2.3.2 Ion evidence and titration concentration

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS standard solution

Objective

Use separate ion tests and a balanced mole ratio to determine an unknown concentration. All questions and marking guidance are original.

1 Key knowledge and worked examples

Use separate aliquots. Acidify a sulfate test with dilute HCl before $BaCl_2$; use dilute HNO_3 before $AgNO_3$ for halides. HCl would introduce chloride and spoil the latter test. Warm ammonium salts with aqueous NaOH; ammonia turns damp red litmus blue.

■ Worked method

25.00 cm^3 of 0.0500 mol dm^{-3} Na_2CO_3 uses 24.60 cm^3 HCl. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$.

$$n(Na_2CO_3) = cV = 0.0500 \times 0.02500 = 0.001250 \text{ mol}$$

$$n(HCl) = 2n(Na_2CO_3) = 0.002500 \text{ mol}$$

$$c(HCl) = n/V = 0.002500/0.02460 = 0.1016 \text{ mol dm}^{-3}$$

Concordant titres agree within the method's specified tolerance. Do not include the rough titre in their mean. A titre uses two readings, so add their absolute uncertainties.

2 Practice

2.1 Write the ionic equation for sulfate detection and explain acidification before adding $BaCl_2$. [3]

2.2 $AgNO_3$ gives a cream precipitate after acidification with HNO_3. State the likely halide and its behaviour with dilute and concentrated ammonia. [3]

2.3 A burette reads 0.25 cm^3 initially and 23.90 cm^3 finally. Calculate the titre and its maximum percentage uncertainty if each reading is ± 0.05 cm^3. [3]

3 Exam-style questions

3.1 25.00 cm^3 of H_2SO_4 is neutralised by 20.40 cm^3 of 0.1000 mol dm^{-3} NaOH. Calculate acid concentration in mol dm^{-3} and g dm^{-3}. $M(H_2SO_4) = 98.0$ g mol^{-1}. [5]

3.2 Describe four actions needed to make an accurately known standard solution from a weighed solid acid. Explain why extra deionised water in a titration flask does not change the acid amount delivered by a pipette. [5]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4(s)$. Acid removes carbonate interference.

2.2 Bromide; AgBr remains in dilute ammonia but dissolves in concentrated ammonia.

2.3 Titre $= 23.90 - 0.25 = 23.65$ cm^3. Uncertainty ± 0.10 cm^3; $100(0.10/23.65) = 0.42\%$.

3.1 $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$. $n(\text{NaOH}) = cV = 0.1000 \times 0.02040 = 0.002040$ mol; $n(\text{acid}) = 0.001020$ mol. $c = n/V = 0.001020/0.02500 = 0.04080$ mol dm^{-3}; mass concentration $= cM = 0.04080 \times 98.0 = 4.00$ g dm^{-3}.

3.2 Accurately weigh solid; dissolve fully; transfer quantitatively with rinsings; make to the volumetric mark at eye level then mix thoroughly. Extra flask water changes concentration but not the moles already pipetted.