Chemistry C7 – Energy Changes

1: Law of the conservation of energy

Energy is conserved. This means that the amount of energy in the universe is the same at the start of a reaction and at the end of a reaction.
If the energy within the chemical bonds changes from the reactants to the products (which happens a lot), then the surroundings must either heat up or cool down to keep the total energy the same.

2: Exothermic

A reaction that gives out energy. The temperature of the surroundings increases and the air around the reaction will feel hot. Examples: all combustion (burning) reactions, neutralisation (acid + base) reactions.
Uses:. self-heating hand warmers and self heating coffee cups. The energy in the bonds of the reactants will be higher than the energy of the products.

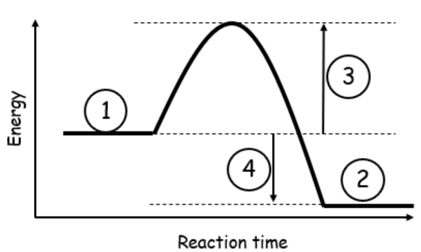
3: Endothermic

A reaction that takes in energy. The temperature of the surroundings decreases and the air around the reaction will feel cold. Examples: thermal decomposition reactions (when you add lots of heat to make the chemicals react) and the reaction between citric acid and sodium bicarbonate. Uses: sports injury or burns cooling pack. The energy in the bonds of the reactants will be lower than the energy of the products.

4: Reaction profile diagram

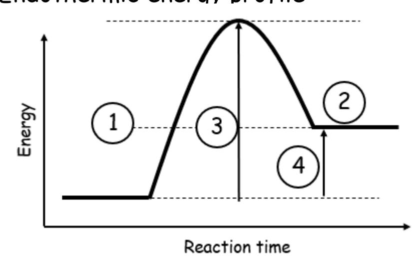
A diagram that shows the energy of the chemical bonds in the reactants and of the products, and how much energy is required to start the reaction (the activation energy E_A). All reactions require particles to collide.

Exothermic energy profile



Product energy is lower than reactant

Endothermic energy profile



Product energy is higher than reactant

1 = reactants. 2 = products. 3 = activation energy (arrow must go from the reactants to the top of the curve), 4 = overall energy change (arrow must go from the reactants to the products)

5: (Higher only) Calculating bond energy

In all chemical reactions breaking the bonds of the reactants needs energy added to the chemicals and making bonds in the new products releases energy.

You will be given a table of the bond energies (you will not need to learn them)

You will need to:
- count the number of each type of bond
- multiply it by the energy for that type of bond.

Then you will need to calculate:
- the total energy needed to break all the bonds in the reactants
- the total energy released when making all the bonds in the products
- the difference between the two totals

If the reaction is endothermic: energy from breaking bonds is biggest
If the reaction is exothermic: energy from making bonds is biggest

6:Cells and Batteries

A cell is made of two different metals and an electrolyte. Because the metals are different, electrons will flow from one metal to the other to produce an electric current. The bigger the difference in reactivity between the two metals the greater the voltage the cell can produce. (Recall reactivity series).
A battery is made up of two or more cells in series which increases the potential difference (voltage) as you will have seen in physics.
Alkaline batteries can only be used once before going flat. Rechargeable batteries can be reused because charging up the battery reverses the chemical process that happens when the battery is in use.

7: Fuel cells

A fuel cell is provided with a fuel (eg hydrogen) and air or oxygen. The fuel is oxidised electrochemically in the fuel cell to produce a potential difference.
Fuel cells can be used in place of a combustion (petrol) engine with two benefits. 1. it does not release thermal energy as waste (a petrol engine does). 2. The only product of this reaction is water, unlike a petrol engine which produces many harmful gases. (Recall atmospheric gases from C13)

8: (Higher only) fuel cell half equation

At the Negative electrode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$
At the Positive electrode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$
Ultimately: hydrogen (g) + oxygen (g) → water (l)
Or in symbols: $2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(l)}$