Year 12 Chemistry

Volumetric Analysis Validation Test 2019

Time allowed: 45 minutes

Name:_____

Marks: _____ / 46

Question 1 (14 marks)

In an investigation a group of students set out to analyse the percentage of Vitamin C (ascorbic acid) in Vitamin C tablets. Ascorbic acid ($C_6H_8O_6$) is a monoprotic acid.

A 14.14g tablet is crushed and dissolved in 4.88×10^{-1} molL^{-1} NaOH solution in a 500.0 mL volumetric flask. 20.00 mL aliquots of this solution with the excess NaOH are titrated with 0.122 molL^{-1} H_2SO_4. The results of the titrations are in the table below.

	Titration 1	Titration 2	Titration 3	Titration 4
Final volume	36.28	37.22	36.28	37.29
Initial volume	1.30	1.77	1.24	2.28
Titre				

(a) Calculate the % by mass of the ascorbic acid

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____
_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(10 marks)

(b)   One pair of students in the group decided to dissolve the crushed tablet in a small quantity of distilled water before they added it to the volumetric flask. They then added the NaOH up to the 500.0 mL mark.

Explain the effect would this have on:

(i)   The concentration of the NaOH after the reaction in the volumetric flask?

_____

_____

_____

(2 marks)

(ii)   The calculated % by mass of ascorbic acid?

_____

_____

_____

Question 2 **(18 marks)**

In a procedure to determine the exact acid concentration in a commercial brand of hydrochloric acid, the following steps were used.

Step 1: A primary standard was prepared

A sample of sodium carbonate is placed in an oven at 110.0 $^\circ$C and left for a day.

A 4.850 ($\pm$ 0.005) g sample of the sodium carbonate was dissolved and transferred quantitatively into a 500.0 ($\pm$ 0.25) mL volumetric flask and made up to the mark with distilled water, in order to prepare a **standard** solution.

(a)   Determine the concentration of the **standard** sodium carbonate.

_____

_____

_____

_____

(2 marks)

(b)   Give two reasons why sodium carbonate is a suitable compound to be used as a primary standard.

Reason 1_____

Reason 2_____

(2 marks)

(c)   Why did the sodium carbonate need to be heated?

_____

_____

(1 mark)

Step 2: The commercial brand of HCl was analysed to determine its exact concentration.

A 5.500 ($\pm$ 0.005) mL sample of the commercial strength acid was delivered into a 250.00 ($\pm$ 0.15) mL volumetric flask and made up to the mark.

25.00 ($\pm$ 0.03) mL aliquots of the previously prepared **standard** sodium carbonate solution were titrated against the HCl solution. After a series of titrations, 3 concordant results were obtained. The average titre was 19.85 mL.

(d)   Find the concentration of HCl in the commercial acid.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6 marks)

(e)   What effect would it have on the concentration of the sodium carbonate if it was not heated initially? Explain why.

_____

_____

(2 marks)

(f)   What effect would it have on the calculated concentration of the hydrochloric acid if the sodium carbonate was not heated initially? Explain why.

_____

_____

(2 marks)

(g)   Using the measurement uncertainties in the equipment, calculate the error in the concentration of the commercial hydrochloric acid. Express your answer to the correct number of significant figures.

_____

_____

_____

_____

(3 marks)

Question 3 (14 marks)

Malic acid is a naturally occurring compound found in many fruits and vegetables, and is largely responsible for the sour taste found in apples and pears. Malic acid is an organic compound with the molecular formula $C_4H_6O_5$. It is a **diprotic acid**.

The **acidity of apple juice** is largely due to **malic acid**. Citric acid is a minor organic acid also found in apple juice.

The mean value for the malic acid content of apple juice is normally in the range 45.0 - 60.0 gL^{-1}.

The malic acid content of apple juice was determined by titration of 20.00mL aliquots of apple juice (dilution to be determined) against 0.1070 $molL^{-1}$ NaOH in a burette.

