science

chemistry

Topic 5 – Energy Changes

Exothermic Reactions

An exothermic reaction is one which gives out heat energy to the surroundings, e.g. respiration, combustion (burning) or explosions.
Exothermic reactions make the surroundings get warmer so temp increases.

Endothermic Reactions

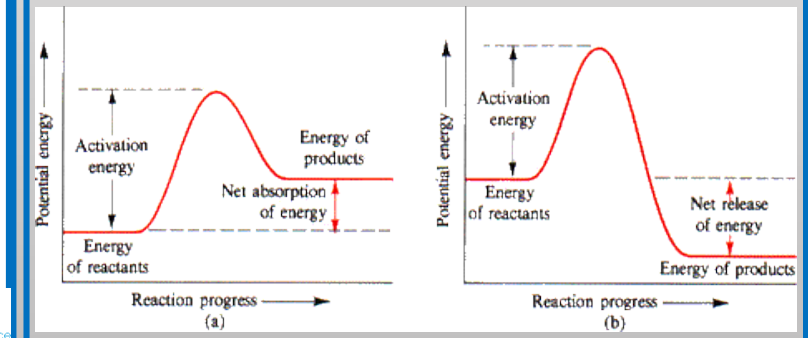
An endothermic reaction (or change) is one which takes in heat energy from the surroundings, e.g. photosynthesis, thermal decomposition reactions or dissolving ammonium nitrate in water.
Endothermic reactions make the surroundings get colder so temperature decreases.

Remember measuring temp

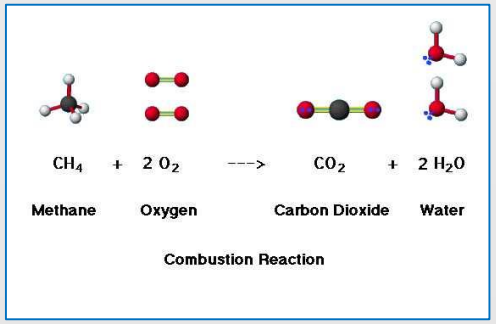
We measure the temperature of the surroundings (the liquid the chemicals are in, the air around it, the glass beaker etc). So if the temperature of the surroundings increases it must be that the energy used to increase the temperature has come from the chemicals. The chemicals have less energy at the end as it has gone into the surroundings.

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

Graph a – shows what happens during an endothermic reaction (the products are higher in energy
Graph b – shows and exothermic reaction(the products are lower in energy.



Making and Breaking



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**.

Catalysts provide a different pathway for a chemical reaction with a lower activation energy.

Required Practical – measuring energy changes.

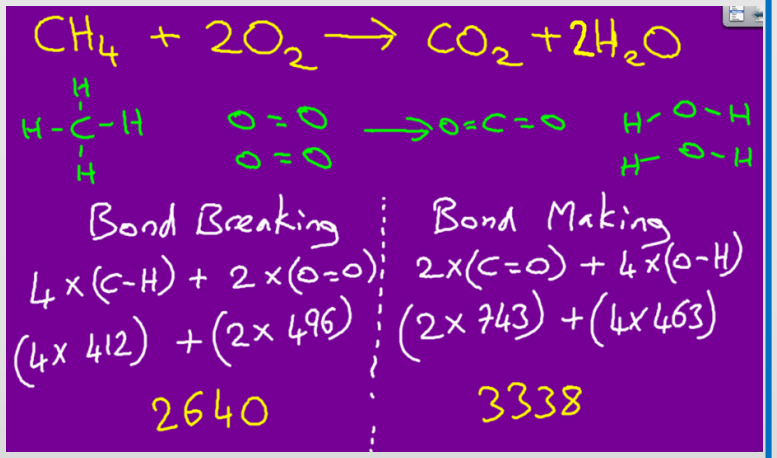
The amount of energy released or absorbed by a chemical reaction in solution can be calculated from the measured temperature change of the solution when the reactants are mixed in an insulated container (making sure you keep stirring and insulate the container / beaker to minimise heat transfer to / from the surroundings.

This method can be used for reactions of solids with water or for neutralisation reactions. (e.g. an acid and an alkali.)
If you add more acid or alkali (or increase the concentration) the temperature change will become greater. This is because there are more particles to react with.
However it will only increase up to a certain point as one of the reactants will be limiting whilst the other is in excess.
See graph to the right.

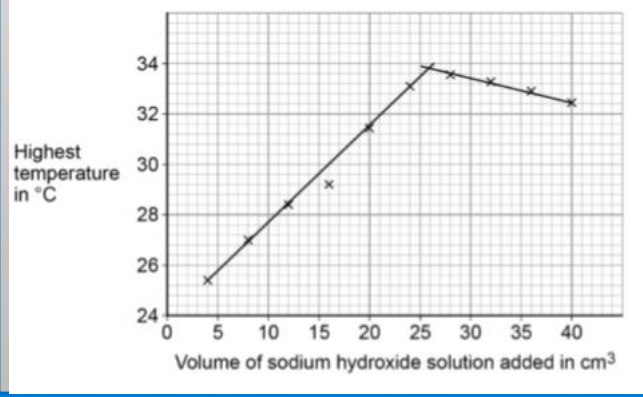
Bond Energy Calculations During a chemical reaction:

