



# Volumetric Analysis/Titration Validation Test 2020

**Time allowed:** 45  
minutes

## Instructions

Please ensure you enter your name  
and circle your teacher's initials below.  
*Scientific calculators only. Chemistry*

**Name**

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**Teacher: (circle)**

CEM

NM

KL

MX

### Question 1

17 marks

A bottle of store bought cloudy ammonia was analysed to determine the concentration of ammonia present.

25.00 ( $\pm 0.03$ ) mL of cloudy ammonia was pipetted into a 250 ( $\pm 0.15$ ) mL volumetric flask and made up to the mark with distilled water.

A standard solution of hydrochloric acid was used, with a concentration of 0.103 ( $\pm 0.002$ ) mol L<sup>-1</sup>.

The standardised HCl was titrated against 20.00 ( $\pm 0.03$ ) mL aliquots of diluted cloudy ammonia, each with 3-5 drops of bromophenol blue added.

The average titre volume obtained was 16.23 ( $\pm 0.10$ ) mL.

- a) Write an ionic equation for the reaction between the household ammonia and the hydrochloric acid. (1 mark)

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- b) The cloudy ammonia advertises its ammonia concentration as 15-20 g/L. Calculate the concentration of ammonia in the cloudy ammonia solution and determine whether it fits within this range. Note: Error analysis not required here. (6 marks)

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c) Complete the table below, calculating the % error in each measurement.

Measurement	Value	% error
25mL pipette	25.00 ( $\pm 0.03$ )	0.12
20 mL pipette	20.00 ( $\pm 0.03$ )	0.15
burette	16.23 ( $\pm 0.10$ )	
Volumetric flask	250 ( $\pm 0.15$ )	
[HCl]	0.103 ( $\pm 0.002$ )	

(1 mark)

d) Hence or otherwise, express your answer calculated in part b) to the correct number of significant figures in the box provided below.

(3 marks)

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Concentration of  $\text{NH}_3$  in cloudy ammonia:

$\pm$	g/L
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e) If you had rinsed the burette with distilled water only, what effect would it have on the calculated concentration of ammonia? Fully explain your answer. (3 marks)

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- f) Bromophenol blue is an indicator that changes colour in the range of pH 3-4.6. With the use of an appropriate equation, explain why this indicator was used.

(3 marks)

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## Question 2

**14 marks**

Acid 'X' is a weak, diprotic, organic acid found naturally in many fruits. It is often used in a concentrated form as a flavouring to give food a sour taste.

A student wanted to set up a titration to determine the concentration of 'Acid X' present in various samples of grapefruit juice to compare their quality and flavour.

The student researched that grapefruit juice can have a percentage by mass of 'Acid X' in the range of 2.5 – 5.0 %. The molar mass for Acid 'X' is  $134 \text{ g mol}^{-1}$ .

The average mass of 20.00 mL samples of grapefruit juice was found to be 20.80 g.

The student had standardised a solution of sodium hydroxide and determined its concentration to be  $0.105 \text{ mol L}^{-1}$ .

- a) Using the information above, perform appropriate calculations to determine if the grapefruit juice needs to be diluted prior to the titration. Explain your decision.

(6 marks)

[illegible]

- b) In the laboratory, the student had access to a 20 mL and 25 mL pipette, as well as volumetric flasks of 125 mL, 250 mL and 500 mL. Using this equipment, give the

procedure you would follow to perform the dilution.

(2 marks)

