science

chemistry

GCSE C5 – Energy Changes

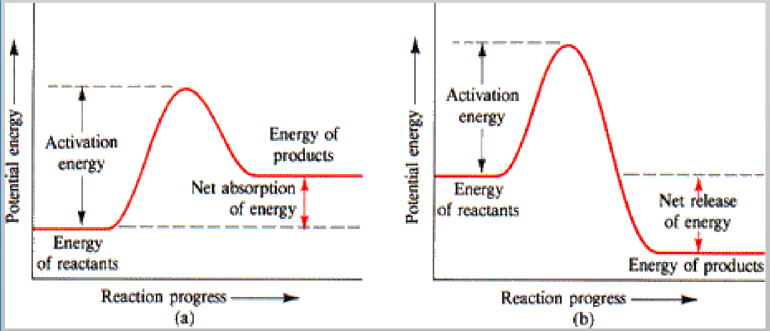
1) Exothermic Reactions
- An exothermic reaction gives out heat energy to the surroundings (e.g. combustion, neutralisation, respiration).
- In exothermic reactions the temperature increases.

2) Endothermic Reactions
- An endothermic reaction takes in heat energy from the surroundings (e.g. photosynthesis, thermal decomposition)
- In endothermic reactions the temperature decreases.

3) Measuring temperature
We measure the temperature of the surroundings (the liquid the chemicals are in, the air around it, the glass beaker etc). If the temperature of the surroundings increases it must be that the energy used to increase the temperature has come from the chemicals. If the chemicals have less energy at the end it has transferred to the surroundings. We can use a digital thermometer to more accurately record the temperature.

4) Reaction profiles (energy level diagrams)
These are used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.

Graph a – shows an endothermic reaction as the products are higher in energy than the reactants.
Graph b – shows an exothermic reaction since the products are lower in energy than the reactants.

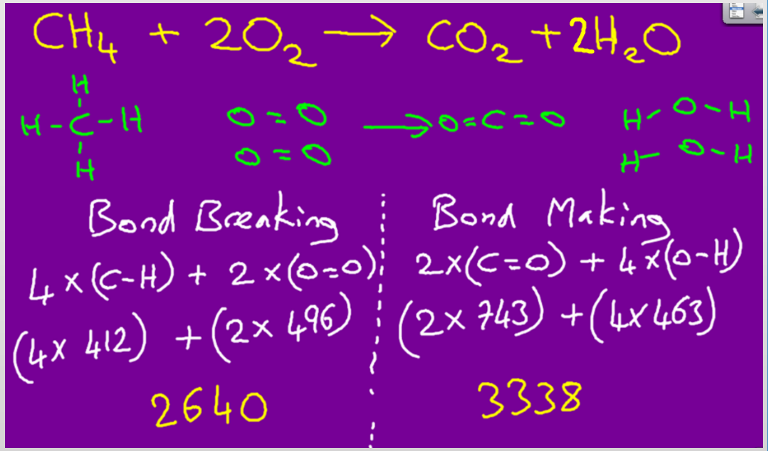


5) Bond Energy Calculations (HT)
During a chemical reaction:
- energy must be supplied to break bonds (endothermic)
- energy is released when bonds are formed (exothermic)

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.

Overall energy change = sum of bonds broken – sum of bonds made

e.g. for the combustion of methane:



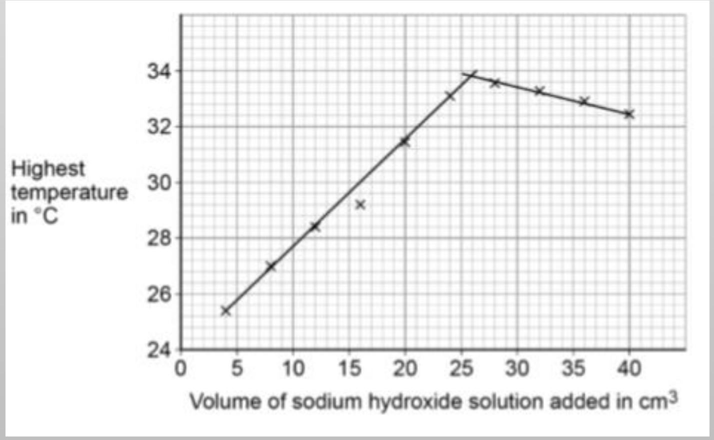
Overall energy change = bonds broken – bonds made
= 2640 – 3338
= -698 kJ/mol

6) Activation energy
- This is the <u>minimum</u> amount of energy that particles must have to react.
- Catalysts provide a different route with a <u>lower activation energy</u> for the reaction to occur.

7) 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.

