**YEAR 12 CHEMISTRY – ATCHE**

**Volumetric Analysis Practical Test**

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**Recommended time: 55 minutes**

Name:

**Total marks**

**/ 40**

Teacher:

**Titration as a Quantitative Chemical Analysis Technique**

Determining the composition of a solution is an important analytical and forensic technique.

Sodium carbonate, **Na2CO3**  is an important industrial chemical as it is used in a number of applications including water treatment, general cleaning, descaling and buffer solutions.

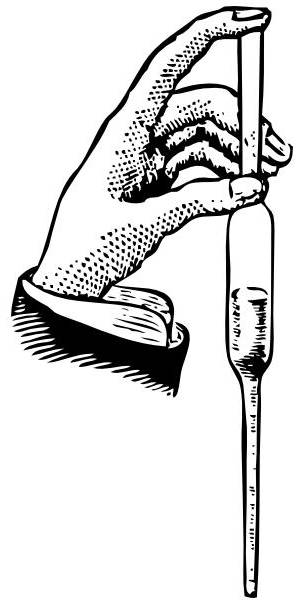
Commercial sodium carbonate has a purity of > 98 %. Major impurities in sodium carbonate include sodium chloride. The purity of commercial sodium carbonate depends on the composition of the raw materials, the production process and the intended use of the product.

One common method of measuring the amount of **pure** sodium carbonate in an **impure sodium carbonate mixture** is mass percent (or percentage by mass) where

**% by mass of Na2CO3 = m (pure Na2CO3) / m (impure Na2CO3 mixture) x 100**

The aim of this investigation is to use knowledge of acid-base reactions and titration technique to accurately determine the amount of **pure** sodium carbonate in a sodium carbonate/sodium chloride (Na2CO3/NaCl) mixture and hence calculate the percentage by mass of sodium carbonate in the sample provided.

Procedure:

1. Use a pipette to transfer a 20.0 mL aliquot of the sodium carbonate/ sodium chloride solution mixture into ONE of the conical flasks given.



2 **Put up your hand** and ask your supervisor to assess your pipetting technique.

3

(3 marks for 1st attempt, 1 mark for 2nd attempt, 0 thereafter)

3 Titrate the 20.0 ml aliquot of sodium carbonate/sodium chloride solution mixture (conical flask) against the standardised hydrochloric acid solution from the burette by selecting **ONE** of the two indicators provided.



**Put up your hand** and ask your supervisor to assess the colour at the end point.

3

(3 marks for 1st attempt, 1 mark for 2nd attempt, 0 thereafter)

4 Repeat Steps 1 – 2 until you obtain consistent results. Record all results in the table provided on the next page.

Write a balanced **IONIC** chemical equation for the titration reaction between HCl and Na2CO3 in the

2

space provided below. Include in your equation the **correct states** of matter.

**2H+(aq) + CO32-(aq) → CO2 (g) + H2O(l)** (2 marks for ionic or 1 mark for non-ionic **and** correctly balanced

1 mark for ionic and not balanced)

Results: Record all your results in the table below and calculate the average titration volume.

3

***Burette Reading***

|  |  |  |  |
| --- | --- | --- | --- |
| **Titration** | **1** | **2** | **3** |
| Final Volume (V2) | Correct use of table (1 mark) | | |
| Initial Volume (V1) |
| Titration Volume (mL)  (ΔV) = V2 - V1 | Must have at least **2 concordant** titre volumes (2 marks) | | |

2

Average Titration Volume = \_\_\_\_\_\_\_\_ mL

Correctly calculated & 2 decimal places answer (2 marks)

**Additional information from the whiteboard**

Concentration of standardised HCl = 0.10665 mol L-1

Calculation:

Use your titration results **and** additional information from the whiteboard to calculate the percentage by mass of Na2CO3 in the Na2CO3/NaCl mixture.

**Marks for Steps 1-3 are awarded for correct procedures and sufficient working shown. Correct final numerical answer is not important.**

1. n(HCl) = c (HCl).VAV = 0.10665 x VAv = mol (1 mark)
2. n(Na2CO3) in 20.0 mL mixture = 0.5 x n(HCl) =  mol (1 mark)

3. m(Na2CO3) in 20.0 mL mixture =x 105.99= g (1 mark)

**For Lance & Craig only**

Mass of Na2CO3/NaCl mixture **in 1L** = 5.653 g

Mass of Na2CO3/NaCl mixture **in 20.0mL** = 0.113 g

m(Na2CO3) in 20.0 mL mixture / m(mixture in 20.0 mL) x 100 =  **/ 0.113g x 100** (1 mark)

