Topic 6: Chemical kinetics

7 hours

Essential idea: The greater the probability that molecules will collide with sufficient energy and proper orientation, the higher the rate of reaction.

6.1 Collision theory and rates of reaction

Nature of science:

The principle of Occam's razor is used as a guide to developing a theory—although we cannot directly see reactions taking place at the molecular level, we can theorize based on the current atomic models. Collision theory is a good example of this principle. (2.7)

Understandings:

- Species react as a result of collisions of sufficient energy and proper orientation.
- The rate of reaction is expressed as the change in concentration of a particular reactant/product per unit time.
- Concentration changes in a reaction can be followed indirectly by monitoring changes in mass, volume and colour.
- Activation energy (E_a) is the minimum energy that colliding molecules need in order to have successful collisions leading to a reaction.
- By decreasing E_a, a catalyst increases the rate of a chemical reaction, without itself being permanently chemically changed.

Applications and skills:

- Description of the kinetic theory in terms of the movement of particles whose average kinetic energy is proportional to temperature in Kelvin.
- Analysis of graphical and numerical data from rate experiments.

International-mindedness:

- Depletion of stratospheric ozone has been caused largely by the catalytic action of CFCs and is a particular concern in the polar regions. These chemicals are released from a variety of regions and sources, so international action and cooperation have been needed to ameliorate the ozone depletion problem.

Theory of knowledge:

- The Kelvin scale of temperature gives a natural measure of the kinetic energy of gas whereas the artificial Celsius scale is based on the properties of water. Are physical properties such as temperature invented or discovered?

Utilization:

Syllabus and cross-curricular links:
Topic 5.3—what might be meant by thermodynamically stable vs kinetically stable?
Topic 13.1—fireworks and ions
Option A.3—everyday uses of catalysts
Option B.2—enzymes
Biology topic 8.1—metabolism

6.1 Collision theory and rates of reaction	
• Explanation of the effects of temperature, pressure/concentration and particle size on rate of reaction. • Construction of Maxwell–Boltzmann energy distribution curves to account for the probability of successful collisions and factors affecting these, including the effect of a catalyst. • Investigation of rates of reaction experimentally and evaluation of the results. • Sketching and explanation of energy profiles with and without catalysts. **Guidance:** • Calculation of reaction rates from tangents of graphs of concentration, volume or mass vs time should be covered. • Students should be familiar with the interpretation of graphs of changes in concentration, volume or mass against time.	**Aims:** • **Aims 1** and **8**: What are some of the controversies over rate of climate change? Why do these exist? • **Aim 6**: Investigate the rate of a reaction with and without a catalyst. • **Aim 6**: Experiments could include investigating rates by changing concentration of a reactant or temperature. • **Aim 7**: Use simulations to show how molecular collisions are affected by change of macroscopic properties such as temperature, pressure and concentration. • **Aim 8**: The role that catalysts play in the field of green chemistry.