C7: Energy Changes: Chemistry Specification

Energy Changes
In a chemical reaction energy is conserved. This means that the amount of energy of energy that goes into a chemical reaction comes out of the reaction.

Exothermic Reactions
An exothermic reaction transfers energy to the surroundings so the temperature of the surroundings increases. This means that the products have less energy that the reactants. Examples of exothermic reactions include combustion, oxidation reactions and neutralisation. Uses of exothermic reactions include self-heating cans and hand warmers.

Cells and Batteries
Cells contain chemicals which react to produce electricity. The voltage produced depends on the the type of electrode and electrolyte. A simple cell can be made by connecting two different metals in contact with an electrolyte. Batteries consist of two or more cells connected together in series to produce a higher 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.

Fuel Cells
Fuel cells are supplied by an external source of fuel and the fuel is oxidised electrochemically within the fuel cell to produce a potential difference. A hydrogen fuel cell involves the oxidation of hydrogen to produce water.

Hydrogen + Oxygen → Water

$$2H_2 + O_2 \rightarrow 2H_2O$$

This can be represented with the half equations:

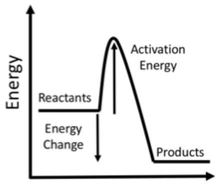
$$2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$$

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

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

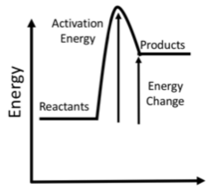
Reaction Profiles
Chemical reactions occur when reacting particles collide with each other with enough energy. The minimum amount of energy that particles must have to react is called the activation energy. This activation energy is needed for a reaction to occur. Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction. You need to be able to draw simple reaction profiles.

Exothermic Reaction Profile
An exothermic reaction can be represented with the following reaction profile:



This shows that the reactants have more energy than the products. This is because energy is released into the surroundings.

Endothermic Reaction Profile
An endothermic reaction can be represented with the following reaction profile:



This shows that the reactants have less energy than the products. This is because energy is taken in from the surroundings.

How to Calculate Energy Changes
1. Check the symbol equation is balanced. If not balance it.
2. Identify the different bonds in the reactants.
3. Identify how many of each type of bond there is.
4. Calculate the energy needed to break these bonds.
5. Identify the different bonds in the products.
6. Identify how many of each type of bond there is.
7. Calculate the energy released when these bonds are formed.
8. Calculate the overall energy change using the formula:
   Energy Change = Bonds Broken – Bonds Made
9. Add the units kJ.

An endothermic reaction will have an energy change that is a positive number, while an exothermic reaction will have an energy change that is a negative number. You will be given a table of common bond energies to use in your calculations.

Endothermic Reactions
An endothermic reaction takes in energy from the surroundings so that the temperature of the surroundings decreases. This means that the products have more energy than the reactants. Examples of endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate. Uses of endothermic reactions include some sports injury packs cool packs.

Energy Changes Calculations
During a chemical reaction energy must first be supplied to break the bonds in the reactants. When bonds in the products are formed energy is then released. The energy needed to break bonds and the energy released when bonds are formed can be calculated from bond energies. The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed 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 while in an endothermic reaction, the energy needed to break existing bonds is greater than the energy released from forming new bonds.

Energy Changes Worked Example:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Bonds Broken	Bonds Made
H-H x 2 = **436** x 2 = 872 O=O x 1 = **498** = 1370 kJ	H-O x 4 = **464** x 4 =1856 kJ

Overall Energy Change = Broken – Made
= 1370 – 1856 = -486kJ

This is an exothermic reaction.
The values in bold are the bond energies that will be given to you in the exam paper!