Oasis Academy Brislington

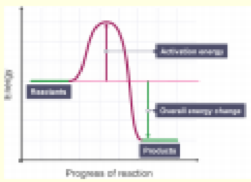
Year 10 – Summer 1– Reacting substances

Exothermic & Endothermic reactions

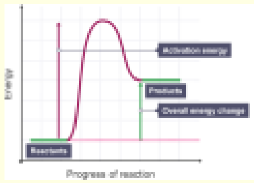
(a) **Exo**thermic: a reaction that **gives out** energy to the surroundings (temperature **increases**)

(b) **Endo**thermic: a reaction that **takes in** energy from the surroundings (temperature **decreases**)

(c) **Energy level diagram** (reaction profile) shows the energy changes taking place in a chemical reaction



(i) Exothermic reaction



(ii) Endothermic reaction

(e) **Activation energy** the minimum amount of energy required for a reaction to take place

(f) In a reaction, chemical bonds are **broken** and **made**.

Breaking bonds = **require** energy = **endo**thermic process
Making bonds = **release** energy = **exo**thermic process

More energy required than released = endothermic reaction
More energy released than required = exothermic reaction

2. Cells and Batteries (triple only)

(a) **Cell** (electrical): contains chemicals that react together to release energy.

The voltage of a cell can be changed by changing the type *of electrode and the type of electrolyte*

(i) **Electrode**: *An electrical conductor used in a cell*

(ii) **Electrolyte**: *A solution* or molten substance that is broken down during electrolysis.

(b) **Battery**: Multiple cells connected together.

(i) **Non-rechargeable battery** – stops producing electricity when one of the reactants has been used up!

(ii) **Rechargeable battery** – the chemical reaction can be reversed using an external electrical current so the battery can be reused.

(c)**Fuel Cell**: Efficient way of producing electrical energy where a fuel is oxidised electrochemically to produced a potential difference (or voltage) (normally *hydrogen*).

Anode: $2H_2 \rightarrow 4H^+ + 4e^-$
Cathode: $O_2 + 4H^+ + 4e^-$ $2H_2O$

+ less stages, less polluting, more efficient

3. Rates of reaction

(a) This is a measure of **how quickly a reactant is used up or a product is made**.

(b) This can be measured by:

(i) Dividing the **amount of reactant** used up by the time taken (g/s)

(ii) Diving the **total volume of product** (gas) produced by the time taken (cm^3/s)

(iii) Measuring the time taken for the reaction mixture to **change colour/become opaque**.

RoR = (1/time taken)

(c) **Collision theory**: *Chemical reactions only occur when the reacting particles collide with each other with sufficient energy. The minimum energy required for a reaction is called the activation energy.*

(d) **4 factors** affecting rate of reaction:

Temperature –
(i) Hot reaction
(ii) Particles move faster
(iii) Collide more often
(iv) Greater energy
(v) More collisions are successful
(vi) Faster reaction

Concentration –
(i) Higher concentration
(ii) Particles closer together
(iii) Collide more often
(iv) More successful collisions
(v) Faster reaction

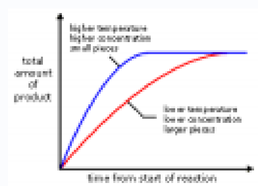
Surface Area –
(i) Large surface area
(ii) Smaller pieces of solid reactant
(iii) More particles exposed
(iv) More collisions
(v) Faster reaction

Catalyst –
(i) Provides an alternative pathway with a lower activation energy
(ii) More successful collisions
(iii) Faster reaction

(c) **Limiting reactant**: This is the reactant that is completely used up in a reaction. It stops the reaction from continuing.

(d) **Rates of reaction graphs**:

- *Steep line* = *fast reaction*
- *Horizontal line* = reaction has stopped (one reactant has finished)
- (given enough time) *The lines will meet* = both products will produce the same amount of product from the same amount of reactants, just at a different rate.
- *Gradient of line* = rate of the reaction!



5. Le Chatelier's Principle (HT)

Le Chatelier's principle – if a system that is in equilibrium is subjected to a change in conditions, the system will shift to counteract the change.

Exothermic reactions:
Temperature ↑ = Yield ↓
Temperature ↓ = Yield ↑

Endothermic reactions:
Temperature ↑ = Yield ↑
Temperature ↓ = Yield ↓

Gas reactions:
Pressure ↑ = Favours the side that produces **least** number of gas molecules

Pressure ↓ = Favours the side that produces **largest** number of gas molecules

Concentration of reactant/product:

System no longer in equilibrium so favours the reaction which will return to equilibrium.

