6 Rates of reaction

Rates of reaction

The rate of a chemical reaction can be found by measuring the **quantity of a reactant used** or the **quantity of product formed** over time:

- mean rate of reaction = quantity of reactant used/ time taken

or

- mean rate of reaction = quantity of product formed/ time taken

The quantity of reactant or product can be measured by the mass in grams, by a volume in cm^3 or by an amount in moles.

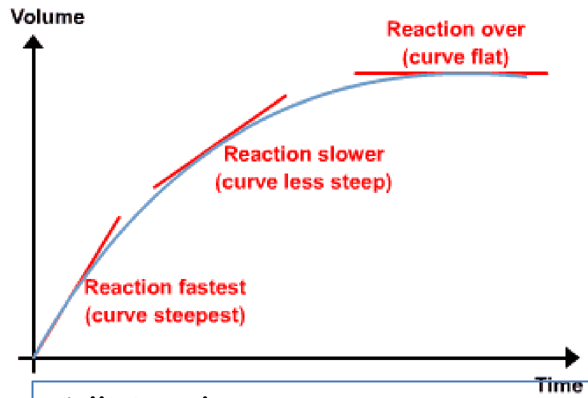
The units of rate of reaction may be given as g/s, cm^3/s or mol/s.

5 Factors which affect the rates of chemical reactions:

- the **concentrations** of reactants in solution,
- the **pressure** of reacting gases,
- the **surface area** of solid reactants,
- the **temperature**
- the presence of **catalysts**.

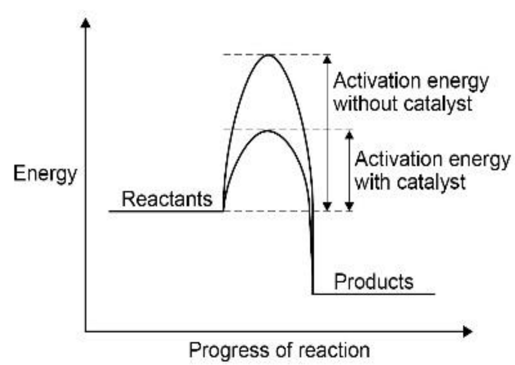
Catalysts

- Catalysts **change the rate** of chemical reactions **but are not used up** during the reaction.
- Different reactions need different catalysts.
- Enzymes act as catalysts in **biological** systems.
- Catalysts increase the rate of reaction by providing **a different pathway** for the reaction that has **lower activation energy**.



Collision theory

- 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**.
- Increasing the **concentration** of reactants in solution, the **pressure** of reacting gases, and the **surface area** of solid reactants increases the **frequency** of collisions and so increases the rate of reaction.
- Increasing the **temperature** increases the **frequency** of collisions and makes the collisions **more energetic**, and so increases the rate of reaction.



Reversible reactions

In some chemical reactions, the products of the reaction can react to produce the original reactants. Such reactions are called reversible reactions and are represented:

$A + B \rightleftharpoons C + D$

If a reversible reaction is **exothermic** in one direction, it is **endothermic** in the opposite direction. The same amount of energy is transferred in each case.

When a reversible reaction occurs in apparatus which prevents the escape of reactants and products, **equilibrium** is reached when the forward and reverse reactions occur at exactly the **same rate.**

Definitions

Equilibrium – A reversible reaction in a sealed container where the rate of the forward and backward reactions are the same.

Exothermic - a reaction that transfers energy to the surroundings so the temperature of the surroundings increases.

Endothermic - a reaction that takes in energy from the surroundings so the temperature of the surroundings decreases.

Catalyst- a substance that alters the rate of a chemical reaction, by changing the activation energy, without being used up itself.

Activation energy - the minimum amount of energy needed for a reaction to start.

Changes to equilibrium HT only

•If a system is at equilibrium and a change is made to any of the conditions, then the system responds to counteract the change.

•The effects of changing conditions on a system at equilibrium can be predicted using **Le Chatelier's Principle**.

•If the <u>concentration</u> of one of the reactants or products is changed, the system is no longer at equilibrium and the concentrations of all the substances will change until equilibrium is reached again.

•If the concentration of a **reactant** is **increased**, **more products** will be formed until equilibrium is reached again. Equilibrium moves to the right.

•If the concentration of a **product** is **decreased**, **more reactants** will react until equilibrium is reached again. Equilibrium moves to the left.

•If the <u>temperature</u> of a system at equilibrium is **increased**:

- •the relative amount of **products** at equilibrium **increases** for an **endothermic** reaction. Equilibrium move to the right.
- •the relative amount of **products** at equilibrium **decreases** for an **exothermic** reaction. Equilibrium move to the left.

•If the **temperature** of a system at equilibrium is **decreased**:

- •the relative amount of **products** at equilibrium **decreases** for an **endothermic** reaction. Equilibrium moves to the right.
- •the relative amount of **products** at equilibrium **increases** for an **exothermic** reaction. Equilibrium moves to the left..

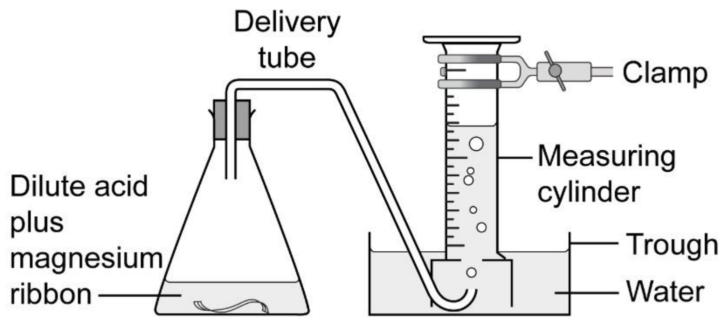
•For <u>gaseous</u> reactions at equilibrium:

•an **increase** in pressure causes the equilibrium position to shift towards the side with the **smaller number of molecules** as shown by the balanced symbol equation for that reaction

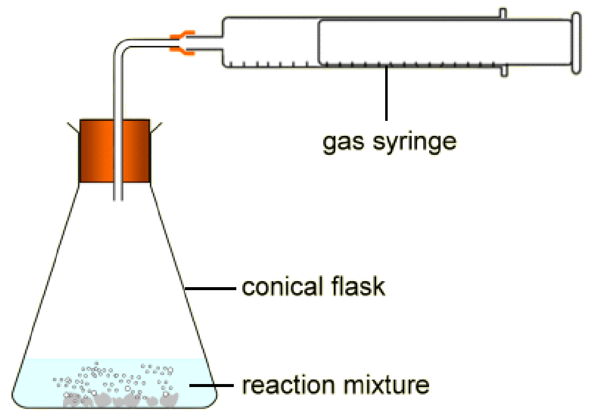
•a **decrease** in pressure causes the equilibrium position to shift towards the side with the **larger number of molecules** as shown by the balanced symbol equation for that reaction.

Required practical

Measuring cylinder
- used to measure gas
Production over time



Gas syringe - used to measure gas production over time



'Disappearing' cross – used to measure how quickly the colour changes