- energy must be supplied to break bonds (endothermic)
- energy is released when bonds are formed (exothermic)

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.
You should be able to calculate the energy transferred in reactions using supplied bond energies. Total energy change is the sum of the bonds broken – sum of bonds formed.
e.g. for the combustion of methane:



Overall energy change = total bonds broken – total bonds formed
= 2640 – 3338
= -698 KJ/mol



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Topic 5 – Energy Changes (Single Chemistry ONLY)

Electrochemical cells

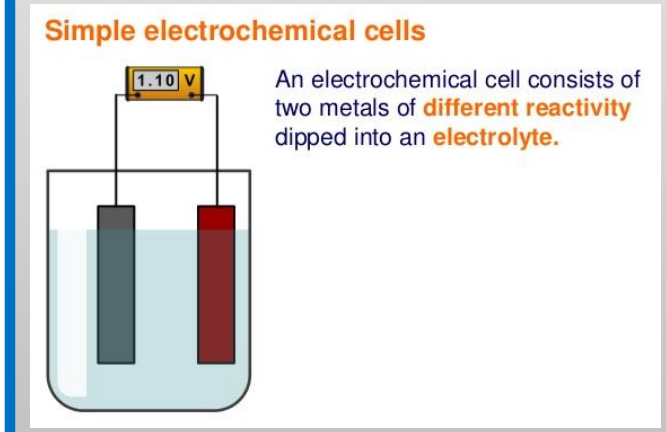
Simple cells contain chemicals which react to produce electricity.
A simple cell can be made by connecting two different metals in contact with an electrolyte.
They work on the idea that you have two metals of different reactivity.
In a simple cell zinc atoms donate electrons via the connecting wires to the copper ions. The zinc is therefore acting as the negative terminal of the battery.

The voltage produced by a cell is dependent upon a number of factors including the type of electrode, electrolyte, and the difference in reactivity between the two electrodes.
Batteries consist of two or more cells connected together in series to provide a greater voltage.

Non – rechargeable cells and batteries

The chemical reactions stop when one of the reactants has been used up. Alkaline batteries are non-rechargeable. They have to be recycled as they contain heavy metals.

Rechargeable cells and batteries can be recharged because the chemical reactions are reversible so when an external electrical current is supplied the reaction goes in the opposite direction. However they are more expensive.



Fuel Cells

Advantages

Direct energy transfer – energy not converted into heat first but straight into electrical energy.
Less polluting (water only product).
Fuels cells last longer than conventional batteries – don't need to be recharged.

Disadvantages

Hydrogen is highly flammable.
Difficult to store as it is a gas.
The hydrogen produced for the cells can be made by non-renewable sources.

Half equations

$Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$

Mg is more reactive so is oxidised to Mg^{2+} ions (OIL)
$Mg \rightarrow Mg^{2+} + 2e^-$

Zinc ions are reduced to zinc metal by gaining electrons (RIG)
$Zn^{2+} + 2e^- \rightarrow Zn$

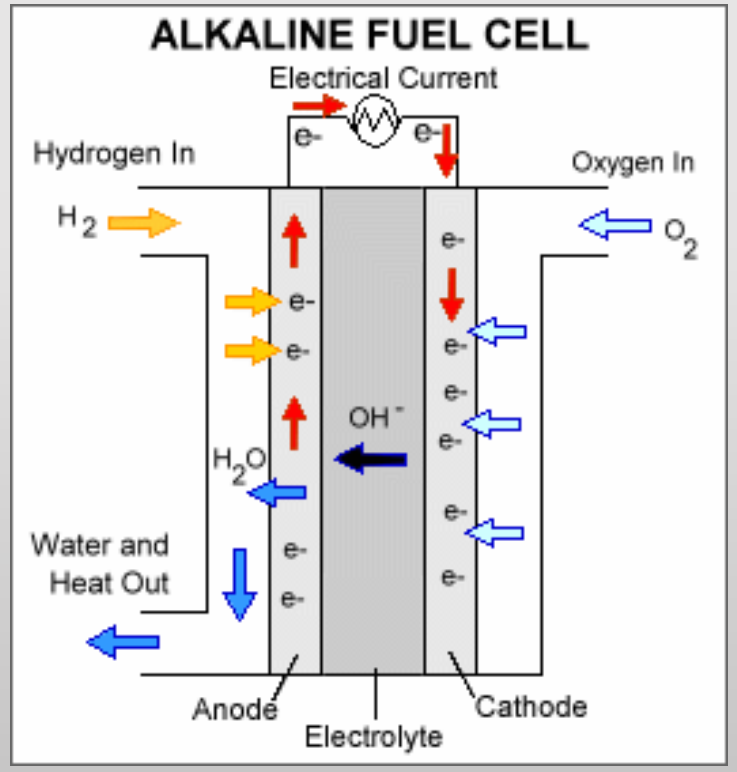
Fuel cells

Fuel cells are a special type of electric cell.
They do not need replacing or recharging.
They do have tank that's needs refilling every now and then.
The fuel is hydrogen & it reacts with oxygen from the air releasing water & lots of energy.
Hydrogen is supplied to the negative electrode.

$2H_{2\,(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^-$

Oxygen is supplied to the positive electrode

$O_{2\,(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$



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