CHEMISTRY TWO

ASSESSABLE PRACTICAL TWO

JOSEPH CURTIS.

AIM To determine, using titration the amount of pure Na_2CO_3 contained in a 2 to 3 gram sample of Na_2CO_3 contaminated with NaCl.

CONCLUSION The amount of pure Na_2CO_3 contained in the contaminated sample of Na_2CO_3 and NaCl was found using titration to be 2.36 grams.

BACKGROUND

The reactions and stoichiometry of the substances:

Reaction between Na_2CO_3 (primary standard) and HCl to determine the concentration of the HCl for the experiment.

1 mole of sodium carbonate + 2 moles of hydrochloric acid reacts to produce 2 moles of sodium chloride + 1 mole of water + 1 mole of carbon dioxide.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

All reactions in this experiment use this same stoichiometric equation.

Relevant new terms:

A primary standard is a solution of accurately known concentration. Na_2CO_3 is used as a primary standard for this experiment because carbonates do not react with the air or absorb water and therefor don't loose their accuracy over time. Acids are bad primary standards because they absorb water from the air over time and their concentration changes and because you can not accurately dilute them. Bases are not good primary standards because they also absorb water from the air and loose their accuracy. Bases also react with the CO_2 in the air causing them to chemically change over time. That is why we use carbonates and in this experiment, sodium carbonate as a primary standard.

The indicator, Methyl orange was used for determining when the titrate changes to neutral because it changes colour very quickly when it changes from acidic to basic so you can get a very accurate reading on the burette. Some other indicators change colour very slowly making it difficult to determine exactly when the substance had actually been neutralized and therefor unsuitable for this kind of prac, where accuracy is the key to a correct analysis of a substance.

Only 2 to 3 grams of contaminated Na_2CO_3 were used because if any larger amount had been used then the amount of acid that would have had to of been used would have been quite high. If any more Na_2CO_3 had of been used then more that 250mLs of HCl would have had to been mixed up. That would of not only been a waste of acid but quite difficult to get accurate. This is because there were only 250mL volumetric flasks and cruder measurements would have had to have been made which would have introduced an increased error into the experiment which would have been counterproductive to the accuracy of the prac.

Formulas used:

$n = cv$

$c = n/v$

c = concentration (M)
n = Number of moles
v = Volume(L)

n = m/MM
m = n*MM

n = Number of moles
m = mass(g)
MM = Molar mass

Molar mass of Na_2CO_3 = 105.986

Precalculation:

If 2.5g of Na_2CO_3 were used for the 250mL primary standard solution.

n = m/MM
m = 2.5g
MM = 105.986

n = 2.5 / 105.986
n = 0.023588021 moles

c = n/v
n = 0.023588021 moles
v = 0.250L

c = 0.023588021 / 0.250
c = 0.09435 M

If the concentration of HCl is approx. 0.2M

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

1 mole : 2 moles

n(HCl) = cv
c = 0.2
v = 0.0212

n = 0.2 * 0.021
n = 0.00424

n(Na_2CO_3) = n(HCl) / 2
n(Na_2CO_3) = 0.00212

m = n*MM
n = 0.00212
MM = 105.986

m = 0.00212 * 105.986
m = 0.22469032g in 25mL
m * 10 to get 250mL
m(250mL) = 2.2469032g

Should get approx. 2.24g of Na_2CO_3 for HCl with a concentration of 0.2M

METHOD

Preparing the standard solution:

1. 2-3g of Na_2CO_3 was weighed and the mass recorded.
2. Na_2CO_3 was poured through a funnel into a 250mL volumetric flask and funnel was rinsed with distilled water so that all the Na_2CO_3 was washed into the volumetric flask.
3. More distilled water was added so that all of the Na_2CO_3 was dissolved.
4. The volume was made up to 250mL.
5. 3 x 25mL aliquots were pipetted into separate conical flasks.
6. 3 drops of Methyl Orange indicator was added to each flask.

