Foxford Learning Plan | KS4 Chemistry C05 – Energy Changes

Energy changes are an important part of chemical reactions. The interaction of particles often involves transfers of energy due to the breaking and formation of bonds. Reactions in which energy is released to the surroundings are exothermic reactions, while those that take in thermal energy are endothermic. These interactions between particles can produce heating or cooling effects that are used in a range of everyday applications. Some interactions between ions in an electrolyte result in the production of electricity. Cells and batteries use these chemical reactions to provide electricity. Electricity can also be used to decompose ionic substances and is a useful means of producing elements that are too expensive to extract any other way.

Understanding - Over the course of the topic, I will understand:

- ☐ energy is conserved in chemical reactions.
- ☐ an exothermic reaction is one that transfers energy to the surroundings, so the temperature of the surroundings increases.
- ☐ an endothermic reaction is one that takes in energy from the surroundings, so the temperature of the surroundings decreases.
- ☐ activation energy is the minimum amount of energy required for a reaction to happen.
- ☐ energy must be supplied to break bonds in the reactants.
- ☐ energy is released when bonds in the products are formed.
- ☐ how the difference between the energy required for bond breaking and making will determine if a reaction is endothermic or exothermic.
- ☐ chemical reactions can occur only when particles collide with each other with sufficient energy.
- ☐ cells contain chemicals which react to produce electricity.
- ☐ batteries consist of two or more cells connected in series to provide a greater voltage.
- ☐ the difference between rechargeable and n0n-rechargeable batteries.
- ☐ how a fuel cell works.

Skills - Over the course of the topic, I will be able to

- ☐ use appropriate apparatus to make and record a range of measurements accurately **(AT1)**
- ☐ use appropriate apparatus and techniques for conducting and monitoring chemical reactions **(AT3)**
- ☐ make and record of appropriate observations during chemical reactions **(AT5)**
- ☐ demonstrate safe use and careful handling of gases, liquids and solids **(AT6)**
- ☐ recognise and use expressions in decimal form **(MS1a)**
- ☐ distinguish between exothermic and endothermic reactions on the basis of the temperature change.
- ☐ interpret a reaction profile diagram.
- ☐ interpret data for relative reactivity of different metals and evaluate the use of cells.
- ☐ evaluate the use of hydrogen fuel cells in comparison with rechargeable cells and batteries.
- ☐ write the half equations for the electrode reactions in the hydrogen fuel cell.

What are endothermic and exothermic and endothermic reactions?

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

Exothermic

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.

Endothermic

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 hydrogen carbonate.

Some sports injury packs are based on endothermic reactions.

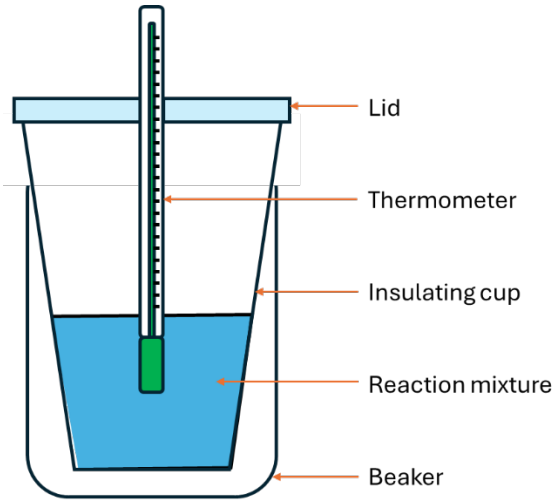
How do we investigate the energy changes in a reaction?

To investigate the factors that affect the temperature changes in a rection we use the apparatus shown in the diagram.

The reactants are added to the insulating cup and the temperature change is measured using a thermometer.

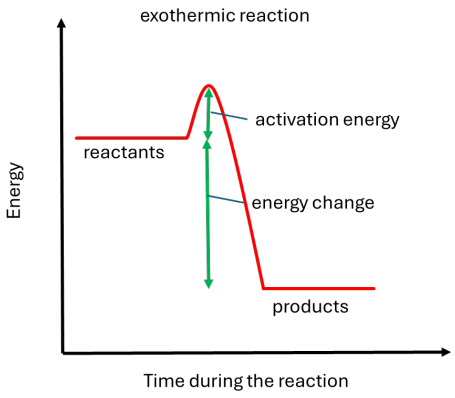
The temperature will change as the reaction happens. It is important that the maximum temperature change is recorded before the products return to room temperature.

An insulated cup and lid are used to stop heat transferring to the surroundings. The beaker is used to make the cup more stable.



