

# CHEMISTRY TWO

# ASSESSABLE PRACTICAL TWO

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**AIM** To determine, using titration the amount of pure  $\text{Na}_2\text{CO}_3$  contained in a 2 to 3 gram sample of  $\text{Na}_2\text{CO}_3$  contaminated with  $\text{NaCl}$ .

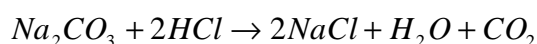
**CONCLUSION** The amount of pure  $\text{Na}_2\text{CO}_3$  contained in the contaminated sample of  $\text{Na}_2\text{CO}_3$  and  $\text{NaCl}$  was found using titration to be 2.36 grams.

## **BACKGROUND**

### **The reactions and stoichiometry of the substances:**

Reaction between  $\text{Na}_2\text{CO}_3$  (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.



All reactions in this experiment use this same stoichiometric equation.

### **Relevant new terms:**

A primary standard is a solution of accurately known concentration.  $\text{Na}_2\text{CO}_3$  is used as a primary standard for this experiment because carbonates do not react with the air or absorb water and therefore don't lose 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 lose their accuracy. Bases also react with the  $\text{CO}_2$  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 therefore 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  $\text{Na}_2\text{CO}_3$  were used because if any larger amount had been used then the amount of acid that would have had to be used would have been quite high. If any more  $\text{Na}_2\text{CO}_3$  had been used then more than 250mLs of HCl would have had to be mixed up. That would not only be 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  $\text{Na}_2\text{CO}_3 = 105.986$

### **Precalculation:**

If 2.5g of  $\text{Na}_2\text{CO}_3$  were used for the 250mL primary standard solution.

$n = m/MM$

$m = 2.5\text{g}$

MM = 105.986

$n = 2.5 / 105.986$

$n = 0.023588021$  moles

$c = n/v$

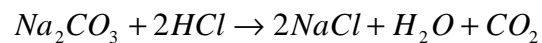
$n = 0.023588021$  moles

$v = 0.250\text{L}$

$c = 0.023588021 / 0.250$

$c = 0.09435$  M

If the concentration of HCl is approx. 0.2M



1 mole : 2 moles

$n(\text{HCl}) = cv$

$c = 0.2$

$v = 0.0212$

$n = 0.2 * 0.021$

$n = 0.00424$

$n(\text{Na}_2\text{CO}_3) = n(\text{HCl}) / 2$

$n(\text{Na}_2\text{CO}_3) = 0.00212$

$$m = n \cdot MM$$
$$n = 0.00212$$
$$MM = 105.986$$

$$m = 0.00212 \cdot 105.986$$
$$m = 0.22469032 \text{g in } 25 \text{mL}$$
$$m \cdot 10 \text{ to get } 250 \text{mL}$$
$$m(250 \text{mL}) = 2.2469032 \text{g}$$

Should get approx. 2.24g of  $\text{Na}_2\text{CO}_3$  for HCl with a concentration of 0.2M

## **METHOD**

### **Preparing the standard solution:**

1. 2-3g of  $\text{Na}_2\text{CO}_3$  was weighed and the mass recorded.
2.  $\text{Na}_2\text{CO}_3$  was poured through a funnel into a 250mL volumetric flask and funnel was rinsed with distilled water so that all the  $\text{Na}_2\text{CO}_3$  was washed into the volumetric flask.
3. More distilled water was added so that all of the  $\text{Na}_2\text{CO}_3$  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  $\text{Na}_2\text{CO}_3$  was repeated so that 3 consecutive titres were within 0.1mL of each other.
10. The concentration of the acid was calculated from the volume of the acid.
11. The  $\text{Na}_2\text{CO}_3$  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<sub>2</sub>CO<sub>3</sub> 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<sub>2</sub>CO<sub>3</sub> (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<sub>2</sub>CO<sub>3</sub>

$n = \text{mass} / \text{molar mass}$

mass = 2.845

molar mass = 105.986

$n = 2.845 / 105.986$

$n = 0.026843167$

$c = n / v$

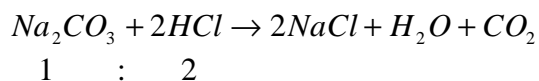
$n = 0.026843167$

$v = 0.2500$

$c = 0.026843167 / 0.2500$

$c = 0.107372671 \text{ M}$

### **Calculation of HCl concentration:**



$$n(\text{Na}_2\text{CO}_3) = 0.026843167$$

$$n(\text{HCl}) = n(\text{Na}_2\text{CO}_3) * 2$$

$$n(\text{HCl}) = 0.053686334$$

divide by 10 to get number of moles in 25 ml

$$n(\text{HCl}) = 0.0053686334$$

for HCl

$$c = n / v$$

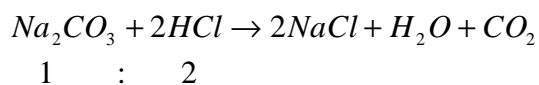
$$n = 0.0053686334$$

$$v = 0.0255166$$

$$c = 0.0053686334 / 0.0255166$$

$$c = 0.210397678 \text{ M}$$

### **Calculation of mass of pure Na<sub>2</sub>CO<sub>3</sub> in contaminated sample:**



for HCl

$$n = cv$$

$$c = 0.210397678$$

$$v = 0.0212$$

$$n = 0.210397678 * 0.0212$$

$$n(\text{HCl}) = 0.00446043$$

for Na<sub>2</sub>CO<sub>3</sub>

divide by 2 to get number of moles for Na<sub>2</sub>CO<sub>3</sub>

$$n(\text{Na}_2\text{CO}_3) = 0.002230215 \text{ for 25mls}$$

x by 10 to get n for 250 mils

$$n = 0.02230215$$

$$m = n * \text{MM}$$

$$n = 0.02230215$$

$$\text{MM} = 105.986$$

$$m = 0.02230215 * 105.986$$

$$m = 2.36371569$$

Mass of pure  $\text{Na}_2\text{CO}_3$  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  $\text{Na}_2\text{CO}_3$  used to make up the primary standard was caught in the funnel as the  $\text{Na}_2\text{CO}_3$  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  $\text{Na}_2\text{CO}_3$  in the contaminated sample to be larger than actual and therefore inaccurate.

If any of the contaminated  $\text{Na}_2\text{CO}_3$  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  $\text{Na}_2\text{CO}_3$  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 if 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  $\text{Na}_2\text{CO}_3$  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  $\text{Na}_2\text{CO}_3$  is larger than the calculated value and then the end mass of  $\text{Na}_2\text{CO}_3$  ends up to be more than the calculated mass.