4

Final Answer

|  |
| --- |
| % by mass of Na2CO3 to **three (3)** significant figures = **74.9%** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Accuracy | 0 | 1 | 2 | 3 |

Answer in 3 s.f. (1 mark)

Answer within (70% - 80%) (2 marks)

Answer between (60% - 90% ) (1 mark)

Other answers (0)

**For Gurdeep, Leon & Hao**

Mass of Na2CO3/NaCl mixture **in 1L** = 6.3599 g

Mass of Na2CO3/NaCl mixture **in 20.0mL** = 0.127 g

m(Na2CO3) in 20.0 mL mixture / m(mixture in 20.0 mL) x 100 =  **/ 0.127g x 100** (1 mark)

4

Final Answer

|  |
| --- |
| % by mass of Na2CO3 to **three (3)** significant figures = **66.7%** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Accuracy | 0 | 1 | 2 | 3 |

Answer in 3 s.f. (1 mark)

Answer within (62% - 72%) (2 marks)

Answer between (52% - 82% ) (1 mark)

Other answers (0)

(1 mark)

4

\* Note: Follow-through marks awarded if student used an incorrect mass of mixture for calculation in Step 4\*.

above i.e. Students use m(mixture) in 1L (as per whiteboard) for calculation instead of m(mixture) in 20.0 mL.

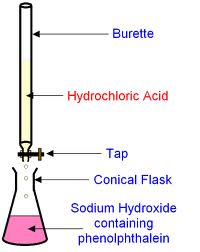
**Volumetric Analysis – Written Section (20 marks)**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1 mark each)

Teacher: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

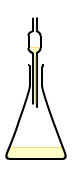
In each of the following, write the correct name, formula, number or descriptive term that best match the description.

|  |  |  |
| --- | --- | --- |
| 1 | A name given to a solution of exactly known concentration that can be obtained highly pure with a known formula and high molecular mass. | Primary standard |
| 2 | ONE (1) example of a substance that satisfies the conditions listed in Question 1. | Na2CO3, H2C2O4, NaHCO3 |
| 3 | A name given to glass equipment used to accurately deliver a **fixed** volume of solution. | Pipette |
| 4 | Name of glass equipment that must **not** be pre-rinsed with the solution to be added to it. | Conical flask |
| 5 | The level of accuracy to which final and initial volumes should be read from the burette. | 2 decimal places, or +/- 0.05mL |
| 6 | A name given to the **volume difference** between the initial volume of and the final volume of titration. | Titration volume or titre |
| 7 | Name of a substance that can be added to the reaction mixture in the conical flask **without** affecting the outcome of the titration. | Distilled water or indicator |
| 8 | Name of an indicator that should be used in the titration between a weak base and a strong acid. | Methyl orange |
| 9 | Name of an indicator that should be used in the titration between ethanoic acid and sodium hydroxide. | Phenolphthalein |
| 10 | The reading (to the correct number of significant figures)  shown on the burette opposite is: | 14.58  Accept  14.57 - 14.59 |



The following questions refers to the following titration:

**Ethanoic acid**



Pipette

For this experiment, state the correct **final** rinsing solution for each of the following glassware:

|  |  |  |
| --- | --- | --- |
| 11 | Burette | Ethanoic acid |
| 12 | Pipette | Sodium hydroxide |
| 13 | Conical flask | Water |

Questions 15-18 refer to the use of indicators in the titration above.

|  |  |  |
| --- | --- | --- |
| 14 | State the **change** in the colourof **phenolphthalein** indicator as the titration proceeds. | From pink to faint pink /colourless |
| 15 | State the pH of the reaction mixture at the **equivalence point**. | Greater than 7 |
| 16 | State the **change** in indicator colourif **methyl orange** was usedinstead of phenolphthalein. | From yellow to orange/red |
| 17 | State the pH at the **end point** of **methyl orange** indicator. | 3.1 - 4.4 or any numbers in between. |

State the effect of the following acts on the **volume** of ethanoic acid used to achieve the equivalence point in the titration above. Write your answer as **more acid is needed**, **less acid is needed** or **no effect.**

|  |  |  |
| --- | --- | --- |
| 18 | Distilled water was used as the final rinse for the burette. | More acid is needed |
| 19 | Sodium hydroxide was used as the final rinse for the conical flask. | More acid is needed |
| 20 | Methyl orange was used as the indicator. | No effect (nasty!)  OR More acid |