- Add a fixed volume of water to a beaker / test tube
- Insulate the beaker
- Measure the initial temperature (with a thermometer)
- Add a fixed mass of solid / volume of liquid
- Stir the mixture
- Measure the final temperature of the solution
- Calculate the temperature change
- Repeat with different masses
- Repeat with the same volume of water

This method can be used for reactions of solids with water or for neutralisation reactions (e.g. an acid and an alkali).
However it will only increase up to a certain point as one of the reactants will be limiting whilst the other is in excess.



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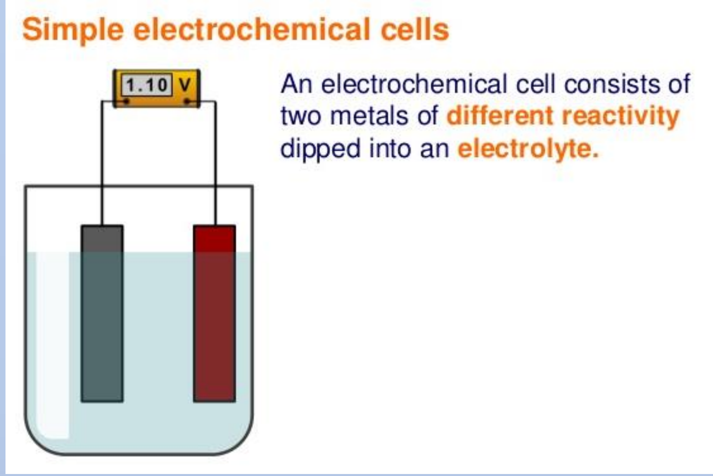
GCSE C5 – Energy Changes (Single Chemistry ONLY)

8) Electrochemical cells

Simple cells contain chemicals which react to produce electricity.

- A simple cell can be made by connecting two metals (with different reactivity) in contact with an electrolyte.
- Batteries consist of two or more cells connected together in series to provide a greater voltage.



- The voltage produced depends upon a number of factors including the type of electrode, electrolyte, and the difference in reactivity between the two electrodes.

9) 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.

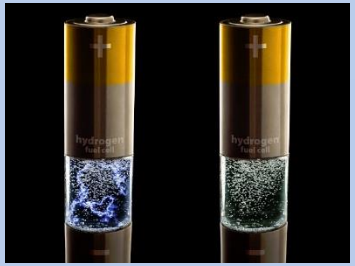
10) Rechargeable cells and batteries

- 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.

11) Fuel Cells

Advantages

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



Disadvantages

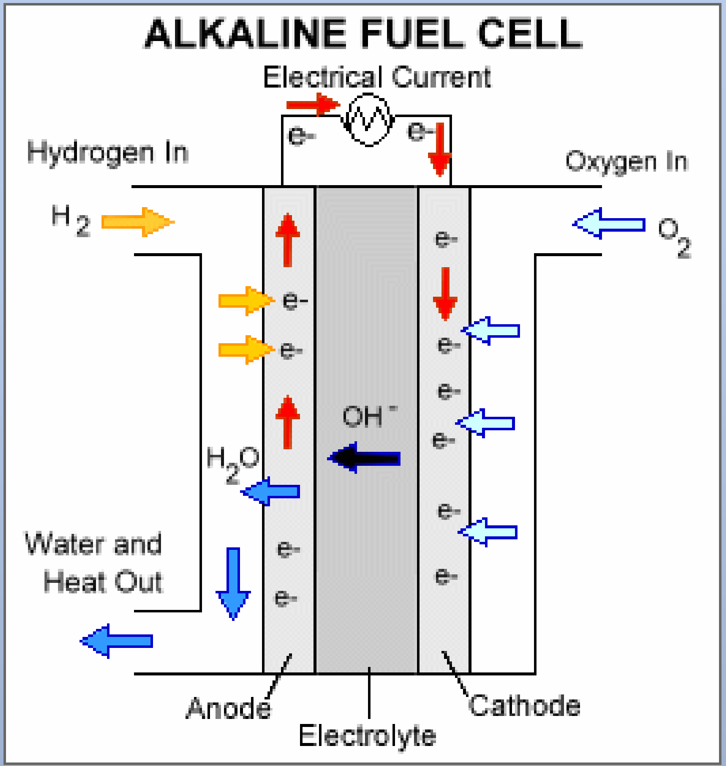
- Hydrogen is highly flammable.
- Difficult to store as it is a gas.
- The hydrogen produced for the cells can be made by non-renewable sources.

12) Fuel cells – how they work

- Fuel cells are a special type of electric cell.
- They do not need replacing or recharging.
- They do have tank that 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.
- $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$

- Oxygen is supplied to the positive electrode
- $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$



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