

Grade 12 Physical Sciences: Chemical Equilibrium Study Guide

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1. Chemical Equilibrium

A reversible reaction reaches dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction. At equilibrium:

- Concentrations of reactants and products remain constant
- Both forward and reverse reactions still occur
- Equilibrium is dynamic, not static

2. Equilibrium Constant (K_c)

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

K_c =	$[C]^c * [D]^d / [A]^a * [B]^b$
$K_c > 1$:	Products favoured at equilibrium
$K_c < 1$:	Reactants favoured at equilibrium
$K_c = 1$:	Equal amounts of reactants and products

TIP Pure solids and liquids are NOT included in the K_c expression. Only gases and aqueous (aq) species are included.

3. Le Chatelier's Principle

When a system at equilibrium is disturbed, it will shift to counteract the disturbance and restore equilibrium.

Effect of Changes

- Increase [reactant]: equilibrium shifts RIGHT (forward reaction favoured)
- Increase [product]: equilibrium shifts LEFT (reverse reaction favoured)
- Increase pressure (gases): equilibrium shifts toward FEWER moles of gas
- Decrease pressure: shifts toward MORE moles of gas
- Increase temperature: shifts in endothermic direction
- Decrease temperature: shifts in exothermic direction
- Catalyst: speeds up both directions equally; no shift in position; equilibrium reached FASTER

4. Acid-Base Equilibria

Bronsted-Lowry Theory

Acid = proton (H^+) donor; Base = proton acceptor.

Conjugate acid-base pairs differ by one H^+ .

K_w (water):	$[H_3O^+][OH^-] = 10^{-14}$ at 25 degC
pH:	$pH = -\log[H_3O^+]$
pOH:	$pOH = -\log[OH^-]$
pH + pOH:	= 14 at 25 degC
Strong acid:	Fully dissociates $\rightarrow [H_3O^+] = \text{initial concentration}$
Weak acid:	Partially dissociates; use K_a expression

5. Electrochemistry

Galvanic Cell (Spontaneous)

Converts chemical energy to electrical energy. Oxidation at ANODE (negative), Reduction at CATHODE (positive). Electrons flow from anode to cathode through external circuit.

Electrolytic Cell (Non-spontaneous)

Uses electrical energy to drive a non-spontaneous reaction. Anode is positive (connected to +), cathode is negative.

Examples: electroplating, chloralkali process, Hall-Heroult (aluminium)

Cell potential:

$$E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$$

Spontaneous if:

$$E_{\text{cell}} > 0$$

TIP Remember OIL RIG: Oxidation Is Loss (of electrons), Reduction Is Gain (of electrons). The species with the higher reduction potential is reduced at the cathode.