Finding out how much acid there is in a solution

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CS 6A5

1.0 PLAN

1.1 Aim

I am to be given a sample of sulphuric acid thought to have a concentration between 0.05 and 0.15 mol dm^{-3} and have to find out the accurate concentration of the acid. I am also provided with solid, anhydrous sodium carbonate, a range of indicators and details about the suitability of the indicators for different types of titration.

1.2 List of Apparatus

- Burette.
- Sulphuric acid ($250cm^3$).
- Anhydrous sodium carbonate
- $250cm^3$ volumetric flask.
- Clamp stand.
- $250cm^3$ conical flask.
- $25cm^3$ pipette.
- Pipette filler.
- Weighing boat.
- Weighing scale.
- Spatula.
- Filter funnel.
- Wash bottle and distilled water.
- Methyl Orange indicator solution.

1.3 Risk Assessment

During my investigation there are key hazards that I have to look out for. They are listed in the table below:

Chemical	Risk	Precaution	Action in the event of an accident occurring
Sulphuric acid	Irritant	Be careful when handling	Wash affected area with water.
Methyl Orange indicator solution	Highly Flammable	Wear lab coat	Using a fire extinguisher extinguish any flames.
Anhydrous sodium carbonate	Powdery	Be careful when handling	Clean up the mess.

1.4 Method

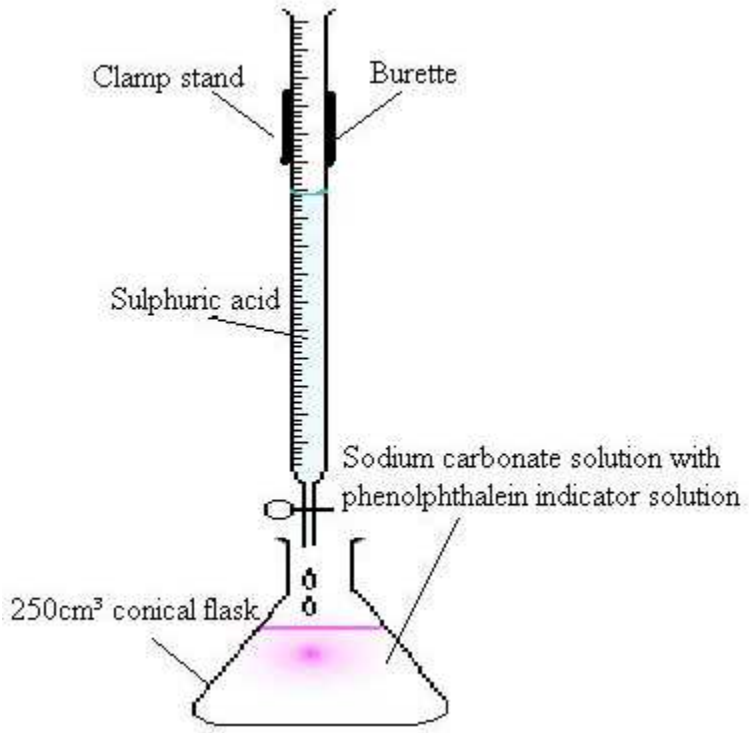

Diagram of investigation

- I need to calculate the mass of sodium carbonate I will need in order to make up a standard solution.
- Calculation to find the mass of sodium carbonate:

I have chosen to use a 0.1moldm-3 solution of sodium carbonate, this is because it is in the middle of the range for the concentration given in the aim. I have chosen to use 250cm3 of sodium carbonate because it is an easy to handle quantity, it allows me to do many titrations without wasting too much which isn't used. To make a solution of this concentration I will have to dissolve an amount of sodium carbonate in a fixed amount of water here is my calculation for this:

Find the relative molecular mass (Mr) of sodium carbonate by adding the relative atomic mass (Ar) of everything that makes up sodium carbonate (Na2CO3) together.

Na, Ar = 23 C, Ar = 12 O, Ar = 16

23 + 23 + 12 + 16 + 16 + 16 = 106 Mr = 106

The mass of 1 mole of Na2CO3 is 106g

If 106g of Na2CO3 was added to 1dm3 of water this would produce a 1moldm-3 solution. I want 250cm3 of 0.1moldm-3 solution to find this I will apply the formula:

Concentration = number of moles

Volume we need to find the number of moles so by multiplying concentration by volume to give number of moles

To do this calculation the volume must be converted into dm3 from cm3 this is done by dividing the volume by 1000.

250 = 0.25dm3

1000

Concentration x volume = moles

0.1moldm-3 x 0.25dm3 = 0.025 moles

Multiplying the number of moles required by the mass of 1 mole gives the mass required to make the solution.

106 x 0.025 = 2.65g of Na2CO3 required to make 250cm3 of 0.1moldm-3 solution.