(a) Using a calculation, determine whether the apple juice needs to be diluted to achieve approximately the same titre volume as the aliquot of apple juice. If so, by what factor does it need to be diluted?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(b)   Comment on any assumptions made in this investigation and their effect on the validity of the procedure.

_____

_____

_____
(2 marks)

The titration curve below is for the titration of 25.00 mL of 0.1 molL $^{-1}$ malic acid (H_2M) with 0.1 molL $^{-1}$ NaOH. There are two equivalence points because malic acid is a diprotic weak acid.
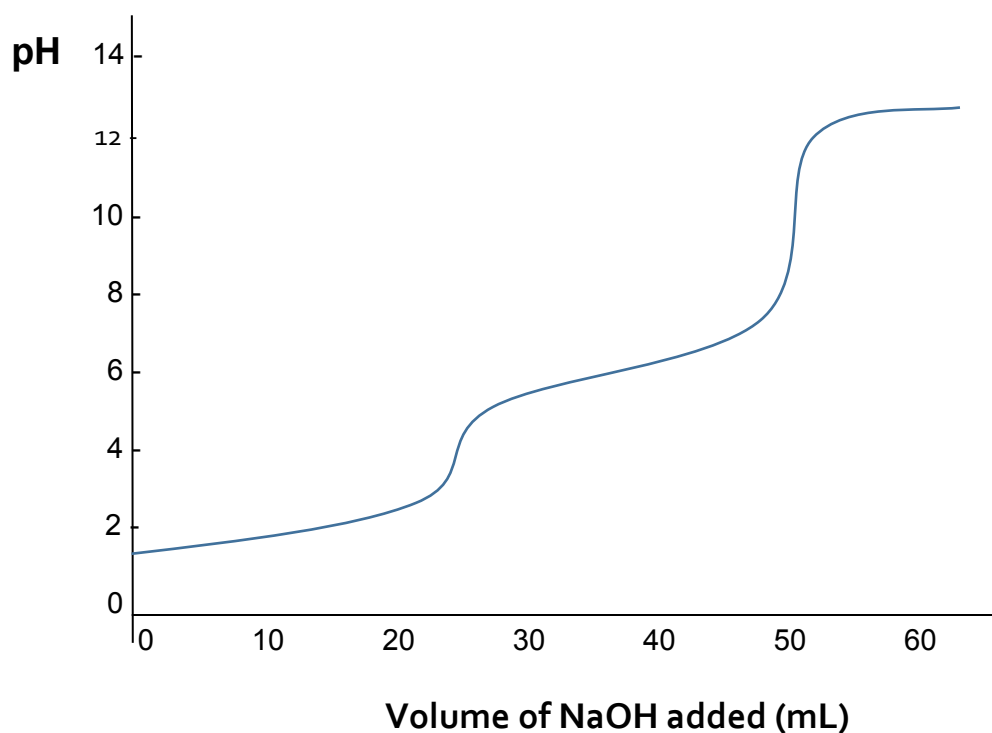
(c)   The equation for the neutralisation at the second end point is:

   $HM^- + OH^- \rightarrow H_2O + M^{2-}$
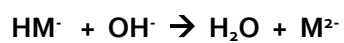
   Write the equation for the neutralisation at the first equivalence point

_____
(2 marks)

You have 3 indicators to choose from in your titration.

Indicator	pH range	Colour (lower pH – higher pH)
Methyl orange	3.1– 4.4	red –yellow
Methyl red	4.4–6.2	pink – yellow
Phenolphthalein	8.3–10.0	colourless – pink

(d)

    (i)   Which indicator would you choose to identify each equivalence point

        Equivalence point 1 _____

        Equivalence point 2 _____

                         (2 marks)

    (ii) Would it matter which equivalence point was identified to calculate the moles of malic acid in the aliquot. Explain your answer.

_____

_____

_____

                         (2 marks)

END OF TEST

11