E.g. ↑reactant concentration = ↑ products formed

↑ product concentration = ↓ products formed

4. Reversible reactions

(a) Reversible reactions: *A reaction that can go forwards and backwards.*

$$A + B \rightleftharpoons C + D$$

In a reversible reaction, the reaction will be endothermic in one direction and exothermic in the other direction.

e.g. *Ammonium chloride* ⇌ *ammonia + hydrogen chloride* (heat / cold)

(b) Equilibrium: When the rate of the forward reaction is equal to the rate of the backwards reaction.

6. Units

Measurement	Unit (words)	Unit
Mass	Grams	g
Volume	Centimetres cubed	cm^3
Rate	Grams per second	g/s
Rate	Centimetres cubed per second	Cm^3/s
Rate	Moles per second	Mol/s
Concentration	Moles per decimetre cubed	Mol/dm^3
Moles	Mol	Mol
Percentage Yield	Percent	%
Atom Economy	Percent	%
Relative Atomic Mass (Ar)	No unit	No unit
Relative Formula Mass (Mr)	No unit	No unit

7. Calculations

(a) Conservation of Mass: Mass of reactants = mass of products

(b) Relative Atomic Mass (Ar) the mass of one atom e.g. Ar of carbon = 12 (shown in the periodic table)

(c) Relative Formula Mass (Mr) the sum of the relative atomic masses of all the atoms in a formula e.g. $CO2 = 12 + 16 + 16 = 44$

(d) Atom economy = how much of the reactant is turned into **useful** product.

(e) Percentage yield = tells us how much of a product is actually produced compared to the theoretical yield

$$\text{Percentage yield (\%)} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

(f) Factors effecting percentage yield are:

- Products being lost during transfer from one container to another
- Not all of the reactants reacting together
- Some of the products escaping as a gas
- Some reactants forming a product with an unexpected substance

8. Calculations (HT)

(a) **Calculating yield**: Calculate the yield of a product when given the mass of a reactant

$$\textbf{Mass of desired product} = \frac{\textbf{Mr of desired product} \times \textbf{mass of reactant}}{\textbf{Mr of reactant}}$$

Moles: A measure of the number of particles in a substance

1 mole = 6.02×10^{23} (This is called the **Avogadro Constant**)
Ar = Mass of one mole of an element (i.e. six hundred thousand billion billion atoms of carbon will weigh 12g.)

$$\text{Moles (Mol)} = \frac{\text{Mass (g)}}{Mr}$$

1 mole of gas at room temp takes up a volume of $24dm^3$

$$\textbf{Volume = amount (mol)} \times 24dm^3$$

(b) Calculating masses of reactants from a balanced equation

1. Write down balanced symbol equation
2. Work out the Mr of each substance

$$MassA = \frac{MassB}{MrB} \times MrA$$

3. Use the formula to calculate the mass of substance A.

9. Acids and Alkalis

(a) When a substance dissolves in water, they dissociate (split) into their individual ions

Hydroxide ions (OH-) = alkaline
Hydrogen ions (H+) = acidic

(b) **pH scale** is a measure of acidity/alkalinity of a solution

(c) **Indicators** = a dye that changes colour depending on if it is acidic/alkaline

(d) **Neutralisation** = acid and alkali reacting together to produce a neutral solution

Acid + Metal Oxide -> Salt + Water

Acid + Metal Carbonate -> Salt + Water + Carbon Dioxide

Hydrochloric acid -> Chloride Salts
Nitric acid -> Nitrate salts
Sulphuric acid -> Sulphate salts

(e) Strong acids (E.g. HCl) are completely ionised in water
Weak acids (e.g. ethanoic acid) are only partly ionised in water

10. Concentration (HT)

(a) Concentration = the amount of a substance in a given volume, normally measured in mol/dm^3

$$\textbf{Concentration of a solution } (mol/dm^3) = \frac{\textbf{amount of substance (mol)}}{\textbf{volume } (dm^3)}$$

(b) **Titration:** An accurate technique to calculate how much acid is needed to neutralise an alkali (or vice versa)

(c) To calculate concentration using results from a titration:

(i) Write a balanced equation
(ii) Calculate the moles in the substance you know (A) (using equation above)
(iii) Calculate concentration of substance you want to find out (B) (using the equation above)