So I will dissolve 2.65g of sodium carbonate in 250cm3 of distilled water to make 250cm3 of 0.1moldm-3 sodium carbonate solution.

  - In order to make a standard solution I will collect sodium carbonate with the mass that I had calculated by using a weighing boat, weighing scale and spatula.
  - I will then place this in the 250cm³ volumetric flask and fill the volumetric flask with a small amount of distilled water, I will place the lid on the volumetric flask and then shake the flask so that the sodium carbonate dissolves into the distilled water.
  - Once the sodium carbonate has dissolved in the volumetric flask I will then fill it up with distilled again but to the graduation mark using a wash bottle.

- I will then pipette 25cm³ of this sodium carbonate solution into a 250cm³ conical flask using a pipette and pipette filler and add 3 drops of the methyl orange indicator solution to the conical flask.

- After this I am going to rinse a burette with the sulphuric acid by filling it up and releasing its contents. After rinsing I will fill up the burette with the sulphuric acid and place it on the clamp and record its initial reading.
- I will then place the conical flask containing the sodium carbonate solution under the burette and then titrate it until the solution becomes clear.
- Once the solution has become clear I will record the burette's final reading and take the initial reading away from it to find the titre.
- I will repeat the titration on a new sample of sodium carbonate another to time to ensure that I have reliable results and obtain and average.

1.5 Bibliography

Below is the list of any sources I have used for my investigation.

1	OCR	Activity Booklet- Chemistry for life - Elements of Life - EL 2.1	2000	
2	OCR	Activity Booklet, Chemistry of Natural Resources, Atmosphere – A 3.3	2000	Pages 59-279
3				
4				
5				

2.0 ANALYSIS

2.1 Results Table

Table showing the volume of sulphuric acid used				
	1	2	3	4
Final Reading	34.20	37.80	37.60	27.00
Initial Reading	0.20	0.20	0.10	0.00
Volume of sulphuric acid used	34.00	37.60	37.50	27.00

From my results I have obtained two results that are consistent to ±0.2cm. These results are from the 2nd and 3rd trials. They are 37.60 and 37.50, in order for me to find out the concentration of the sulphuric acid used I will have to find the mean value of these values by adding the two values together and dividing by two. The average volume of sulphuric acid used is 37.55cm3.

2.2 Calculations and Graph

After collecting a few consistent results I am now able to find the exact concentration of the sulphuric acid.

Concentration of sodium carbonate = Volume used/ RFM

RFM of Na_2CO_3 = 2 X 23 + 12 + 3 X 16 = 106

Concentration of sodium carbonate = 2.65/106

Concentration of sodium carbonate = 0.03

During each trial I did not use the same 1 mole of sodium carbonate as I used 25cm3 of sodium carbonate and not 250cm3. Therefore, I have to divide the concentration by 10 to find the actual concentration used which is 0.003.

To work out the concentration I have to divide the number of moles used by the volume.

Concentration of sulphuric acid = 0.003/(37.55/1000)

$=0.08 \text{ mol dm}^{-3}$

2.3 Findings

From my results I have found that I have two anomalous results as a result of them being inconsistent. However, I did manage to obtain two consistent results. As a result of this I was eventually able to calculate the concentration of sulphuric acid used. The concentration of the acid was found to be 0.08 mol dm^{-3}

3.0 EVALUATION

3.1 Suitability and Accuracy

I feel that my method was suitable for this investigation. This is because only a basic set up was required for my investigation. However, as with all investigations mine was not free from any flaws. There were plenty of flaws that had an impact on my results and as a consequence I do not have a decent set of results.

3.2 Percentage errors

For every trial I carried out there was slight errors. Below is a table showing the percentage errors.

Measurement	Percentage Error (%)
Sodium Carbonate	0.005 / 2.65 x 100 = ±0.19
Average volume of sulphuric acid used	0.1 / 37.55 x 100 = ±0.27
Total percentage error = ±0.46	

The total percentage of errors can be found by adding the values in the last column together. The overall percentage of error in my investigation is ±41.58%. This is very significant as half the investigation seems flawed.

3.3 Significant Errors

In my investigation there were many significant errors within the procedure used and the measurements taken. I have listed the errors below.

Procedural Errors

- The amount of sulphuric acid placed into the sodium carbonate solution may have had fluctuations as the methyl orange can only be seen once you shake it and the flask was not shaken all the time.
- When I was making the sodium carbonate solution all the sodium carbonate may not have dissolved into the distilled water.

Measuring Errors

- The burette had an error of ±0.1cm³ which could have shown fluctuations in the amount of sulphuric acid that was used.
- The weighing scale had an error of ±0.005g which could have had an impact on the amount of sodium carbonate that was used for the experiment.

3.4 Improvements

I could have made many significant changes to my investigation to make it more reliable. These include:

- Continuously shake the flask containing the sodium carbonate.