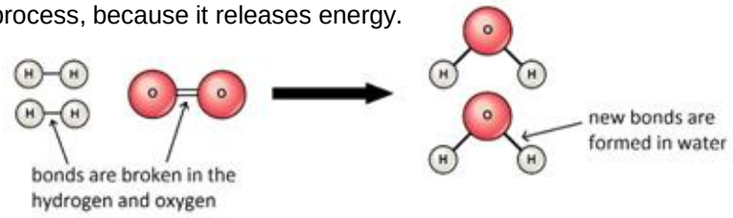
AQA C5 ENERGY CHANGES
CHEMISTRY HIGHER
Required practical – Temperature Changes

Key Word	Definition
endothermic	A reaction where energy is taken in from the surroundings so the temperature of the surroundings decreases.
exothermic	A reaction where energy is transferred to the surroundings so the temperature of the surroundings increases.
activation energy	The minimum amount of energy that colliding particles must have for a reaction to take place.
reaction profile diagram	A reaction profile diagram shows the overall energy changes in a reaction.
reactant	A chemical you start with before a reaction begins.
product	A chemical made after a reaction takes place.

Example of Reactions
Endothermic Reactions: Thermal decomposition and sports injury packs.
Exothermic Reactions: Combustion, hand warmers and neutralisation.

BREAKING AND FORMING BONDS

For a reaction to take place, bonds in the reactants have to be first broken. The atoms then rearrange, and bonds form to make a new product.
The amount of energy change in a reaction depends on the amount of bonds broken and formed. Bond breaking is an endothermic process, because it requires energy. Bond forming is an exothermic process, because it releases energy.

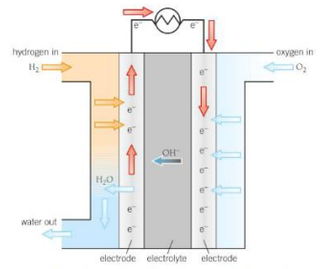


HYDROGEN FUEL CELLS

The advantages of hydrogen fuel cells are that no pollutants are produced and they can be used in many different devices. However, hydrogen is highly flammable and difficult to store.

Word Equation
hydrogen + oxygen → water
Symbol Equation
$2H_2 + O_2 \rightarrow 2H_2O$

Half equations at electrodes
$H_2 \rightarrow 2H^+ + 2e^-$
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$



OVERALL ENERGY CHANGES IN REACTIONS

In endothermic reactions, the energy needed to break existing bonds is greater than the energy released when new bonds are formed.

In an exothermic reaction, the energy released when new bonds are formed is greater than the energy taken in breaking the existing bonds.

CELLS AND BATTERIES

Cells and batteries provide devices with electrical energy. A simple cell can be made by attaching two different metals in an electrolyte. A battery is just two or more cells connected in series to increase the voltage.

Another way of increasing the voltage is by increasing the difference in reactivities between the metals used.

TYPES OF BATTERIES

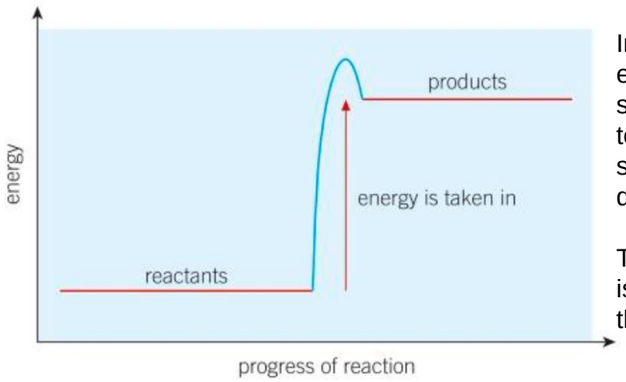
Alkaline Batteries
Alkaline batteries are non-rechargeable cells. They stop working when one of the reactants has been used up.

Rechargeable Batteries
These batteries can be recharged because the chemical reactions are reversed when an external electrical current is supplied. This can be achieved simply by charging the batteries using a mains supply of electricity.

REACTION PROFILE DIAGRAMS

In reaction profile diagram, the energy change in a reaction, is the difference between the reactants and products.

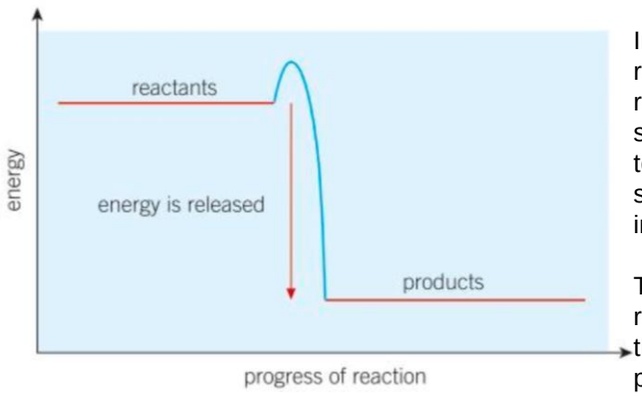
Endothermic Reaction



In an endothermic reaction, energy is taken in from the surroundings. The temperature of the surroundings therefore decreases.

The energy of the products is higher than the energy of the reactants.

Exothermic Reaction



In an exothermic reaction, energy is released to the surroundings. The temperature of the surroundings therefore increases.

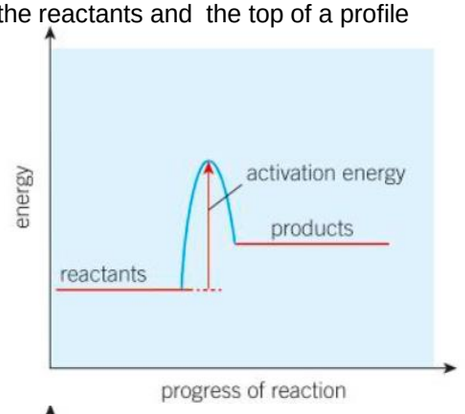
The energy of the reactants is higher than the energy of the products.

ACTIVATION ENERGY

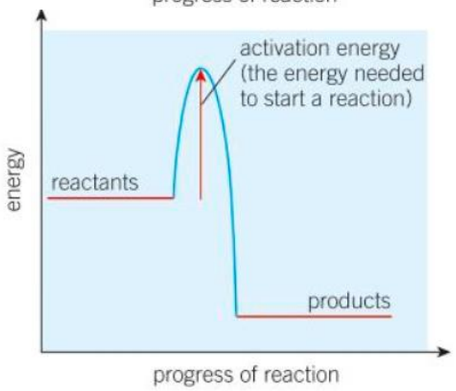
In order for a reaction to take place, collisions must occur between particles. The activation energy is the minimum amount of energy needed, for particles to successfully collide and react.

The activation energy can also be labelled on reaction profile diagrams. This is the difference between the reactants and the top of a profile diagram.

Endothermic Reaction



Exothermic Reaction



CALCULATING ENERGY CHANGES IN REACTIONS

The energy change in a reaction can be calculated by using bond energies. Bond energies are measured in kJ/mol. Individual bonds in molecules have energy values. By working out the difference between the energy needed to form bonds and to break bonds, the energy difference can be calculated. Below is an example.

Calculate the overall energy change for the reaction
$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Bond energies (in kJ/mol): H-H 436, H-N 391, N≡N 945

Bond breaking: 945 + (3 x 436) = 945 + 1308 = 2253 kJ/mol

Bond making: 6 x 391 = 2346 kJ/mol

Overall energy change =

2253 - 2346 = -93kJ/mol

Therefore reaction is exothermic overall, because the value is negative.
(If the value is positive the reaction is endothermic)