Volumetric Analysis 3

To determine the relative molecular mass of a soluble base

Introduction

In *Volumetric Analysis 1 & 2* you prepared a standard solution of sodium carbonate and used it to standardise an unknown concentration of dilute hydrochloric acid. In this practical you will use your new-found skills to find out the relative molecular mass of an unknown group 1 carbonate – the mysterious "Substance Z". Group 1 carbonates are soluble in water (although Li_2CO_3 is only sparingly soluble) and will react with dilute hydrochloric acid according to the overall equation below:

$$X_2CO_3(aq) + 2HCl(aq) \rightarrow 2XCl(aq) + CO_2(g) + H_2O(l)$$

(X represents a group 1 element)

If you know the amount of hydrochloric acid that will react with a known amount of Substance Z, you should be able to determine the M_r of Substance Z and so identify the group 1 element in it.

You will need to make careful notes about your experiment as you go along today.

Apparatus

Consult your notes from *Volumetric Analysis 1 & 2* to decide upon the apparatus you need.
Make sure that your practical write-up includes the apparatus you use today.

Method

Consult your notes from *Volumetric Analysis 1 & 2* and *The Burette* to remind yourself of the procedures needed for safe and accurate working.
Make sure that your practical write-up includes the methods you use today.

1. Weigh out accurately between 1.3g and 1.7g of Substance Z.
   Record your weighings in a suitable form. Dissolve your weighed Substance Z in de-ionised water, and make up the solution to 250cm^3 in a volumetric flask.

2. Clean your burette with de-ionised water and then with the standard 0.100M hydrochloric acid to be used for the titration.

3. Pipette 25cm^3 of the Substance Z solution into a clean conical flask.
   Using methyl orange indicator, titrate with the standard hydrochloric acid.

4. Repeat step 3 until concordant results are obtained.
   Record your results as in *Volumetric Analysis 2.*

After cleaning and clearing away, determine the identity of Substance Z as described overleaf.

Analysis

As in *Volumetric Analysis 2*, 1 mole of X_2CO_3 will react with 2 moles of HCl (see equation below):

$$X_2CO_3(aq) + 2HCl(aq) \rightarrow 2XCl(aq) + CO_2(g) + H_2O(l)$$

(X represents a group 1 element)

1. Calculate the number of moles of HCl there were in your mean titre.

2. Calculate the number of moles of HCl that would react with the entire $250cm^3$ of Substance Z solution.

3. Work out the number of moles of X_2CO_3 were there in the $250cm^3$ of Substance Z solution.

You now know:

- the mass of X_2CO_3 in your Substance Z solution; and
- the number of moles of X_2CO_3 in your Substance Z solution.

4. Calculate the mass of one mole of X_2CO_3.

5. What is Substance Z, and why?

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Technician's Notes

Prior to practical

Sodium carbonate*

Heat required amount of sodium carbonate (Na_2CO_3) to drive off water of crystallisation.

Either: heat in an evaporating dish over a Bunsen burner for 30 minutes approx., or
heat in a drying oven at about 110^{o}C for 1 hour.

Agitate the solid periodically with a clean glass rod.
Transfer to a desiccator after heating, and label it "Substance Z - Harmful".

Care: Use tongs and eye protection.
Beware of hot solid and apparatus.
Sodium carbonate forms caustic alkaline solutions with water; if spilt on skin wash with plenty of water.

Analytical balances

Please check cleanliness and correct functioning of analytical balances.

De-ionised water

Please check 6th Form wash bottles are clean and filled with de-ionised water.
Make sure that additional de-ionised water is available in the aspirator.

Burettes

Please check the cleanliness and correct functioning of the burettes.

Per class

Sodium carbonate solid (see above). Allow approx. 2.5g per student.
Analytical balances (see above).
Top pan digital balances (minimum of two if possible).
De-ionised water (see above).
0.100M hydrochloric acid* (a good home-made solution should suffice for this practical).
Allow 200cm^3 per student.
Methyl orange indicator solution (the more bottles the better).

Per student

(Normally found in lab anyway)

1 x pair of safety goggles
1 x bench mat
2 x 100cm^3 beaker
2 x 250cm^3 beaker
1 x 250cm^3 conical flask
1 x glass funnel (check that it will enter the neck of the volumetric flask easily)

Per student

(Additional apparatus to put out)

1 x glass rod (long)
1 x 250cm^3 volumetric flask with stopper to fit
1 x 25cm^3 bulb pipette
1 x pipette filler (check correct functioning)
1 x burette (see overleaf)
1 x burette stand
1 x weighing bottle with lid
1 x 6th Form wash bottle containing de-ionised water
1 x small spatula
1 x white tile
1 x small plastic filter funnel

1 x copy of N-ch1-37 (student guide to practical)

*Health and Safety Notes

Hydrochloric acid

Corrosive.
Use pre-prepared standard solution, or refer to Hazcards for correct method to prepare an accurate 0.100M solution.

Sodium carbonate (solutions and solid)

Sodium carbonate solutions are alkaline and therefore caustic.
Exercise care in handling - wear eye protection and, if spilt, wash with a lot of water.