REVISION NOTE

Equilibrium

Anne Hodgson explains useful equilibrium equations

An equilibrium exists when forward and reverse reactions occur at equal rates, so that there is no overall change in the concentration of the reactants or products. Equilibria can exist in solution, where we use the *concentration* of the chemicals in the liquid, or in a gas, in which case we can use their *partial pressures*. The partial pressure of an individual gas in a mixture is the pressure that it would exert were it present alone in the vessel.

Manipulation of these equations can help to solve a range of problems encountered in your chemistry studies. The conditions of the equilibrium reaction must be stated, as the equilibrium position can be affected by temperature and pressure. To read about some applications of equilibria, see CHEMISTRY REVIEW Vol. 33, No. 1, pp. 2–6.

Generalised equilibrium reaction

A, B, C and D represent the chemical species in the reaction (compounds, elements or ions)

$$aA + bB \rightleftharpoons cC + dD$$

a, b, c and d are moles of A, B, C and D from the balanced reaction equation

For reactions in solution

Equilibrium constant (in terms of concentration)

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

The square brackets mean 'concentration of'

Note that the units of concentration are moles per cubic decimetre (mol dm^{-3}). The units for K_c depend on the specific reaction and need to be calculated in each case.

For a given reaction, we can represent an equilibrium using an equation, in which the concentrations (or partial pressures) of the reactants and products equate to an *equilibrium constant* (K).

For reactions in the gas phase

For reactions in the gas phase, either K_c or K_p can be used.

Equilibrium constant (in terms of partial pressures)

$$K_p = \frac{p_C^{\,c}\, p_D^{\,d}}{p_A^{\,a}\, p_B^{\,b}}$$

$p_A^{\,a}$, $p_B^{\,b}$, $p_C^{\,c}$ and $p_D^{\,d}$ are the partial pressures of the reactants and products in the gaseous mixture

$$p_{total} = p_A^{\,a} + p_B^{\,b} + p_C^{\,c} + p_D^{\,d}$$

The units of p are units of pressure, such as Pa (pascals) or atm (atmospheres). Once again, the units for the equilibrium constant (K_p) will depend on the specific reaction and need to be calculated in each case.

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