Standardizing the acid:

7. Approx. 300mL of 0.2M HCl was made up. The acid was swirled and then the burette was filled above the zero mark. Some acid was run through the burette into a beaker until the meniscus was level with the zero mark; the runoff acid was discarded.
8. One conical flask was placed under the burette and acid was run through the burette until the colour changed permanently, the liquid was swirled continuously. The volume of the acid was recorded to the nearest 0.05mL.
9. The burette was refilled and the titration of the acid into the Na_2CO_3 was repeated so that 3 consecutive titres were within 0.1mL of each other.
10. The concentration of the acid wad calculated from the volume of the acid.
11. The Na_2CO_3 was discarded and the acid was kept.

Determination of the unknown:

1. Unknown was obtained and number written down.
2. Unknown was dissolved and made up to standard volume.
3. Unknown was titrated with the HCl of known concentration.

4. Mass of sodium carbonate in contaminated sample was calculated.

DATA

Mass of Na_2CO_3 used to make up primary standard.

Mass = 2.845g

Titration to determine the concentration of the HCl using the primary standard.

Rough	1	2	3
25.70 ml	25.60 ml	25.45 ml	25.50 ml

Average = 25.52 ml

Titration to determine the mass of the Na_2CO_3 (in the contaminated sample) using the HCl.

Rough	1	2	3
21.30 ml	21.20 ml	21.20 ml	21.20 ml

Average = 21.20 ml

ANALYSIS

Preparation of primary standard:

For Na_2CO_3

n = mass / molar mass
mass = 2.845
molar mass = 105.986

n = 2.845 / 105.986
n = 0.026843167

c = n / v
n = 0.026843167
v = 0.2500

c = 0.026843167 / 0.2500
c = 0.107372671 M

Calculation of HCl concentration:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

1 : 2

$n(Na_2CO_3)$ = 0.026843167
n(HCl) = $n(Na_2CO_3)$ * 2
n(HCl) = 0.053686334

divide by 10 to get number of moles in 25 ml

n(HCl) = 0.0053686334

for HCl

c = n / v
n = 0.0053686334
v = 0.0255166

c = 0.0053686334 / 0.0255166
c = 0.210397678 M

<u>Calculation of mass of pure Na_2CO_3 in contaminated sample:</u>

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

1 : 2

<u>for HCl</u>

n = cv
c = 0.210397678
v = 0.0212

n = 0.210397678 * 0.0212
n(HCl) = 0.00446043

<u>for Na_2CO_3</u>

divide by 2 to get number of moles for Na_2CO_3

$n(Na_2CO_3)$ = 0.002230215 for 25mls
x by 10 to get n for 250 mils
n = 0.02230215

m = n * MM

n = 0.02230215
MM = 105.986

m = 0.02230215 * 105.986
m = 2.36371569

Mass of pure Na_2CO_3 in contaminated sample = 2.36 grams (3sf)

ERRORS

With the HCl being left overnight before it was used in the experiment there is a possibility that the HCl absorbed some water from the air and therefor became slightly weaker as a result. This would cause the end mass to be calculated as larger, because the concentration was weaker than the actual value used in the calculations. This decreases the overall accuracy of the experiment and is very bad.

If any of the Na_2CO_3 used to make up the primary standard was caught in the funnel as the Na_2CO_3 was poured into the volumetric flask and this did not get mixed in with the solution, then the concentration of the primary standard would be less than the calculated concentration. This would make it inaccurate and so the concentration of the HCl would be determined to be higher than was actually true, this in turn would end up in the calculating of the mass of Na_2CO_3 in the contaminated sample to be larger than actual and therefore inaccurate.

If any of the contaminated Na_2CO_3 was to get stuck on the funnel and not get into the volumetric flask, then the concentration would be less and it would take less HCl to neutralize it. This would make the number of moles calculated to be less than the actual number of moles, therefor making the end calculated mass, less than the actual mass of the Na_2CO_3 in the contaminated sample.

Any errors in calculation would affect the end result in a way specific to the error that had been made. If a decimal point had been accidentally left out, or a number misplaced then the calculated answer would be inaccurate but to what degree can only be known it the exact nature of the error is known.

If you fill the volumetric flask for the primary standard up too much then the volume of the Na_2CO_3 will be more than the calculated amount and therefore the concentration less. Therefor the end mass will be calculated as less than actual.

If you misread the burette and record less volume than there actually is then the number of moles in the Na_2CO_3 is larger than the calculated value and then the end mass of Na_2CO_3 ends up to be more than the calculated mass.