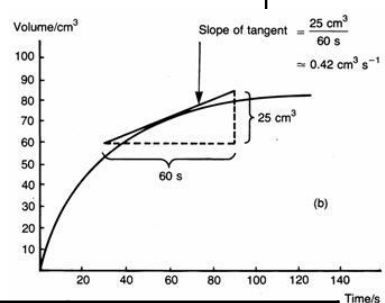


Rate of chemical reaction	<i>This can be calculated by measuring the quantity of reactant used or product formed in a given time.</i>	Rate = $\frac{\text{quantity of reactant used}}{\text{time taken}}$ Rate = $\frac{\text{quantity of product formed}}{\text{time taken}}$
---------------------------	---	---

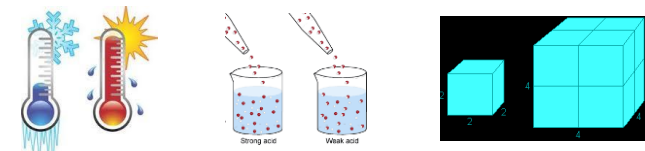
Quantity	Unit
Mass	Grams (g)
Volume	cm ³
Rate of reaction	Grams per cm ³ (g/cm ³) HT: moles per second (mol/s)



Rates of reaction

Factors affecting rates

Factors affecting the rate of reaction	
Temperature	<i>The higher the temperature, the quicker the rate of reaction.</i>
Concentration	<i>The higher the concentration, the quicker the rate of reaction.</i>
Surface area	<i>The larger the surface area of a reactant solid, the quicker the rate of reaction.</i>
Pressure (of gases)	<i>When gases react, the higher the pressure upon them, the quicker the rate of reaction.</i>



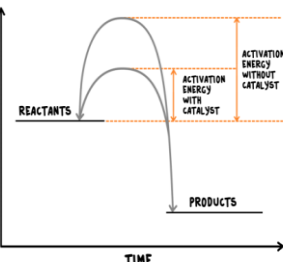
Collision theory and activation energy

Collision theory	<i>Chemical reactions can only occur when reacting particles collide with each other with sufficient energy.</i>	Increasing the temperature increases the frequency of collisions and makes the collisions more energetic, therefore increasing the rate of reaction.
Activation energy	<i>This is the minimum amount of energy colliding particles in a reaction need in order to react.</i>	Increasing the concentration, pressure (gases) and surface area (solids) of reactions increases the frequency of collisions, therefore increasing the rate of reaction.

EDEXCEL TOPIC 7: Rates of reaction and energy changes

Catalysts

Catalyst	A catalyst changes the rate of a chemical reaction but is not used in the reaction.
Enzymes	These are biological catalysts.
How do they work?	Catalysts provide a different reaction pathway where reactants do not require as much energy to react when they collide.



If a catalyst is used in a reaction, it is not shown in the word equation.

Heat energy changes in chemical reactions

Bond energy calculation	Calculate the overall energy change for the forward reaction $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ Bond energies (in kJ/mol): H-H 436, H-N 391, N≡N 945
	Bond breaking: $945 + (3 \times 436) = 945 + 1308 = 2253 \text{ kJ/mol}$
	Bond making: $6 \times 391 = 2346 \text{ kJ/mol}$
	Overall energy change = $2253 - 2346 = -93 \text{ kJ/mol}$ Therefore reaction is exothermic overall.

Heat energy changes	Occur in the following: - Salts dissolving in water - Neutralisation reactions - Displacement reactions - Precipitation reactions
Exothermic reactions	Heat energy is given out as bonds are being formed.
Endothermic reactions	Heat energy is taken in as bonds are being broken.

Endothermic		Products are at a higher energy level than the reactants. As the reactants form products, energy is transferred from the surroundings to the reaction mixture. The temperature of the surroundings decreases because energy is taken in during the reaction.
Exothermic		Products are at a lower energy level than the reactants. When the reactants form products, energy is transferred to the surroundings. The temperature of the surroundings increases because energy is released during the reaction.