AQA GCSE Chemistry: Topic 6

"Grade 7" Examiner Cheat Sheet — Rate & Extent of Change

Section 1: The Collision Theory Rosetta Stone

The Golden Rule: For a reaction to occur, particles must collide with energy greater than or equal to the **Activation Energy (E_a)**.
Rate of Reaction Definition: The frequency of **successful** collisions per unit time.

The 4-Mark Explanation Algorithm:

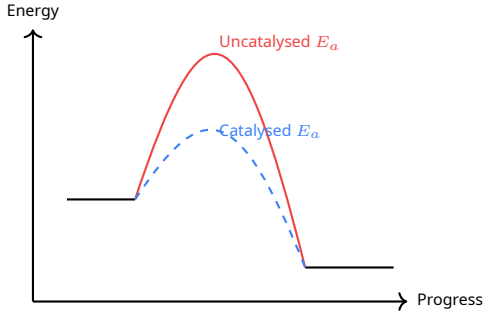
1. State how the particles are affected (e.g. they are more crowded or move faster).
2. State that the **frequency of collisions** increases.
3. (For Temp) State that more particles have energy $> E_a$.
4. Conclude that the **frequency of successful collisions** increases.

Section 2: Factors Affecting Rate

Factor	How it works (Grade 7 Language)
Concentration	More particles in the same volume $\rightarrow$ more frequent collisions.
Pressure (Gas)	Particles are pushed closer together $\rightarrow$ more frequent collisions.
Surface Area	More particles are exposed at the surface $\rightarrow$ more frequent collisions.
Temperature	Particles have more KE and move faster $\rightarrow$ more frequent collisions. **ALSO** more particles have the E_a required to react.

Section 3: Catalysts & Success

Definition: Catalysts speed up reactions without being used up. **Mechanism:** They provide an **alternative reaction pathway** with a **lower activation energy**.

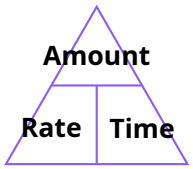


Section 4: Calculating Rate Algorithm

Rate Formulas:

- Rate $= \frac{\text{Amount of Reactant used}}{\text{Time}}$
- Rate $= \frac{\text{Amount of Product formed}}{\text{Time}}$

Units: g/s or cm^3/s or mol/s.



The Tangent Trap (Higher Tier): To find the rate at a **specific time** on a curve: 1. Draw a tangent line (a straight line touching the curve at that point). 2. Calculate the **gradient** of the tangent ($\frac{\text{change in y}}{\text{change in x}}$).

Section 5: Required Practical 5 — Measuring Rate

Method A: Gas Collection (Mg + HCl)

- Measure volume of H_2 gas produced using a **gas syringe**.
- Take readings at regular intervals (e.g. every 10s).
- **Variables:** Indep: Concentration of HCl. Dep: Rate of gas production.

Method B: Disappearing Cross (Sodium Thiosulfate + HCl)

- Reaction produces a **sulfur precipitate** (makes solution cloudy).
- Measure time taken for a black cross under the flask to disappear.
- **Problem:** This method is **subjective** (people see the cross disappear at different times).

Section 6: Graph Interpretation Masterclass

Why does the line get less steep over time?

1. Reactants are **used up**.
2. The **concentration** of reactants decreases.
3. The **frequency of collisions** decreases.
4. The **rate of reaction** decreases until the line goes horizontal (reaction stopped).

Reversible Reactions & Equilibrium

Section 7: Reversibility Fundamentals

Symbol: $\rightleftharpoons$ The Rules:

- If a reaction is **Exothermic** in one direction, it is **Endothermic** in the other.
- The **same amount of energy** is transferred in each direction.

Example: Blue Hydrated Copper Sulfate $\rightleftharpoons$ White Anhydrous Copper Sulfate $+$ Water. (Heating is Endothermic forward; adding water is Exothermic backward).

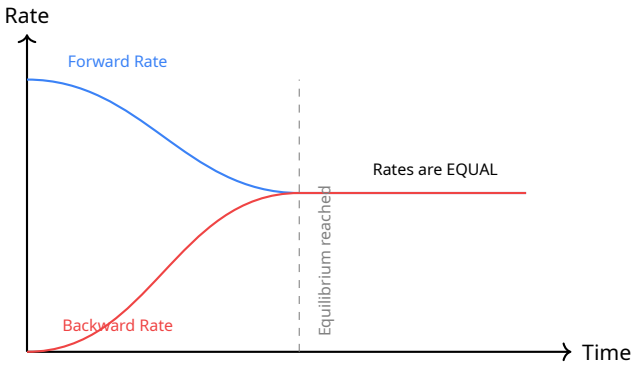
Section 8: Dynamic Equilibrium Master Rules

The Definition (2 Marks):

1. The **forward and backward rates are equal**.
2. The **concentrations** of reactants and products remain **constant**.

THE CRITICAL CONDITION: Equilibrium can only be reached in a **Closed System** (where no reactants or products can escape).

Section 9: The Equilibrium Graph



Section 10: Le Chatelier's Principle (HT Only)

The Rule: If a system at equilibrium is changed, the system **shifts to counteract** (oppose) the change.
The "Rebel" Logic:

- **Increase Temperature?** System shifts to **absorb heat** (moves to the **Endothermic** side).
- **Decrease Temperature?** System shifts to **release heat** (moves to the **Exothermic** side).
- **Increase Pressure?** System shifts to **reduce pressure** (moves to the side with **fewer moles** of gas).
- **Increase Concentration?** System shifts to **use up** the added substance.

Section 11: The Pressure Shift Algorithm

Task: Predict the shift in: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

1. **Count Moles Left:** $1 + 3 = \mathbf{4}$.
2. **Count Moles Right: 2**.
3. **Apply Change:** If pressure **increases**, equilibrium shifts **Right** (to the side with fewer moles).
4. **Conclusion:** Yield of Ammonia (NH_3) increases.

Section 12: Temperature Shift Algorithm

Task: If forward is Exothermic ($\Delta H = -$), what happens if we cool it?

1. **Rule:** Lowering temp favors the **Exothermic** direction.
2. **Shift:** Equilibrium shifts **Right** to release more heat.
3. **Conclusion:** Yield of product increases, but the **rate** of reaching equilibrium will be **slower**.

Mark Scheme Tip: Industry uses a compromise temperature to balance yield and speed.

"Collision Theory = Rate. Le Chatelier = Position. Closed system = Key."