Understanding Rates of Reaction

GCSE Chemistry

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Rate of Reaction

Rate of reaction refers to how quickly reactants are converted into products during a chemical reaction.

Units: g/s or cm^3/s

Formula:

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

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

Measuring Rate of Reaction

The quantity of reactants or products can be measured by:

- **Mass (grams)** for solid reactants/products.
- **Volume ($\mathbf{cm^3}$)** for gaseous reactants/products.

Example: If 10 grams of a reactant are used up in 5 seconds, the rate of reaction is:

$$\text{Rate} = \frac{10\,\text{g}}{5\,\text{s}} = 2\,\text{g/s}$$

Factors Affecting Rate of Reaction

The rate of reaction can be affected by several factors:

- **Concentration:** Higher concentration increases collision frequency.
- **Pressure (for gases):** Higher pressure compresses particles, increasing collisions.
- **Surface area:** Finely divided solids provide more surface for collisions.
- **Temperature:** Higher temperature increases collision frequency and energy.
- **Catalysts:** Provide a pathway with lower activation energy.

Collision Theory and Activation Energy

Collision Theory:
Chemical reactions only occur when particles collide with sufficient energy.

Activation Energy:
The minimum energy particles need to react.

How factors affect collisions:

- **Concentration/Pressure:** More particles lead to more frequent collisions.
- **Surface Area:** Increases exposure of reactants.
- **Temperature:** Particles move faster, increasing both collision frequency and energy.

Catalysts

What are Catalysts?
Catalysts speed up chemical reactions without being used up.

Key Points:

- Different reactions require specific catalysts.
- Catalysts provide a lower-energy pathway for the reaction.
- Enzymes are biological catalysts.

Example: Enzymes in the human body catalyse reactions like digestion and respiration.

Catalyst Diagram

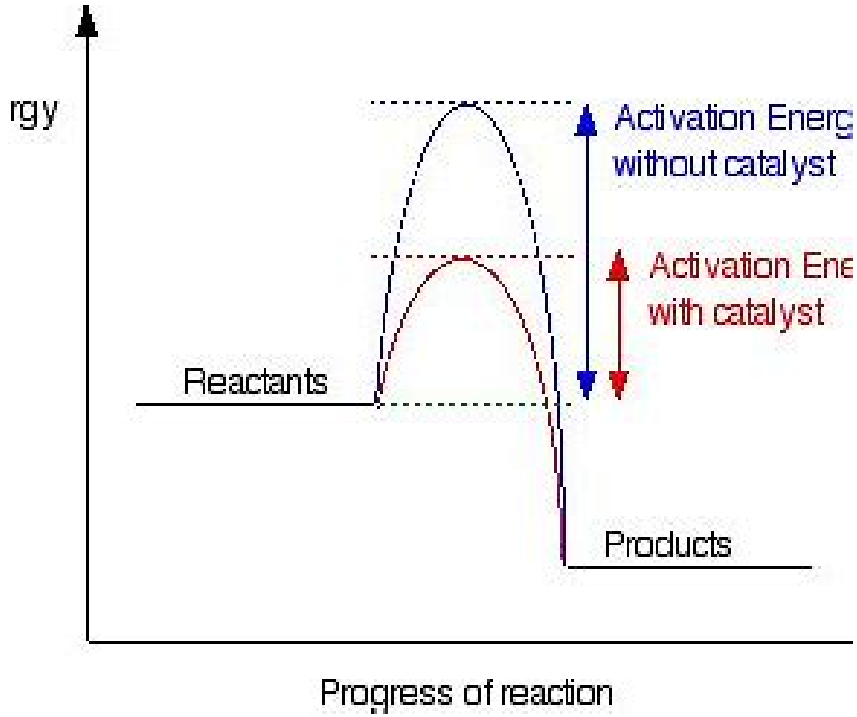

Figure: Catalyst Affect on Rate of Reaction

Practice Problems

1. A reaction produces 50 cm^3 of gas in 25 seconds. What is the rate of reaction?

2. How does increasing temperature affect the rate of reaction? Explain using collision theory.

3. Identify one example where a catalyst is used in industry.

Answers to Practice Problems

1. *Rate of Reaction:*
The rate of reaction is calculated as:

$$\text{Rate} = \frac{\text{quantity of gas produced}}{\text{time}} = \frac{50\,\text{cm}^3}{25\,\text{s}} = 2\,\text{cm}^3/\text{s}$$

2. *Effect of Temperature on Rate of Reaction:*
Increasing the temperature increases the rate of reaction because:

- Particles move faster, leading to more frequent collisions.
- Collisions occur with more energy, exceeding the activation energy more often.