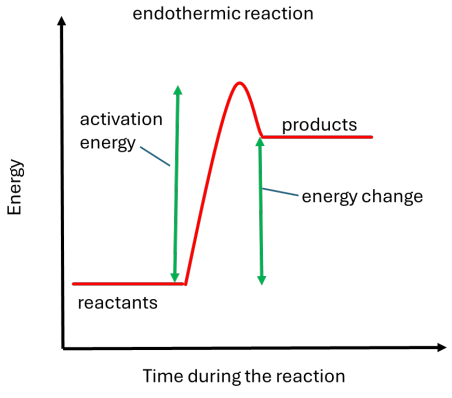
How can we show energy changes?

The minimum amount of energy that particles must have to react is called the activation energy.



To show the energy changes that happen during a reaction we use a reaction profile. This is sometimes called an energy level diagram.

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

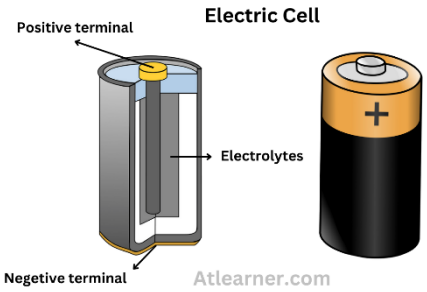


How do cells work?

Cells contain chemicals which react to produce electricity.

A simple cell can be made by connecting two different metals in contact with an electrolyte. The type of metals and electrolyte will affect the voltage.

Batteries consist of two or more cells connected together in series to provide a greater voltage.



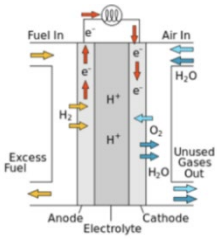
In non-rechargeable cells and batteries the chemical reactions stop when one of the reactants has been used up. Alkaline batteries are non-rechargeable.

Rechargeable cells and batteries can be recharged because the chemical reactions are reversed when an external electrical current is supplied.

How do fuel cells work?

Fuel cells are supplied by an external source of fuel (eg hydrogen) and oxygen or air. The fuel is oxidised electrochemically within the fuel cell to produce a potential difference.

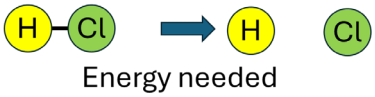
The overall reaction in a hydrogen fuel cell involves the oxidation of hydrogen to produce water.



Hydrogen fuel cells offer a potential alternative to rechargeable cells and batteries.

Type of cell	Pros	Cons
Alkaline cell	Cheaper to manufacture	May end up in landfill sites once fully discharged; recyclable though it is expensive
Rechargeable cell	Can be recharged many times before being recycled, reducing the use of resources	Costs more to manufacture
Hydrogen fuel cell	Easy to maintain as there are no moving parts; small size; water is the only chemical product	Very expensive to manufacture; need a constant supply of hydrogen fuel, which is a flammable gas

How do the bonds between atoms affect a reaction?



During a chemical reaction:

- energy must be supplied to break bonds in the reactants
- energy is released when bonds in the products are formed.



The energy to make or break bonds is calculated from bond energies.

The difference between the energy used to break bonds and released to make bonds is the overall energy change of the reaction.

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

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

Key vocabulary	
Activation energy	The minimum amount of energy reactant particle must have when they collide inorder to react
Battery	Two or more cells connected together in series
Bond	The attraction of two atoms for each other caused by the transfer or sharing of electrons.
Bond energy	The amount of energy required to break a bond, or The amount of energy released when a bond is made.
Cell	A system that contains chemicals which react and produce a voltage
Electrode	An electrical conductor that is placed in a an electrolyte
Electrolyte	A liquid that is used to conduct electricity.
Endothermic	A reaction that takes energy from the surroundings. It causes the temperature of the surroundings to fall.
Energy level diagram	A chart showing how the energy levels change as a reaction progresses. Also known as a reaction profile
Exothermic	A reaction that releases energy to the surroundings. It causes the temperature of the surroundings to rise
Fuel cell	A cell that is supplied with oxygen and fuel and produces a voltage rom their reaction.
Oxidation	The loss of electrons during a reaction. The opposite of reduction.
Potential difference	The difference in electrical energy between two points. It causes a current to flow in a conductor. It is sometimes called a voltage.
Product	The substance made in a chemical reaction.
Reactant	The substances that are used in a chemical reaction.
Reaction profile	A chart showing how the energy levels change as a reaction progresses. Also known as an energy level diagram.
Rechargeable	A battery where the chemical reaction can be reversed and the chemicals returned to their original form.
Reduction	The gain of electrons during a reaction. The opposite of oxidation.