2.6 Quantitative Chemistry: 30-minute Pack

AQA 8462 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A molecule of water is H_2O. Use the Ar values H = 1, O = 16 to calculate the Mr of water.

(Total for Question 1 is 2 marks)

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2 Required practical: Aisha carries out a titration to find the concentration of a hydrochloric acid solution using a standard solution of sodium hydroxide of known concentration. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

(a) Name the piece of apparatus used to add the hydrochloric acid to the conical flask so that the volume added can be measured accurately. **(1)**

(b) Name the piece of apparatus used to measure a fixed, accurate volume of the sodium hydroxide solution into the conical flask. **(1)**

(c) Name a suitable indicator for this titration and describe the colour change seen at the end point as the acid is added from the burette. **(2)**

(d) Describe how Aisha should carry out the titration to obtain accurate, concordant results for the volume of hydrochloric acid needed to neutralise the sodium hydroxide. **(6)**

(e) In one titration, 25.0 cm^3 of 0.100 mol/dm3 sodium hydroxide exactly neutralised 22.50 cm^3 of the hydrochloric acid. Calculate the concentration of the hydrochloric acid in mol/dm3. **(4)**

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(f) Calculate the concentration of the hydrochloric acid in g/dm3. (Ar: H = 1, Cl = 35.5) **(2)**

(Total for Question 2 is 16 marks)

3 Explain how you would carry out a titration to find the concentration of a hydrochloric acid solution using a standard 0.10 mol per dm3 sodium carbonate solution. In your answer describe the key steps, the measurements you would make, and two sources of error and how to reduce them.

(Total for Question 3 is 6 marks)

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Mark scheme · 2.6 Quantitative Chemistry: 30-minute Pack

Question 1

substitutes numbers: Mr = (2 x 1) + 16 **M1**

Mr = 18 cao **A1**

Answer: 18

Question 2

(a) burette **B1**

(a) Answer: Burette

(b) (volumetric/graduated) pipette (with a pipette filler) **B1**

(b) Answer: Pipette (with a pipette filler)

(c) phenolphthalein (or methyl orange, with a consistent colour change) **B1**

(c) changes from pink (in the alkali) to colourless at the end point (oe, must match indicator named) **B1**

(c) Answer: Phenolphthalein; pink to colourless at the end point.

(d) **L3** A detailed, logically sequenced description covering measuring the alkali by pipette into the conical flask, adding indicator, carrying out a rough titration first, then accurate repeat titrations adding acid dropwise (swirling the flask) near the expected end point, repeating until concordant titres are obtained (within 0.10 cm^3 of each other) and calculating a mean from the concordant results only. **5-6**

(d) **L2** A description of most key steps of the method with some logical order, but with gaps in detail (e.g. no mention of a rough titration, dropwise addition, or checking for concordant results). **3-4**

(d) **L1** Basic relevant points made, such as naming apparatus or the indicator, but the method is incomplete or lacks a logical structure. **1-2**

(d) **L0** No relevant content. **0**

(d) Indicative content:

- Rinse the pipette with the sodium hydroxide solution and the burette with the hydrochloric acid before use
- Use the pipette (and filler) to measure a fixed volume, e.g. 25.0 cm^3, of sodium hydroxide into a conical flask
- Add a few drops of a suitable indicator to the flask
- Fill the burette with hydrochloric acid and record the initial reading
- Carry out a rough titration first, adding acid at a moderate rate while swirling, to find an approximate end point volume
- Repeat with accurate titrations, adding acid dropwise (swirling constantly) as the end point is approached
- Record the volume of acid added at the colour change (end point) for each repeat
- Repeat the titration until two or more concordant results are obtained (titres within 0.10 cm^3 of each other)
- Calculate the mean titre using only the concordant results, discarding the rough titration and any anomalous results

(d) Answer: See levels/indicative content.

(e) moles NaOH = concentration x volume = 0.100 x (25.0/1000) = 0.00250 mol **M1**

(e) uses the 1:1 mole ratio from the equation, so moles HCl = 0.00250 mol **M1**

(e) converts 22.50 cm^3 to 0.02250 dm3 and uses concentration = moles / volume **M1**

(e) 0.111 mol/dm3 (awrt 0.111) **A1**

(e) Answer: 0.111 mol/dm3

(f) Mr of HCl = 1 + 35.5 = 36.5, uses concentration (g/dm3) = concentration (mol/dm3) x Mr (ft from e) **M1**

(f) 4.06 g/dm3 (awrt, ft from e) **A1**

(f) Answer: 4.06 g/dm3

Question 3

Level 3 Detailed method with correct use of a burette and pipette, clear description of measurements and calculations, and two valid sources of error with appropriate ways to reduce them. **5-6**

Level 2 Method is mostly correct with some detail missing; includes at least one correct calculation and one source of error with a way to reduce it. **3-4**

Level 1 Only basic steps given or brief description of titration with limited or no evaluation of errors. **1-2**

Indicative content:

- Use a pipette to transfer a measured volume (for example 25.0 cm^3) of the HCl sample to a conical flask and add a few drops of an appropriate indicator such as methyl orange.
- Fill a burette with the standard 0.10 mol per dm3 sodium carbonate solution and record the initial burette reading.
- Titrate by adding the carbonate from the burette to the acid while swirling the flask until the indicator shows the end point; record the final burette reading and calculate the volume used (final - initial).
- Repeat the titration at least three times and use concordant results to find a mean volume; use the mean to reduce random error.
- Calculate moles of Na_2CO_3 added using moles = concentration x volume (convert cm3 to dm3), use the mole ratio between Na_2CO_3 and HCl to find moles of HCl, then calculate concentration of HCl from moles / volume of acid pipetted.
- Sources of error: parallax reading error at the burette (reduce by reading at eye level and using consistent readings), overshooting the end point (reduce by adding indicator near the end and adding solution dropwise), impure standard or inaccurate pipette (reduce by using calibrated glassware and standard solution)

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