4.6 The rate and extent of chemical change
Topic 6 – Paper 2

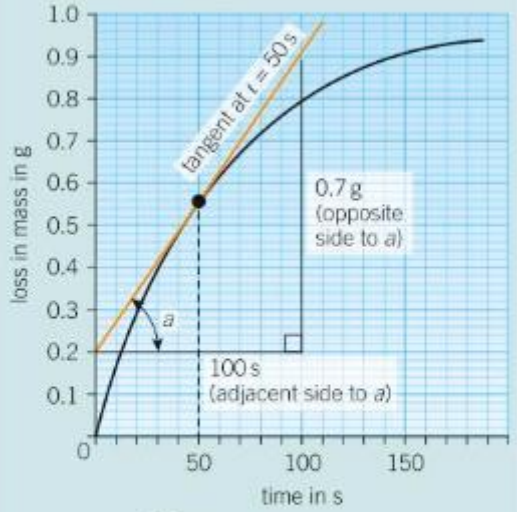
$$\text{mean rate of reaction} = \frac{\text{quantity of reactant used}}{\text{time taken}}$$

$$\text{mean rate of reaction} = \frac{\text{quantity of product formed}}{\text{time taken}}$$

Units of rate of reaction - g/s or cm3 /s or mol/s (HT).

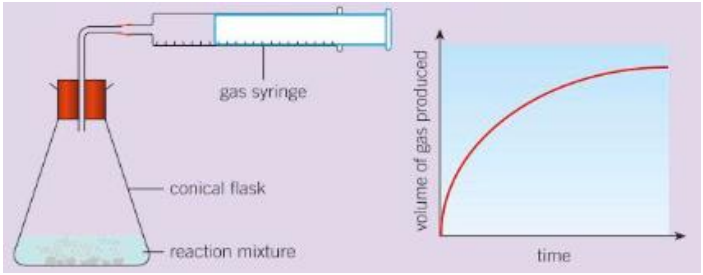
Factors that affect Rate of Reaction	The higher the …. The faster the rate of reaction because …
• Concentrations of reactants • Pressure of reacting gases • Surface area of solid reactants • Temperature • Catalyst	More particles in the same volume, increased frequency of collisions. Particles are closer together so there is an increased frequency of collisions. Small particles have a larger surface area to volume ratio, so increased frequency of collisions. Particles collide more energetically and more frequently. Provides an alternative pathway which is at a lower activation energy.

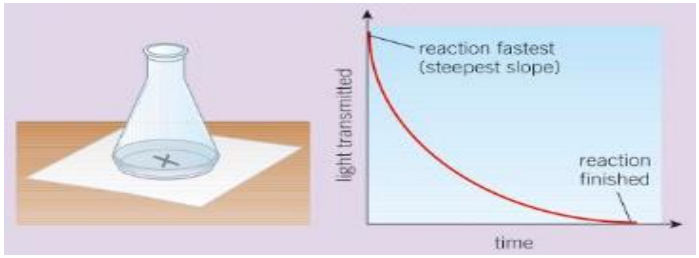
- Make sure you include the units of rate, usually g/s, cm^3/s or mol/s.

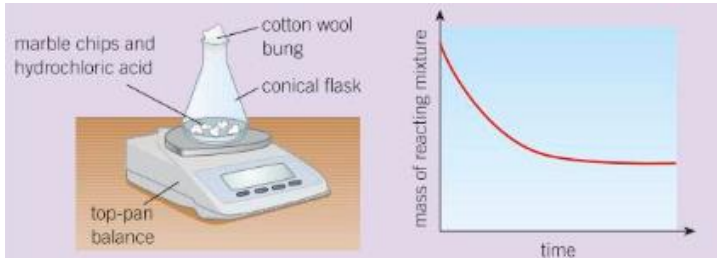


Rate at 50 s = $\frac{0.7\text{ g}}{100\text{ s}} = 0.007\text{ g/s}$

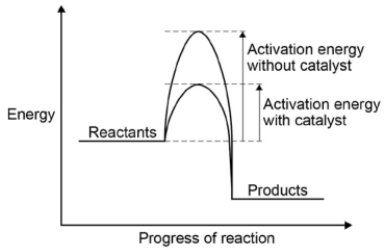
(The gradient is the tangent of angle *a* in the right-angled triangle, i.e. opposite side divided by adjacent side.)







