Topic 5 – Energy changes

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5.1.1 Energy transfer during exothermic and endothermic reactions
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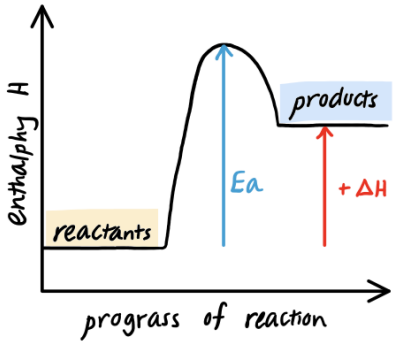
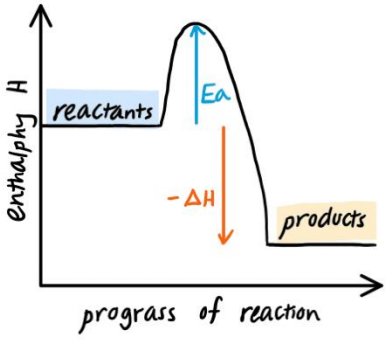
Exothermic

- Eg thermal decomposition, citric acid + $NaHCO_3$
- Take in energy from surroundings
- Temp ↓
- Products more energy than reactants
- Energy taken to break bonds more than energy released when making bonds



Endothermic

- Combustion (O_2 + heat), neutralisation
- Gives out energy to surroundings
- Temp ↑
- Products less energy than reactants
- Energy released to make bonds more than energy taken when breaking bonds



Activation energy (Ea) – min energy required to start a reaction
Enthalpy change = ∑ reactants - ∑ products

Describe an experiment that the student could do to prove that this reaction is exothermic.
To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words. (6)

1. Pour cold water into a beaker
2. Take temp of water at the start using a thermometer
3. Pour soup power into beaker of cold water and mix it with a glass rod
4. Take temp of the solution with a thermometer
5. The temp increases which indicate that it's an exothermic reaction

How to reduce heat loss? (1)

- Add a lid / use insulation

Suggest why it's important to stir the chemicals thoroughly (1)

- To make sure all substances are fully reacted

Why scientists' conclusion immediately accepted? (2)

- They had proof
- Experiment can be repeated

How reliability of work confirmed? (1)

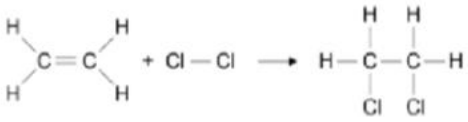
- Experiment was repeated

Describe overall reaction (2)

- Net energy transfer
- Exo/endo reaction

Figure 3 shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

Figure 3



"The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms."

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

Size and strength

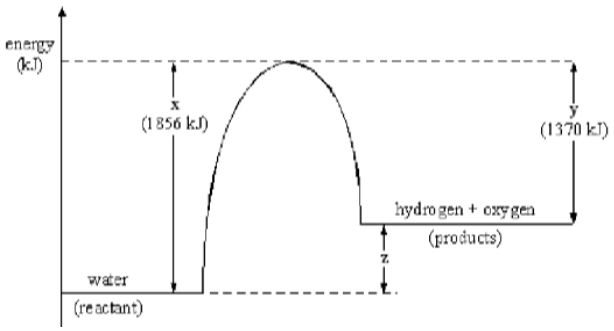
- Cl atoms have fewer electron energy levels / shells
- Cl atoms form stronger bonds
- Cl-Cl bond stronger than Br-Br
- C-Cl bond stronger than C-Br

Energy required

- More energy required to break bonds with Cl
- More energy given out when making bonds with Cl
- Overall energy change depends on size of energy changes

Conclusion

- If C-Cl bond changes less → exothermic
- If C-Cl bond changes more → endothermic
- Can't tell how overall energy change will differ as don't know which changes more



X - energy required to break bonds of water (activation energy)

