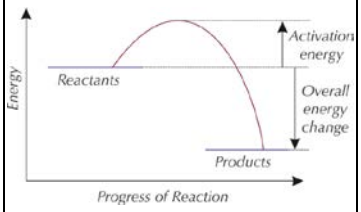
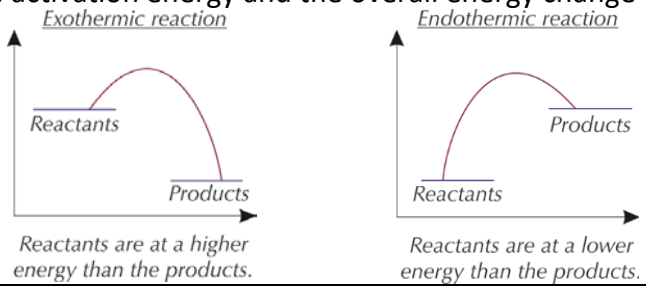
4.5 Energy changes – Knowledge organiser

4.5.1	Exothermic and endothermic reactions
4.5.1.1 Energy transfer during exothermic and endothermic reactions	Energy is **conserved** in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place. If a reaction transfers energy to the surroundings the product molecules must have less energy than the reactants, by the amount transferred. An **exothermic** reaction is one that transfers energy **to the surroundings** so the temperature of the **surroundings increases**. Exothermic reactions include **combustion**, many **oxidation** reactions and **neutralisation**. Everyday uses of exothermic reactions include self-heating cans and hand warmers. An **endothermic** reaction is one that takes in energy **from the surroundings** so the temperature of the **surroundings decreases**. Endothermic reactions include **thermal decompositions** and the reaction of citric acid and sodium hydrogencarbonate. Some sports injury packs are based on endothermic reactions. **Required practical 4**: Investigate the variables that affect temperature changes in reacting solutions
4.5.1.2 Reaction profiles 	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**. 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. 
4.5.1.3 The energy change of reactions (HT only)	During a chemical reaction: • energy must be **supplied** to **break bonds** in the reactants (endothermic) • energy is **released** to **form bonds** in the products (exothermic). 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. ***Energy change = Energy of bond breaking – Energy of bond making*** ***(reactants) (products)*** 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.

4.5.2	Chemical cells and fuel cells (Chemistry only)
4.5.2.1 **Cells and batteries**	**Cells** contain **chemicals** which **react** to produce **electricity**. The voltage produced by a cell is dependent upon a number of factors including 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 provide a **greater** voltage. In **non-rechargeable** cells and batteries the chemical reactions stop when a **reactant 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.
4.5.2.2 **Fuel cells**	**Fuel cells** are supplied by an **external source of fuel** (eg hydrogen) **and oxygen** or air. The **fuel is oxidised** electrochemically within the fuel cell **to produce a potential difference**. The overall reaction in a **hydrogen fuel cell** involves the oxidation of hydrogen to **produce water**. Hydrogen fuel cells offer a potential alternative to rechargeable cells and batteries.