

**Date:** Friday 5<sup>th</sup> Oct. 2012

**Workstation #:** 1

**Title of Experiment:** Acid – Base Titrations

- Aim/Objectives:**
- 1) To prepare a standard solution of Sodium Carbonate.
  - 2) To standardise a solution of hydrochloric acid with sodium carbonate solution.
  - 3) To standardise a solution of sodium hydroxide using hydrochloric acid.
  - 4) To determine the relative molecular mass of an acid.

**Procedure:** *State in point form, past tense.* Also state any corrections that were made and any deviations that were made from the procedure. This is especially important to do.

**Results/Observations/Data:**

***Table 1: Mass of sodium carbonate used***

Mass of Bottle and Salt	1.9658 g
Mass of Bottle	0.6495 g
Mass of Salt	1.3163 g

**Table 2: Titre values for the Standardization of Hydrochloric Acid**

Burette Readings	Rough	I	II
Final Volume (mL)	36.00	37.30	30.40
Initial Volume (mL)	15.00	17.00	10.00
Volume of acid used	21.00	20.30	20.40

**Table 3: Titre values for the Standardization of NaOH**

Burette Readings	Rough	I	II
Final Volume (mL)	35.40	37.90	
Initial Volume (mL)	3.50	6.00	
Volume of NaOH used	31.90	31.90	

**Table 4: Mass of sodium carbonate used**

Mass of Bottle and Salt	1.8128
Mass of Bottle	1.3126 g
Mass of Salt	0.5002 g

**Table 5: Titre values for the determination of the Relative Molecular Mass of Solid Acid Sample**

Burette Readings	I
Final Volume (mL)	19.40
Initial Volume (mL)	3.50
Volume of NaOH used	15.90

**Calculations:**

[1] *To determine the mass of 1 mole of Sodium Carbonate for experiment 1, part A*

$$\begin{aligned} 1 \text{ mole of Na}_2\text{CO}_3 &= (22.9897 \times 2) + (12.0107) + (15.9994 \times 3) \\ &= 105.9721 \text{ g} \end{aligned}$$

[2] *To determine how many moles of sodium carbonate in 250 mL for experiment 1, part A*

Firstly, 1.3163 g (see table 1) of Sodium Carbonate was dissolved in 250 mL

Since 1 mole of  $\text{Na}_2\text{CO}_3 = 105.9721 \text{ g}$

Let us say then that  $x$  moles of  $\text{Na}_2\text{CO}_3 = 1.3163 \text{ g}$

Therefore 
$$x = \frac{1 \text{ mol} \times 1.3163 \text{ g}}{105.9721 \text{ g}}$$

$$= 0.01242 \text{ mol}$$

Thus, there is 0.01242 moles of  $\text{Na}_2\text{CO}_3$  in 250 mL of solution

[3] *To determine the number of moles of  $\text{Na}_2\text{CO}_3$  in 25 mL of solution, for experiment 1, part B*

Since there is 0.01242 moles of  $\text{Na}_2\text{CO}_3$  in 250, then in 25 mL there would be,

$$\frac{0.01242 \text{ mol}}{10} = 1.242 \times 10^{-3} \text{ mol}$$

Thus, there is  $1.242 \times 10^{-3}$  mol of  $\text{Na}_2\text{CO}_3$  in 25 mL of solution.

**[3A]** : To determine the molarity of  $\text{Na}_2\text{CO}_3$  solution

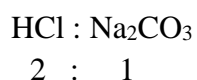
Try yourself!

**[4]** To determine the concentration of Hydrochloric Acid Solution

From table 2, the volume of acid used for burette readings I and II were used. These values were 20.30 mL and 20.40 mL

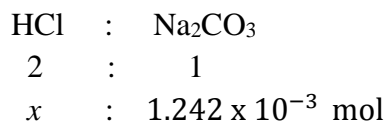
Firstly, consider the titre value of 20.30 mL.

The Hydrochloric Acid reacts with Sodium Carbonate in a 2:1 ratio, i.e.



From calculation [3], it is known that in 25 mL of  $\text{Na}_2\text{CO}_3$  solution there is  $4.968 \times 10^{-4}$  mol of  $\text{Na}_2\text{CO}_3$ .

