Beatty Secondary School
Science Department (Chemistry Unit)
Chemistry 6092

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Name: _____ ( ) Date: _____

Class: 4E___

Practical 1: VA1 – Acid-Base Titration (Beatty Prelim 2019)

1 Antacids contain calcium carbonate that can neutralise the acid in your stomach to relieve indigestion and heartburn.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

You are going to determine the mass of calcium carbonate in one antacid tablet. Excess acid is added to an antacid tablet. The volume of the unreacted acid is then determined by a titration with an alkali.

In this experiment, one antacid tablet is reacted with 250 cm^3 of 0.500 mol/dm^3 hydrochloric acid, to form solution **P**.

Solution **P** contains the excess hydrochloric acid that did not react with the antacid tablet.

Solution **Q** is 0.40 mol/dm^3 sodium hydroxide.

(a) (i) Put **P** into the burette.

Pipette 25.0 cm^3 of solution **Q** into a conical flask. Add solution **P** from the burette until the end point is reached. The end point is indicated by the colour change of the indicator.

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results.

Results

titration number	1	2	3
final burette reading / cm^3	23.40	23.10	23.10
initial burette reading / cm^3	0.00	0.00	0.00
volume of solution P added / cm^3	23.40	23.10	23.10
best titration results		✓	✓

[5]

(ii) From your titration results, obtain an average volume of **P** to be used in your calculations. Show clearly how you obtained this volume.

Average volume of P used = (23.10 + 23.10) ÷ 2
= 23.10 cm^3 (2 decimal places)

average volume of **P** **23.10 cm^3** [1]

(b) **Q** is 0.40 mol/dm^3 sodium hydroxide.
Calculate the number of moles of sodium hydroxide present in 25.0 cm^3 of solution **Q**.

No of mol of Q $= 0.40 \times \frac{25}{1000}$

= 0.0100 mol (3 sf)

number of moles of sodium hydroxide **0.0100 mol** [1]

(c) Using your answer from **(b)**, calculate the number of moles of hydrochloric acid that reacted with 25.0 cm^3 of **Q**.

Compare mole ratio:

NaOH	:	HCl
1	:	1
0.01	:	0.01

number of moles of acid that react with **Q** **0.0100 mol** [1]

(d) Using your answer from **(c)**, calculate the number of moles of hydrochloric acid in 250 cm^3 of **P**.

By proportion:

23.10 cm^3	----------	**0.0100 mol**
1 cm^3	----------	$\frac{0.01}{23.10}$
250 cm^3	----------	$\frac{0.01}{23.10} \times 250$
	=	**0.10822 mol**

number of moles of acid in 250 cm^3 of **P** **0.108 mol** [1]

(e) Calculate the number of moles of hydrochloric acid in 250 cm^3 of 0.500 mol/dm^3 hydrochloric acid.

No of mol of HCl $= 0.5 \times \frac{250}{1000}$

= 0.125 mol (3 sf)

number of moles in 250 cm^3 of hydrochloric acid **0.125 mol** [1]

(f) Using your answer from **(d)** and **(e)**, calculate the number of moles of hydrochloric acid that reacted with calcium carbonate in one antacid tablet.

(e) – (d) **No of mol of acid that reacted with $CaCO_3$**
= Initial mole of acid – No of mol of unreacted acid
= 0.125 – 0.10822
= 0.016775 mol

Number of moles of acid that reacted with calcium carbonate **0.0168 mol** [1]

(g) Using your answer to **(f)**, calculate the mass of calcium carbonate in one antacid tablet.

Compare mole ratio:

HCl	**:**	**$CaCO_3$**
2	**:**	**1**
0.016775	**:**	**0.0083874**

Mass **= 0.0083874 × 100**

= 0.839 g (3 sf)

mass of calcium carbonate in one antacid tablet **0.839 g** [2]

(h) Ethan repeated the experiment and he washed the burette with solution **Q**.

Describe and explain the effect it would have on the mass of calcium carbonate calculated.

The actual volume of hydrochloric acid required for titration would be larger than expected, resulting in a larger number of moles of 25 cm^3 of acid involved. However, this leads to a smaller number of moles in 250 cm^3 of acid. As such, the number of moles of hydrochloric acid (reacted with calcium carbonate) calculated would be larger than expected. Hence, the number of moles of calcium carbonate would be larger, leading to a larger calculated mass of calcium carbonate.

[Total: 15]

2 Some salts, when crystallised from aqueous solution, contain water molecules in the structure. These water molecules are known as 'water of crystallisation'.

Outline a method to determine the formula of hydrated sodium carbonate, $Na_2CO_3.nH_2O$. You can assume all the apparatus and reagents normally found in a school laboratory are available.

In your method you should state any assumption that you make. You should include the measurements you would take and explain how you would use your results to confirm the formula of hydrated sodium carbonate.

1. Measure 1.0 g of solid $Na_2CO_3.nH_2O$ using an electronic balance and place it into an evaporating dish.

2. Heat to remove the water of crystallisation. Measure the mass of the solid every 5 minutes from heating until a constant mass is obtained.

Assumption:
Sodium carbonate does not decompose on heating.

3. Measure the mass of the anhydrous sodium carbonate, *x* g, and calculate the mass of water of crystallisation.

$$\text{mass of water} = (1 - x)\ \text{g}$$

4. Calculate the number of moles of water using the formula

$$\text{No. of mol of water} = \frac{\text{mass of water } (1 - x)}{\text{molar mass } (18)}$$

5. Calculate the number of moles of anhydrous sodium carbonate using the formula

$$\text{No. of mol of } Na_2CO_3 = \frac{\text{mass of } Na_2CO_3\ (x)}{\text{molar mass } (106)}$$

6. Determine the value of *n* by comparing the mole ratio of water to anhydrous Na_2CO_3

$$n = \frac{\text{No. of mol of water}}{\text{No. of mol of } Na_2CO_3}$$

[Total: 6]