Topic 6 – The rate and extent of chemical change

Table of Content

6.1 Rate of reaction

6.1.1 Calculating rates of reactions

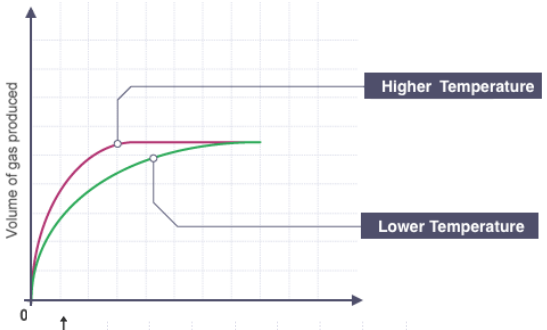
$$mean\ rate\ of\ reaction = \frac{quantity\ of\ reactant\ used\ or\ product\ formed}{time\ taken}$$

6.1.2 Factors which affect the rates of chemical reactions

Collision theory & factors that affect the rate

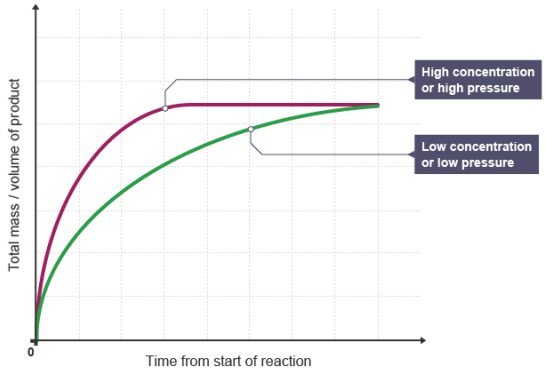
How does increase in temperature affect the rate of reaction?

- ↑ KE – particles move faster
- ↑ frequency of successful collision
- ↑ particles reach required Ea
- ↑ rate



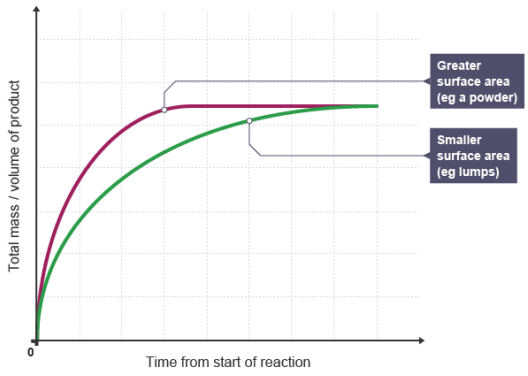
How does increase in concentration / pressure affect the rate of reaction?

- ↑ no of particles per unit vol
- ↑ frequency of successful collision
- ↑ particles reach required Ea
- ↑ rate



How does increase in SA affect the rate of reaction?

- ↑ no of particles exposed
- ↑ availability to react
- ↑ frequency of successful collision
- ↑ particles reach required Ea
- ↑ rate



6.1.3 Collision theory and activation energy

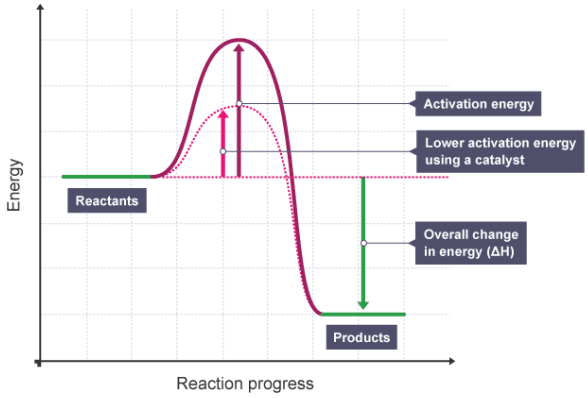
Activation energy (Ea) – min energy required to start a reaction

Collision theory – see 6.1.2 Factors which affect the rates of chemical reactions

6.1.4 Catalysts

Catalyst

- Speed up chemical reaction
  - Provide different pathway which ↓Ea
- Not used up in chemical reaction
- Different reactions need different catalysts



Why is catalyst used in industrial process? (2)

- Not used up
- ↑ rate of reaction
- Small quantities needed

Scientists have developed catalysts which allow quicker reaction at lower temperature. How can this benefit manufacturer and the environment? (2)

- ↑ product obtained in shorter time
- ↓ fuel needed
- ↓ pollution caused by burning fuels

6.2 Reversible reactions and dynamic equilibrium

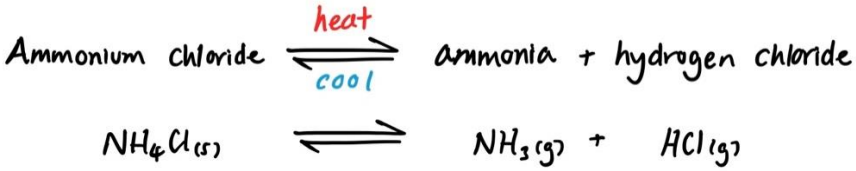
6.2.1 Reversible reactions

Reversible reaction

- Products of reaction can react to produce original reactants
- Under certain conditions
- Occur in apparatus which prevent escape of reactants & products
- A + B ⇌ C + D

Direction of reversible reactions can be changed by changing the conditions

For example



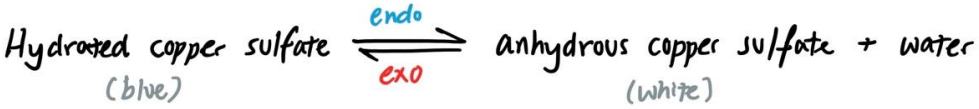
Why is the experiment carried out in fume cupboard? (1)

- Gases are toxic

6.2.2 Energy changes and reversible reactions

- If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction
- Same amount of energy is transferred in each case

For example



6.2.3 Equilibrium

Equilibrium – forward & reverse reactions occur at the same rate

- Reversible reaction occurs in apparatus – prevents reactants & products to escape

6.2.4 The effect of changing conditions on equilibrium (HT only)

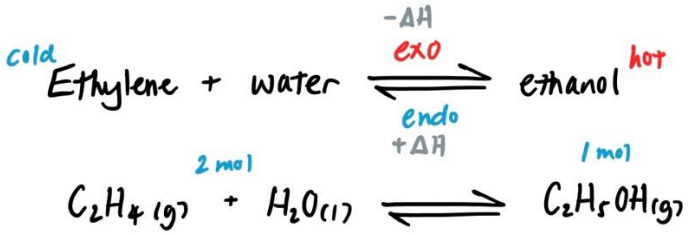
- If a system is at equilibrium & a change is made to any of the conditions, then the system responds to counteract the change
- Effects of changing conditions on a system at equilibrium can be predicted using Le Chatelier's Principle

6.2.5 The effect of changing concentration (HT only)

6.2.6 The effect of temperature changes on equilibrium (HT only)

6.2.7 The effect of pressure changes on equilibrium (HT only)

In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst. The equation for the reaction is:



The forward reaction is exothermic. Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium. Give a reason for your prediction. (2)

- ↑ temp
- Equilibrium position move to the left
- ↓ yield

Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium. (2)

- ↑ pressure
- Equilibrium position move to the right coz least no of moles
- ↑ yield