Topic 17: Equilibrium

4 hours

Essential idea: The position of equilibrium can be quantified by the equilibrium law. The equilibrium constant for a particular reaction only depends on the temperature.

17.1 The equilibrium law

Nature of science:

Employing quantitative reasoning—experimentally determined rate expressions for forward and backward reactions can be deduced directly from the stoichiometric equations and allow Le Châtelier's principle to be applied. (1.8, 1.9)

Understandings:

- Le Châtelier's principle for changes in concentration can be explained by the equilibrium law.

- The position of equilibrium corresponds to a maximum value of entropy and a minimum in the value of the Gibbs free energy.

- The Gibbs free energy change of a reaction and the equilibrium constant can both be used to measure the position of an equilibrium reaction and are related by the equation, $\Delta G = -RT \ln K$.

Applications and skills:

- Solution of homogeneous equilibrium problems using the expression for K_c.

- Relationship between ΔG and the equilibrium constant.

- Calculations using the equation $\Delta G = -RT \ln K$.

Guidance:

- The expression $\Delta G = -RT \ln K$ is given in the data booklet in section 1.

- Students will not be expected to derive the expression $\Delta G = -RT \ln K$.

- The use of quadratic equations will not be assessed.

Theory of knowledge:

- The equilibrium law can be deduced by assuming that the order of the forward and backward reaction matches the coefficients in the chemical equation. What is the role of deductive reasoning in science?

- We can use mathematics successfully to model equilibrium systems. Is this because we create mathematics to mirror reality or because the reality is intrinsically mathematical?

- Many problems in science can only be solved when assumptions are made which simplify the mathematics. What is the role of intuition in problem solving?

Utilization:

- The concept of a closed system in dynamic equilibrium can be applied to a range of systems in the biological, environmental and human sciences.

Syllabus and cross-curricular links:
Topic 1.3—stoichiometric equations
Topic 7.1—equilibrium
Topic 18.2—weak acid and base equilibria
Option A.10—K_{sp}
Options B.7 and D.4—buffer calculations

17.1 The equilibrium law	
	Aims: • **Aim 6**: The equilibrium constant for an esterification reaction and other reactions could be experimentally investigated. • **Aim 7**: The concept of a dynamic equilibrium can be illustrated with computer animations.