WJEC Wales Chemistry GCSE

1.5: Rate of chemical change

Detailed notes

Measuring the rate of reaction

Calculations

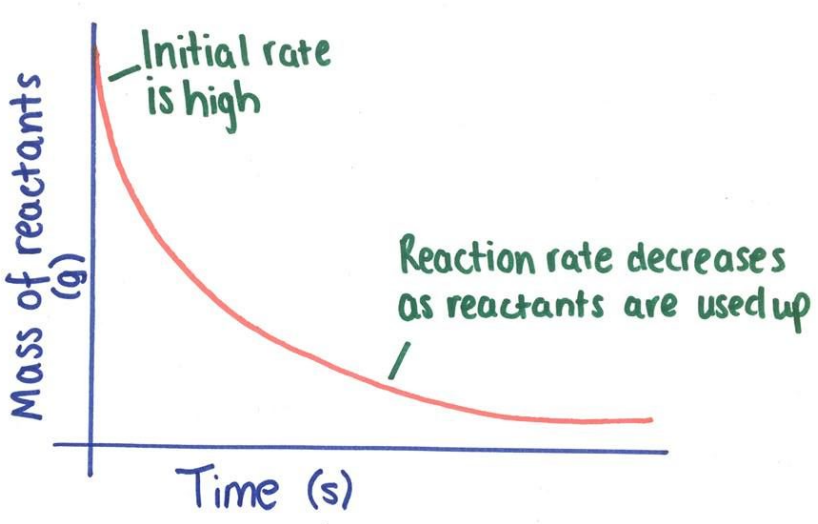
Rate of reaction = $\frac{\text{amount of reactant used}}{\text{Time}}$

Rate of reaction = $\frac{\text{amount of product used}}{\text{Time}}$

- Quantity of reactant or product can be measured by the mass in grams or by a volume in cm^3
- Units of rate of reaction may be given as g/s or cm^3/s
- You can also use quantity of reactants in terms of moles (instead of mass or volume) and therefore, units for rate of reaction in mol/s

Practical methods

- To measure reactant used - if the product is a gas, which will be given off, you can carry out the reaction on a set of weighing scales and measure how much reactant mass is lost over time
- To measure product formed - if the product is a gas, you can measure the volume of gas produced in a gas syringe over time
- With both methods you can use a data logger which records values at given time intervals; this enables you to plot a reaction curve from which you can calculate the initial rate of reaction and the rate of reaction at certain points.
  The reaction graph would look something like this:



Collision theory and activation energy

- Collision theory: chemical reactions can occur only when reacting particles collide with each other and with sufficient energy
- Activation energy: the minimum amount of energy that particles must have to react
- The reactants must collide in the correct orientation

Factors affecting the rate of reaction

There are many factors which affect the rate of reaction. This is important in an industry where the rate of a reaction would want to be maximised. Understanding of collision theory can be used to explain why these factors increase the rate of reaction.

- Concentration of reactants
  - Increasing the concentration increases the frequency of collisions as there are more reactant particles in the same volume
- Pressure
  - Increasing the pressure increases the frequency of collisions as the reactant particles are closer together
- Surface area of reactants
  - A greater surface area means more of the reactant particles are exposed and available to react, so the frequency of collisions increases
- Temperature
  - Increasing the temperature gives particles more kinetic energy.
  - This means they collide more frequently and the collisions have more energy so are more likely to reach the activation energy
- Presence of a catalyst

Catalysts

What are catalysts?

- Catalysts are substances that speed up chemical reactions without being changed or used up during the reaction
- Enzymes are catalysts
- Catalysts are not included in the equation for a reaction
- **Higher tier only: Catalysts decrease the activation energy; this increases the proportion of particles with sufficient energy to react**
- Different catalysts are needed to catalyse different reactions

Enzymes

- Enzymes are catalysts in biological systems
- They are generally made of protein
- Without enzymes the reactions (such as respiration and photosynthesis) occurring in organisms would occur so slowly that the organism could not survive - so they are extremely important!
- Enzymes work best under a certain set of conditions; this may be at a certain temperature and pH.
  - Most enzymes in humans have an optimum temperature of 37 °C, the internal temperature of humans. Above this temperature enzymes can denature and stop working.

Enzyme uses

Enzymes are such good catalysts they are used outside of the human body:

- Many washing detergents contain enzymes
- In the manufacture of cheese
- Yeast is used in the production of ethanol as it is fermented from sugars, ethanol is in alcoholic drinks