3. *Example of Catalyst in Industry:*
One example is the use of **iron** as a catalyst in the **Haber process**, which is used to produce ammonia.

Challenging Question

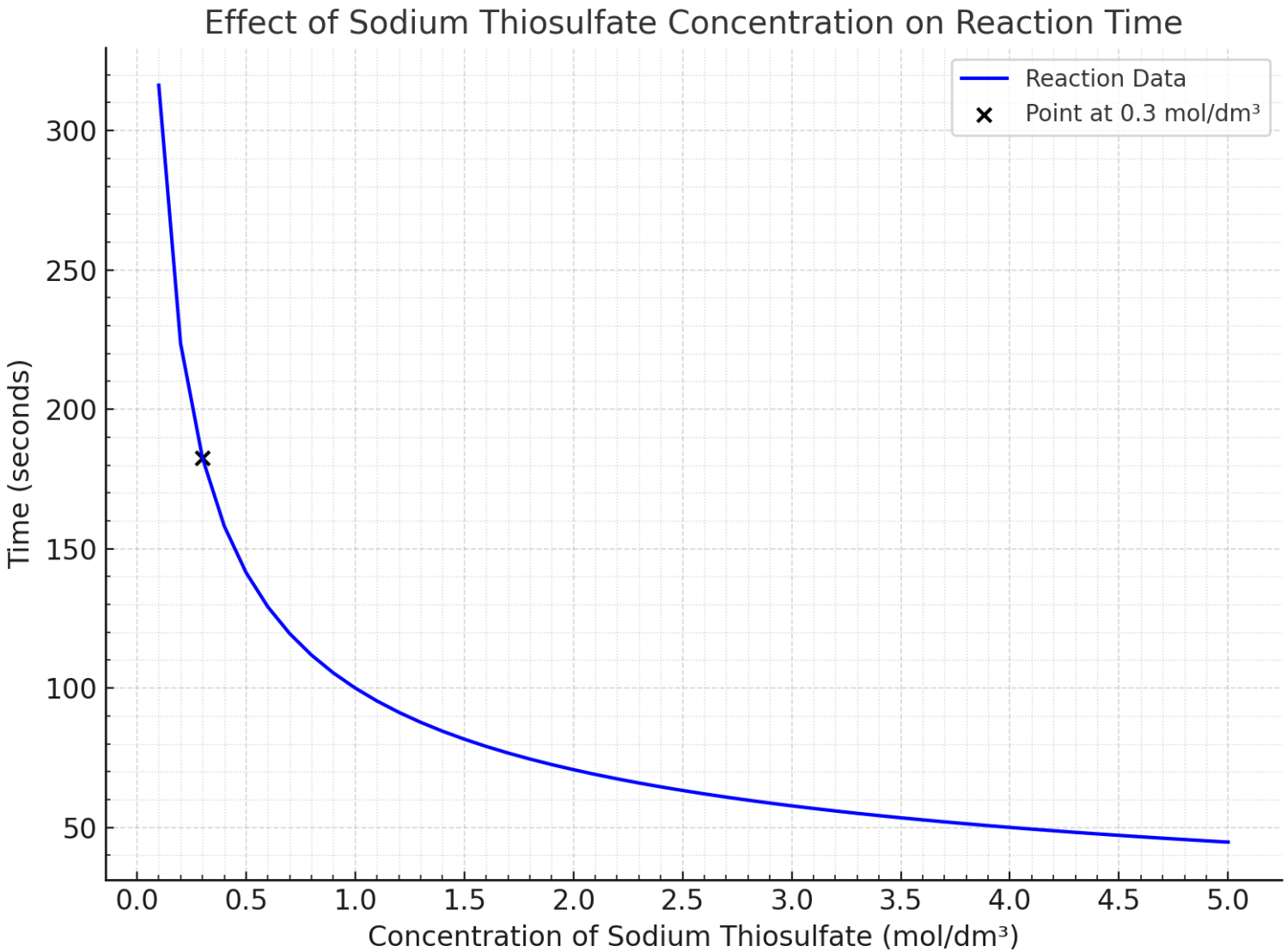

Figure: Calculate the Rate of Reaction at the highlighted point