

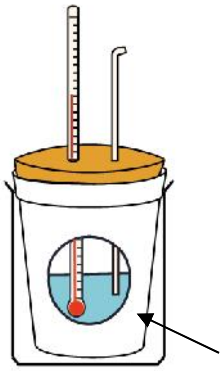
An **exothermic reaction** is one that transfers energy to the surroundings so the **temperature** of the surroundings **increases**.
Exothermic reactions include combustion, many oxidation reactions and neutralisation.

Everyday uses of exothermic reactions include self-heating cans and hand warmers.

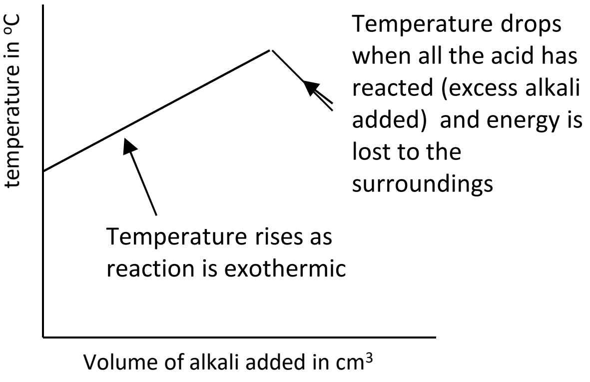
An **endothermic reaction** is one that takes in energy from the surroundings so the **temperature** of the surroundings **decreases**.
Endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate.

Some sports injury packs are based on endothermic reactions

Required practical: measuring energy change: General method
- put polystyrene cup in a beaker for insulation and support
- measure required volumes of solution with measuring cylinder/pipette
- clamp thermometer into place making sure the thermometer bulb is immersed in liquid
- measure the initial temperatures of the solution or both solutions if 2 are used
- transfers reagents to cup. If a solid reagent is used then add the solution to the cup first and then add the solid weighed out on a balance.
- stirs mixture
- measures final temperature



Required practical: measuring energy change: neutralisation
1. put polystyrene cup in a beaker for insulation and support
2. measure required volume of hydrochloric acid with measuring cylinder/pipette
3. clamp thermometer into place making sure the thermometer bulb is immersed in liquid
4. measure the initial temperature of the acid
5. add $5cm^3$ of sodium hydroxide.
6. stirs mixture and measure temperature
7. repeat steps 5 and 6 until $40cm^3$ of NaOH added

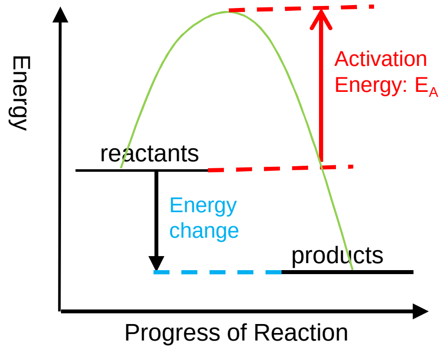


Activation Energy
Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. The **minimum amount** of **energy** that particles must have to **react** is called the activation energy.

Reaction profiles
Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.

A reaction profile for an exothermic reaction can be drawn in the following form on the right:

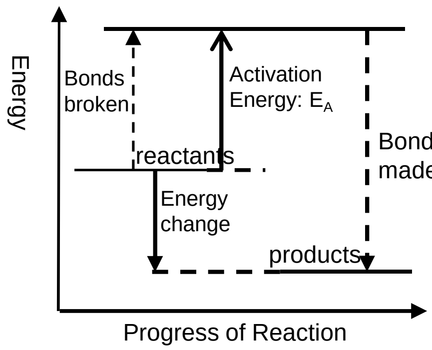
Exothermic
The energy level diagram shows that in an exothermic reaction the **products** are **lower in energy** than the reactants



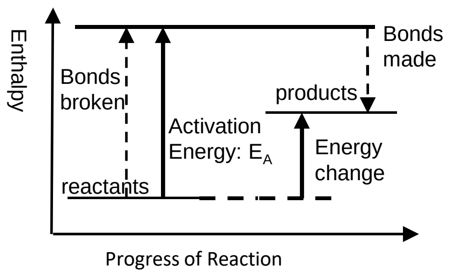
During a chemical reaction:
- energy must be supplied to break bonds in the reactants
- energy is released when bonds in the products are formed.

Exothermic reaction

In an **exothermic reaction**, the **energy** released from **forming** new bonds **is greater** than the energy needed **to break** existing bonds.

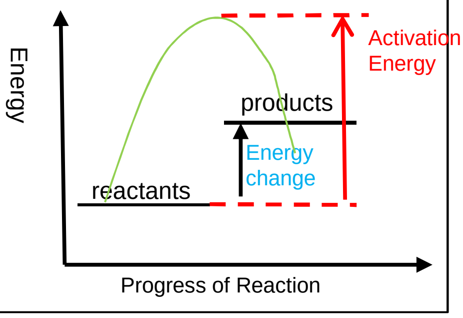


Endothermic reaction



The energy level diagram shows that the **products** are higher **in energy** than the reactants

In an **endothermic reaction, the energy** needed to **break** existing bonds is **greater** than the energy **released from forming** new bonds.



Bond energies
The energy needed to break bonds and the energy released when bonds are formed can be calculated from bond energies.

The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction.

Energy change of reaction = sum of bonds energies broken – sum of bonds energies made

Example . Using the following mean bond energy data to calculate the energy change for this reaction

2 H – H + O = O → **2** H - O - H

Bond	Bond energy (kJ /mol)
H-H	**436**
O-H	**464**
O=O	**498**

Energy change = Sum of bond energies broken – Sum of bond energies made
= (2 x **H-H** + 1x **O=O**) – (4 x **O-H**)
= (2x436 + 498) – (4 x 464)
= - 486 kJ /mol