



The **topics** and **types of questions** examined in this Achievement Standard. Use this sheet to plan and organise your study so that you cover everything that is required.

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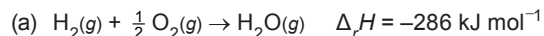
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**2.6 THERMOCHEMISTRY & EQUILIBRIUM AS 90310**

Describe thermochemical and equilibrium principles

2.6 1. Classifying reactions as endothermic or exothermic

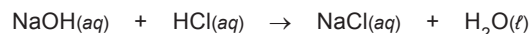
► Classify each of the following processes as either endothermic or exothermic.

**2.6 2. Determine enthalpy changes**

- calculating and using $\Delta_r H$

► 29.6 g of sodium hydroxide was dissolved in water and excess hydrochloric acid was added. Using the temperature increase and the heat capacity of water, it was calculated that 43.5 kJ of heat was released.

(a) Determine the enthalpy change, $\Delta_r H$, for the following reaction:



(b) What mass of sodium hydroxide is required to produce 150 kJ of energy?

2.6 3. Factors affecting rates of reaction

- changes in concentration, temperature, surface area and the presence of a catalyst

► The reaction between 20.0 mL of 0.500 mol L⁻¹ hydrochloric acid and 20.0 mL of 0.250 mol L⁻¹ sodium thiosulfate solution at room temperature (25°C) produces a precipitate of sulfur that makes the solution go cloudy after about 5 minutes.

- (a) How would the time taken for the solution to go cloudy be affected if the reaction were carried out in a water bath at a temperature of 50°C?
- (b) With reference to the collisions of particles, explain why the reaction is affected in this way.

2.6 4. Equilibrium

- writing expressions for the equilibrium constant K_C
- significance of the magnitude of K_C

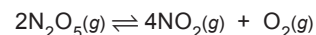
► (a) Write the equilibrium constant expression for the following reaction.



(b) At 200°C the value of K_C is 1.10×10^{-5} . Which species, $\text{NO}_2(\text{g})$ or $\text{NO}(\text{g})$, would be present in the higher concentration in the equilibrium mixture at this temperature. Justify your choice.

- the effect of changes to a system in equilibrium.
- changes include: temperature, concentration, pressure and addition of a catalyst

► The following reaction is exothermic:



Both N_2O_5 and O_2 are colourless gases and NO_2 is a brown gas.

A mixture of these gases exists at equilibrium and is observed as a brown colour.

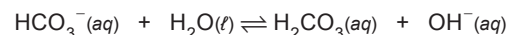
- (a) Write the equilibrium constant expression for the reaction.
- (b) For each of the following changes applied to the equilibrium system, describe the expected observation and explain why this occurs.
- (i) The mixture of gases is heated (at constant pressure).
- (ii) The pressure is increased, by decreasing the volume of the container.

2.6 5. Acids and bases

- the nature of acids and bases in terms of proton transfer

► $\text{HCO}_3^- (\text{aq})$ is a species that may act as an acid or a base.

Consider the equilibrium system:



- (a) Is $\text{HCO}_3^- (\text{aq})$ acting as an acid or a base?
- (b) Justify your answer to (a) above.

- calculations involving K_W and pH

► Determine the $[\text{H}_3\text{O}^+]$, $[\text{OH}^-]$ and pH in each of the following solutions.

(a) 0.00112 mol L⁻¹ HCl solution.

(b) 3.68×10^{-2} mol L⁻¹ NaOH solution.

- properties of aqueous solutions of strong and weak acids and bases.
- properties restricted to conductivity, rate of reaction and pH

► A solution of sodium ethanoate (NaCH_3COO) is tested and found to have a pH of 8.50.

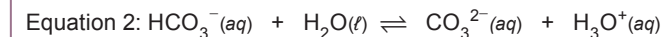
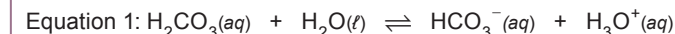
Discuss why the pH of the solution is greater than 7. Include appropriate equation(s) in your answer.

► The elements in Group 17 of the periodic table are called halogens.

Complete the table below to show the states of the first four halogens at room temperature (25°C).

Name of halogen	Formula	Melting point °C	Boiling point °C	State at 25 °C
fluorine	F ₂	-220	-188	
chlorine	Cl ₂	-101	-35	
bromine	Br ₂	-7	59	
iodine	I ₂	114	184	solid

► Chickens make egg shell, CaCO_3 , using carbon dioxide gas from the air. The carbon dioxide forms carbonic acid (H_2CO_3), which then reacts to form the carbonate ions (CO_3^{2-}) needed to make egg shell. Two equations showing part of this process are given below.



- (a) Identify three conjugate acid-base pairs in the equations above.
- (b) HCO_3^- can act as both an acid and a base. Specify which equation above (1 or 2) shows HCO_3^- acting as an **acid**. Give a reason for your answer.