

Exercise walk-through

2.3.5

Ion evidence and standard-solution transfer

Pearson Edexcel · International A-Level · Chemistry

Check the sign and denominator

Your turn

The solution gains 1.20 kJ while 0.0200 mol reacts. What is the molar reaction enthalpy?

- A. $+60.0 \text{ kJ mol}^{-1}$
- B. $-60.0 \text{ kJ mol}^{-1}$
- C. $-0.0240 \text{ kJ mol}^{-1}$
- D. $-1.20 \text{ kJ mol}^{-1}$

Controls distinguish chemical evidence from contamination

- 1 Set up** Match measured amounts, particle size, apparatus and heating rate; compare sample temperature at a consistent decomposition criterion.
- 2 Reason** CO_2 : milky limewater; O_2 : glowing splint relights; NO_2 : brown and acidic.
- 3 Conclude** Clean flame-test wire and keep the flame region/loading consistent. Na yellow, K lilac, Ca brick-red, Sr crimson-red; sodium carry-over can mask another colour.

Independent identification

Your turn

$\text{C}_3\text{H}_6\text{O}$ has a carbonyl IR absorption and gives a positive Fehling's test. Which structure fits all evidence?

- A. CH_3COCH_3
- B. $\text{CH}_3\text{CH}_2\text{CHO}$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D. CH_3COOH

Exercises 2.1·2.2

2.1 Write separate ionic equations for carbonate and hydrogencarbonate with acid. State the gas test, and explain why observing bubbles alone does not identify either anion uniquely. [4]

2.2 An unknown salt gives gas X with dilute acid. X turns limewater milky. A fresh aliquot gives gas Y with warm NaOH; Y turns damp red litmus blue and gives white fumes with HCl. State supported cation/anion conclusions, write two equations for Y, and explain why X does not distinguish carbonate from hydrogencarbonate. [5]

Exercises 2.1·2.2

2.1 Write separate ionic equations for carbonate and hydrogencarbonate with acid. State the gas test, and explain why observing bubbles alone does not identify either anion uniquely. [4]

2.1 $\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$; $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$. Pass gas into limewater:

2.2 An unknown salt gives gas X with dilute acid. X turns limewater milky. A fresh aliquot gives gas Y with warm NaOH; Y turns damp red litmus blue and gives white fumes with HCl. State supported cation/anion conclusions, write two equations for Y, and explain why X does not distinguish carbonate from hydrogencarbonate. [5]

2.2 NH_4^+ is supported; carbonate or hydrogencarbonate is supported, not a unique

Exercises 2.3·3.1

2.3 Hydrochloric acid is added from a burette to NaOH in a flask. Give the start-to-end colour change for methyl orange and for phenolphthalein. Explain why the flask may be rinsed with deionised water but the pipette must be rinsed with the NaOH solution before delivering its measured aliquot. [4]

3 Exam-style questions

3.1 A pure diprotic solid acid H_2A has $M = 126.0 \text{ g mol}^{-1}$. 1.575 g is made to 250.0 cm^3 . A 25.00 cm^3 aliquot needs 23.80 cm^3 NaOH. Write the equation and calculate the NaOH concentration. State two steps that prevent loss of acid while making the standard. [6]

Exercises 2.3·3.1

2.3 Hydrochloric acid is added from a burette to NaOH in a flask. Give the start-to-end colour change for methyl orange and for phenolphthalein. Explain why the flask may be rinsed with deionised water but the pipette must be rinsed with the NaOH solution before delivering its measured aliquot. [4]

3 Exam-style questions

2.3 Methyl orange: yellow to the specified orange endpoint, becoming red with excess acid. Phenolphthalein: pink to just colourless. Flask water does not change the amount of NaOH already delivered; pipette water would dilute the solution before measuring/delivering it, reducing the alkali amount in the nominal aliquot.

3.1 A pure diprotic solid acid H_2A has $M = 126.0 \text{ g mol}^{-1}$. 1.575 g is made to 250.0 cm^3 . A 25.00 cm^3 aliquot needs 23.80 cm^3 NaOH. Write the equation and calculate the NaOH concentration. State two steps that prevent loss of acid while making the standard. [6]

3.1 $\text{H}_2\text{A} + 2\text{NaOH} \rightarrow \text{Na}_2\text{A} + 2\text{H}_2\text{O}$. $n(\text{acid}) = m/M = 1.575/126.0 = 0.01250 \text{ mol}$; $c = 0.01250/0.2500 = 0.05000 \text{ mol dm}^{-3}$. The aliquot has $0.05000 \times 0.02500 = 0.001250 \text{ mol}$ acid, requiring 0.002500 mol NaOH. $c(\text{NaOH}) = 0.002500/0.02380 = 0.1050 \text{ mol dm}^{-3}$. Dissolve fully before transfer and rinse all transferring vessels/funnel into the flask.

Exercises 3.2·3.3

3.2 In the preceding method, mass uncertainty is ± 0.002 g, flask uncertainty ± 0.12 cm³, pipette uncertainty ± 0.06 cm³ and each burette reading uncertainty ± 0.05 cm³. Estimate the maximum overall percentage uncertainty in NaOH concentration. Identify the largest contribution and suggest a change that targets it without claiming repeats correct apparatus calibration. [5]

3.3 A student adds HCl, then AgNO₃, to an unknown solution and calls the white precipitate proof that the unknown contains chloride. Explain the problem and give a valid fresh-aliquot method distinguishing chloride, bromide and iodide, including both ammonia strengths and the ionic precipitation equation. [6]

Exercises 3.2-3.3

3.2 In the preceding method, mass uncertainty is ± 0.002 g, flask uncertainty ± 0.12 cm³, pipette uncertainty ± 0.06 cm³ and each burette reading uncertainty ± 0.05 cm³. Estimate the maximum overall percentage uncertainty in NaOH concentration. Identify the largest contribution and suggest a change that targets it without claiming repeats correct apparatus calibration. [5]

3.2 Mass contribution $100(0.002/1.575) = 0.127\%$; flask $100(0.12/250.0) = 0.048\%$; pipette $100(0.06/25.00) = 0.240\%$. Titre contribution $100(0.10/23.80) = 0.420\%$. Sum = 0.835% , about 0.84% . Burette/titre is largest. Use suitable more precise volume measurement, or a safely larger titre with appropriate concentrations and apparatus capacity. Repetition addresses random endpoint variation, not a calibration bias.

3.3 A student adds HCl, then AgNO₃, to an unknown solution and calls the white precipitate proof that the unknown contains chloride. Explain the problem and give a valid fresh-aliquot method distinguishing chloride, bromide and iodide, including both ammonia strengths and the ionic precipitation equation. [6]

3.3 HCl introduces Cl⁻ and can itself cause AgCl, so the conclusion is invalid. On a fresh aliquot use dilute HNO₃, then aqueous AgNO₃. AgCl is white and dissolves in dilute NH₃; AgBr is cream, remains in dilute but dissolves in concentrated NH₃; AgI is yellow and remains in both. $\text{Ag}^+(\text{aq}) + \text{X}^-(\text{aq}) \rightarrow \text{AgX}(\text{s})$.