

Exercise walk-through

4.4.1

Acid–base models, pH and K_a

Pearson Edexcel · International A-Level · Chemistry

Find the temperature boundary

Your turn

$\Delta H = +36.0 \text{ kJ mol}^{-1}$; $\Delta S(\text{system}) = +120 \text{ J mol}^{-1} \text{ K}^{-1}$. Which condition gives positive total entropy?

- A. T below 300 K
- B. T above 300 K
- C. Every temperature
- D. No temperature

Hydrogen bonds require a donor and acceptor

- 1** Carbonyl O accepts a hydrogen bond from water. Simple aldehydes/ketones lack an O–H donor.
- 2** Acids form hydrogen-bonded associations; compare similar-sized molecules for boiling points.
- 3** A longer non-polar chain can reduce water solubility without removing the polar group.

Independent structural identification

Your turn

$\text{C}_3\text{H}_6\text{O}$ has two carbon-13 signals, gives iodoform and no Tollens' silver. Which structure fits?

- A. Propanal
- B. Propanone
- C. Propan-1-ol
- D. Ethanoic acid

Exercises 2.1·2.3

2.1 Give the conjugate acid of NH_3 and conjugate base of H_2PO_4^- . [2]

2.2 Calculate pH of $0.0250 \text{ mol dm}^{-3}$ HCl in the ideal dilute strong-acid model. [2]

2.3 At 298 K, $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$. Calculate pH of $0.00200 \text{ mol dm}^{-3}$ NaOH . [3]

Exercises 2.1·2.3

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2.1 NH_4^+ ; HPO_4^{2-} .

2.2 Calculate pH of $0.0250 \text{ mol dm}^{-3}$ HCl in the ideal dilute strong-acid model. [2]

2.2 $pH = -\log_{10}(0.0250) = 1.60$.

2.3 At 298 K, $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$. Calculate pH of $0.00200 \text{ mol dm}^{-3}$ NaOH . [3]

2.3 $[H^+] = K_w/[OH^-] = 5.00 \times 10^{-12} \text{ mol dm}^{-3}$; $pH = 11.30$.

Exercises 3.1·3.3

3.1 A $0.0800 \text{ mol dm}^{-3}$ monoprotic acid has pH 3.00. Calculate K_a without replacing c

3.2 A weak acid obeys the small-dissociation model. Predict the pH change on a tenfold dilution and compare with a monoprotic strong acid in its valid concentration range. Explain one limit. [3]

3.3 0.610 g of a monoprotic acid with molar mass 122 g mol^{-1} is made up to 250.0 cm^3 .

Exercises 3.1·3.3

3.1 A $0.0800 \text{ mol dm}^{-3}$ monoprotic acid has pH 3.00. Calculate K_a without replacing c

3.1 $x = 10^{-3.00} = 0.00100 \text{ mol dm}^{-3}$. $K_a = x^2/(0.0800 - x) = 1.27 \times 10^{-5} \text{ mol dm}^{-3}$.

3.2 A weak acid obeys the small-dissociation model. Predict the pH change on a tenfold dilution and compare with a monoprotic strong acid in its valid concentration range. Explain one limit. [3]

3.2 Weak acid $[\text{H}^+]$ falls by $\sqrt{10}$, giving pH increase about 0.5. Strong acid pH increases by 1. At extreme dilution water ionisation is significant, or increased dissociation can invalidate the weak-acid approximation.

3.3 0.610 g of a monoprotic acid with molar mass 122 g mol^{-1} is made up to 250.0 cm^3 .

3.3 $n = m/M = 0.610/122 = 0.00500 \text{ mol}$; $c = n/V = 0.00500/0.2500 = 0.0200 \text{ mol dm}^{-3}$. $x = 10^{-3.00} = 0.00100 \text{ mol dm}^{-3}$. $K_a = x^2/(c - x) = 10^{-6}/0.0190 = 5.26 \times 10^{-5} \text{ mol dm}^{-3}$. Calibrate the pH meter with suitable buffers and control temperature, or use a volumetric flask accurately/rinse the electrode between samples.

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3.4 Partial dissociation gives the weak acid fewer H^+ ions and higher pH than the equimo-