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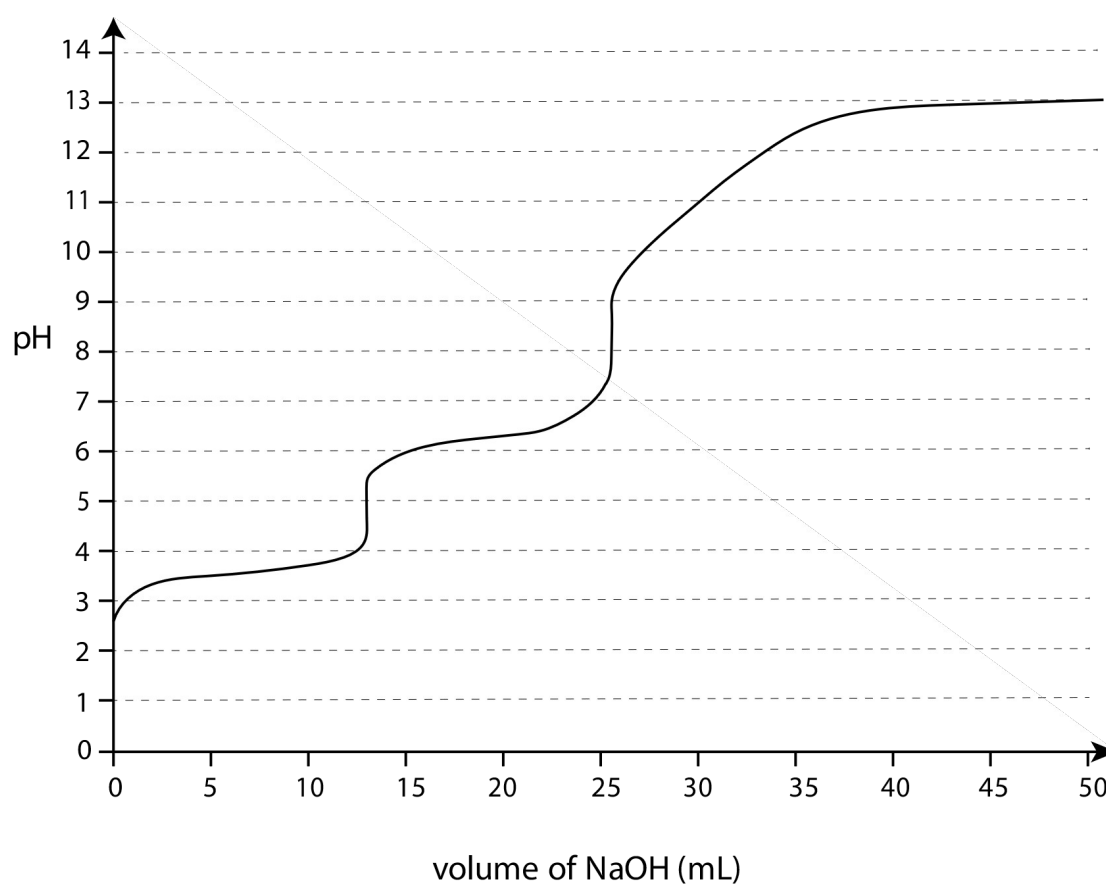
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- c) Describe an assumption the student needed to make when planning their analysis of the grapefruit juice. (1 mark)

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- d) The pH was monitored throughout the titration and the following curve was obtained.



- i) Explain why there are two equivalence points. (1 mark)

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- ii) Using the formula  $\text{H}_2\text{X}$  to denote Acid 'X', write an ionic equation to describe the reaction that has gone to completion at the first equivalence point (12.5 mL of NaOH added).

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(1 mark)

- iii) On the titration curve, draw the curve you would expect to obtain if the concentration of the standard NaOH solution was doubled and a total of 50 mL of was added.

(3 marks)

**Question 3****13 marks**

Antacids are medications that treat heartburn, indigestion and acid reflux. The active ingredients are carbonate containing compounds. A standardised solution of hydrochloric acid ( $1.13 \text{ mol L}^{-1}$ ) was used to determine the percentage by mass of magnesium carbonate in a common antacid tablet using a back titration procedure. The assumption was made that all the carbonate present was in the form of magnesium carbonate.

- Step 1: A 1.67 g sample of the antacid tablet was placed in a conical flask;
- Step 2: 50.0 mL of the standardized hydrochloric acid was added to the conical flask;
- Step 3: At the completion of the reaction, the mixture in the conical flask was added to a 500 mL volumetric flask and made up to the mark with distilled water;
- Step 4: A 25.00 mL aliquot of the diluted mixture was titrated with  $0.0530 \text{ mol L}^{-1}$  sodium hydroxide, using phenolphthalein as the indicator.

The scientists performed a rough titration and then recorded the results of a further 4 titrations in the table below:

	<b>Titration 1</b>	<b>Titration 2</b>	<b>Titration 3</b>	<b>Titration 4</b>
<b>Final volume (mL)</b>	33.80	37.90	31.70	28.80
<b>Initial volume (mL)</b>	5.25	9.50	3.20	0.30
<b>Volume titrated (mL)</b>	28.55	28.40	28.50	28.50

- a) Calculate the average volume of sodium hydroxide used in the titration sequence.

$V_{av} =$  \_\_\_\_\_ (1 mark)

- b) Write an equation for the reaction of magnesium carbonate with hydrochloric acid in Step 2.

\_\_\_\_\_  
(1 mark)

- c) Write an ionic equation for the reaction taking place in Step 4.

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(1 mark)



- [illegible]

- | Equipment               | Solution to be rinsed with |
|-------------------------|----------------------------|
| burette                 |                            |
| 500 mL volumetric flask |                            |