Y - Energy released when hydrogen + oxygen formed

Z: 1856-1370=486 kJ

Overall, reaction is endothermic

5.2 Chemical cells and fuel cells (chemistry only)

5.2.1 Cells and batteries

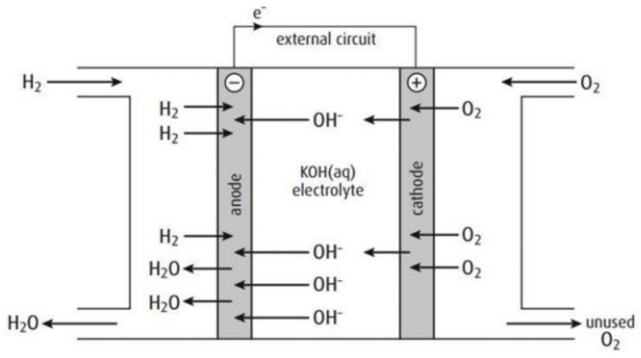
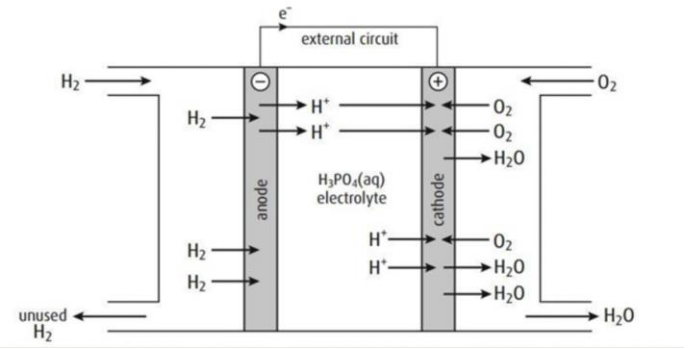
- **Cells** – chemical react → produce electricity
- **Voltage** produced depend on type of electrode & electrolyte

- **Simple cell** – connect 2 different metals in contact with electrolyte
- **Batteries** – 2+ cells connected in series to provide greater voltage
- **Non-rechargeable** – chemical reaction stops coz 1 reactant used up eg alkaline batteries
- **Rechargeable** – reversible reaction → connected to external electrical current

5.2.2 Fuel cells

Bigger the difference of reactivity between metal electrode & copper, higher the voltage

Hydrogen fuel cells

In alkaline condition	In acidic condition
	
In **anode** H_2 (g) + $2OH^-$ (aq) → $2H_2O$ (l) + $2e^-$ In **cathode** O_2 (g) + $2H_2O$ (l) + $4e^-$ → $4OH^-$ **Overall** $2H_2$ (g) + O_2 (g) → $2H_2O$ (l)	In **anode** H_2 (g) → $2H^+$ (aq) + $2e^-$ In **cathode** O_2 (g) + $4H^+$ (aq) + $4e^-$ → $2H_2O$ (l) **Overall** $2H_2$ (g) + O_2 (g) → $2H_2O$ (l)

Advantages	Disadvantages
• X electrically recharged • X pollution coz only water is produced • Range of sizes for different uses	• Highly flammable • If H_2 – not come from renewable source • Hard to store coz explosive

What type of energy is released by hydrogen fuel cells? (1)

- Electrical

Batteries consist of electrochemical cells. Describe how a 9.0V battery can be made from cells of voltage 1.5V (2)

- Use 6 cells of 1.5V each
- Connect them in series to create a battery of 9V

Non-rechargeable cells eventually stop producing electricity. Explain why and name a typical cell that is non-rechargeable. (4)

- One of the reactants is used up which stops the chemical reactions
- There's no flow of electrons so cell stops producing electricity
- Alkaline batteries are typical non-rechargeable cells

Give 2 reasons why using hydrogen fuel cells is seen as a clean source of energy (2)

- Produce water which is non-polluting

Rechargeable cells are cells that can be recharged. Explain how this process occurs (4)

- The chemical reactions are reversed when an external electrical current is supplied

Give 3 factors that affect the voltage produced by cell (3)

- Type of electrode
- Concentration of electrolyte
- Temp
- Electrolyte