Activation Energy	Minimum amount of energy required for particles to react when they collide.
Collision Theory	Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy.
Reversible reaction	A reaction that can turn reactants into products and products into reactants.
Equilibrium	Forward and backward reaction happen at the same time and rate in a closed system.
Closed System	Products/reactants cannot get in or out
Precipitate	A solid is formed from 2 solutions
Enzymes	Biological catalysts



Advantages of Catalysts	Disadvantages of Catalysts
Increases rate of reaction Provides and alternative pathway at a lover activation energy Reduces energy cost for heating Reusable	Specific Expensive? Toxic? Separation stage Clean up

Investigate the concentration of HCl with marble chips

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

The reaction between sodium thiosulphate and dilute hydrochloric acid: (Precipitate)

$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + SO_2(aq) + S(s) + H_2O(l)$

The reaction between hydrochloric acid and magnesium:

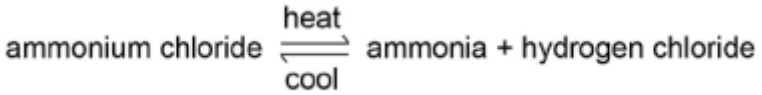
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

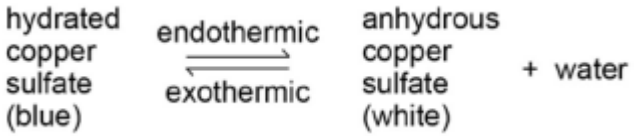
The decomposition of hydrogen peroxide (usually for the catalyst):

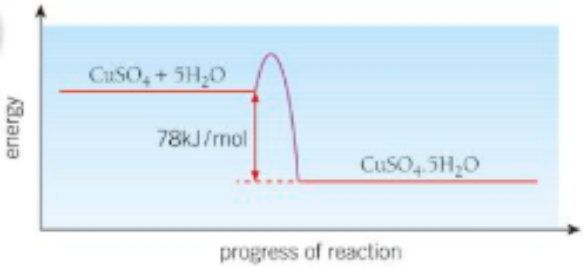
$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$

Le Chatelier's Principle

The direction of reversible reactions can be changed by changing the conditions.

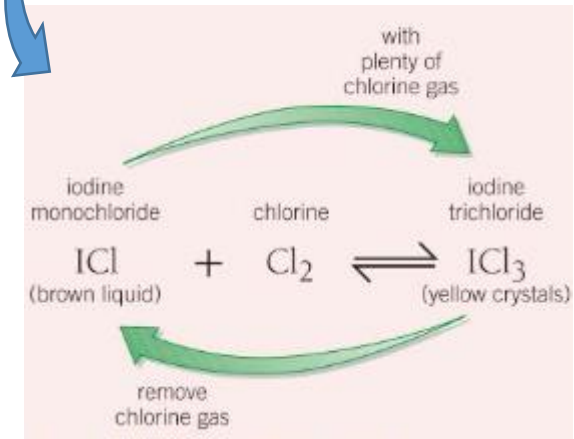


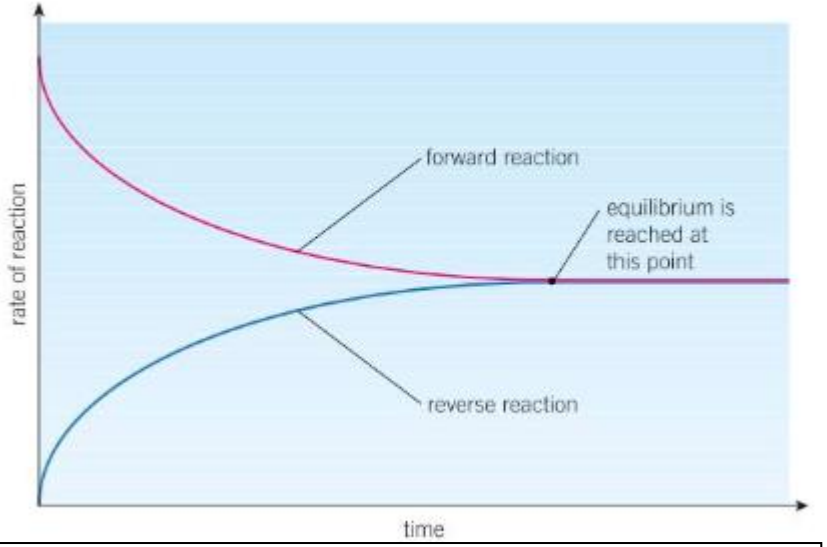




In a reversible reaction one is exothermic and one is endothermic.
The amount of energy transferred to the surroundings in the exothermic reaction is exactly the same amount of energy taken in in the endothermic reaction.

Effect of conditions on equilibrium		
Temperature	Increase	Decrease
Change in equilibrium	The equilibrium shifts in the endothermic direction	The equilibrium shifts in the exothermic direction
Pressure	Increase	Decrease
Change in equilibrium	The equilibrium shifts to the side with least moles	The equilibrium shifts to side with more moles
Concentration	Increase	Decrease
Change in equilibrium	Removes the substance that you've added, moving the equilibrium in the opposite way	Increases the yield of the substance you've removed
Catalyst	Present	Not Present
Change in equilibrium	No effect—however, will make it so the rate to reach equilibrium is faster	





A reaction reaches equilibrium when the rate of the forward and backward reaction are at the same (constant) rate.