Date: Friday 5th 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 hydrocholoric 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*

1 mole of Na_2CO_3 = (22.9897 x 2) + (12.0107) + (15.9994 x 3)

= 105.9721 g

[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 Na_2CO_3 = 105.9721 g

Let us say then that *x* moles of Na_2CO_3 = 1.3163 g

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

$$= 0.01242\ \text{mol}$$

Thus, there is 0.01242 moles of Na_2CO_3 in 250 mL of solution

[3]*To determine the number of moles of Na_2CO_3 in 25 mL of solution, for experiment 1, part B*

Since there is 0.01242 moles of Na_2CO_3 in 250, then in 25 mL there would be,

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

Thus, there is $1.242 \text{ x } 10^{-3}$ mol of Na_2CO_3 in 25 mL of solution.

[3A] : *To determine the molarity of Na_2CO_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.

$$HCl : Na_2CO_3$$
$$2 : 1$$

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

From calculation **[3]**, it is known that in 25 mL of Na_2CO_3 solution there is 4.968×10^{-4} mol of Na_2CO_3.
So,

HCl	:	Na_2CO_3
2	:	1
x	:	1.242×10^{-3} mol

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

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

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

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

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

$= 0.1224$ mol

Thus the concentration of HCl is 0.1224 mol L^{-1} = 0.1224 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

$$\text{Average concentration values} = \frac{(0.1224\ \text{M} + 0.1218\ \text{M})}{2}$$

$$= 0.1221\ \text{M}$$

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^{-1}

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

Therefore, $x = \frac{0.1221\ \text{mol x}\ 25\ \text{mL}}{1000\ \text{mL}}$

$= 3.0525 \times 10^{-3}$ mol

This means that in 25 mL of 0.01221 M HCl solution there is 3.0525×10^{-3} mol of HCl

From table 3, the volume of NaOH used for 1st titre value = 31.90 mL (also applies for 2nd titre value)
Therefore, since reaction of NaOH to HCl is 1:1, then
there is 3.0525×10^{-3} mol of NaOH in 31.90 mL
then *x* mol of NaOH in 1000 mL

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

$$= 0.09569 \text{ mol}$$

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

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

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

Thus, $3.0525 \text{ x } 10^{-3}$ 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 = $3.0525 \text{ x } 10^{-3}$ mol

Thus, $3.0525 \text{ x } 10^{-3}$ mol of solid acid sample → 0.5002 g
1 mol of solid acid sample → *x* g

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

$$= 328.80 \text{ g}$$

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/objetives. In some cases you may just have to state you 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 2nd lab there would be questions that must be answered. You can put the answers in this section.