So,



$$\text{Therefore, } x = \frac{2 \times 1.242 \times 10^{-3}}{1}$$

$$= 2.484 \times 10^{-3} \text{ mol}$$

Thus  $2.484 \times 10^{-3}$  mol of HCl is in 20.30 mL of solution.

Since  $2.484 \times 10^{-3}$  mol of HCl is in 20.30 mL of solution  
Then how many  $x$  mol of HCl is in 1000 mL

$$\text{Therefore, } x = \frac{2.484 \times 10^{-3} \text{ mol} \times 1000 \text{ mL}}{20.30 \text{ mL}}$$

$$= 0.1224 \text{ mol}$$

Thus the concentration of HCl is  $0.1224 \text{ mol L}^{-1} = 0.1224 \text{ M}$

Now for the titre value of 20.4 mL, the same calculation above was applied and the value obtained for the concentration of HCl was 0.01218 M.

Thus the average of concentration values for titre values I and II of experiment 1, part B is

$$\begin{aligned}\text{Average concentration values} &= \frac{(0.1224 \text{ M} + 0.1218 \text{ M})}{2} \\ &= 0.1221 \text{ M}\end{aligned}$$

Thus the concentration of HCl was determined to be 0.1221 M

Alternatively the average of titre values I and II could be found and then the average concentration of HCl could be determined.

**[5]** *To determine the concentration of NaOH for Experiment 2 part B*

Firstly, the number of moles of HCl in 25 mL should be determined

The concentration of HCl = 0.1221 M = 0.1221 mol L<sup>-1</sup>

Thus, there is 0.1221 mol of HCl → 1000 mL of solution  
                   $x$  mol of HCl → 25 mL of solution

$$\begin{aligned}\text{Therefore, } x &= \frac{0.1221 \text{ mol} \times 25 \text{ mL}}{1000 \text{ mL}} \\ &= 3.0525 \times 10^{-3} \text{ mol}\end{aligned}$$

This means that in 25 mL of 0.01221 M HCl solution there is 3.0525 x 10<sup>-3</sup> mol of HCl

From table 3, the volume of NaOH used for 1<sup>st</sup> titre value = 31.90 mL (also applies for 2<sup>nd</sup> titre value)

Therefore, since reaction of NaOH to HCl is 1:1, then  
there is 3.0525 x 10<sup>-3</sup> mol of NaOH in 31.90 mL  
then            $x$            mol of NaOH in 1000 mL

$$x = \frac{3.0525 \times 10^{-3} \text{ mol} \times 1000 \text{ mL}}{31.90 \text{ mL}}$$

$$= 0.09569 \text{ mol}$$

Therefore the concentration of NaOH solution = 0.09569 M

**[6]** *To determine the mass of solid acid sample*

From table 5, the titre value was 31.90.

From calculation **[5]**, 0.09569 mol of NaOH → 1000 mL

Now  $x$  mol of NaOH → 31.90 mL

$$x = \frac{0.09569 \text{ mol} \times 15.9 \text{ mL}}{1000 \text{ mL}}$$

$$= 1.5215 \times 10^{-3} \text{ mol}$$

Thus,  $3.0525 \times 10^{-3}$  mol of NaOH reacted with 0.5002 g of solid acid sample.

The solid acid sample is monobasic therefore 1:1 ratio reaction with NaOH

Therefore, no. of moles of solid acid sample =  $3.0525 \times 10^{-3}$  mol

Thus,  $3.0525 \times 10^{-3}$  mol of solid acid sample → 0.5002 g

1 mol of solid acid sample →  $x$  g

$$x = \frac{0.5002 \text{ g} \times 1 \text{ mol}}{1.5213 \times 10^{-3}}$$

$$= 328.80 \text{ g}$$

Therefore the RMM of solid acid sample = 328.80 g

**Discussion:**

- Explain results
- Discuss why results do not match theoretical data
- Outline sources of error, if any.
- State precautions that were taken.
- Discuss how lab may be improved or why a particular procedure is good

**Conclusion:**

Give very brief summary of what was calculated and answer the aims/objectives. In some cases you may just have to state your inferences as they relate to your results.

**Additional Exercises:**

There may be additional questions that may be asked at the end of the lab for you to answer. For the first lab there wasn't any but in the 2<sup>nd</sup> lab there would be questions that must be answered. You can put the answers in this section.