Christ Church Grammar School

Year 12 Chemistry

Volumetric Analysis Validation Test 2018

Time allowed: 45 minutes

Name:_____

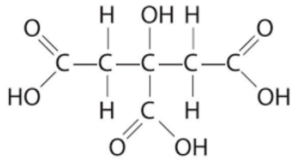
Marks: _____ / 46

Question 1 **(20 marks)**

Citric acid is a weak organic acid occuring naturally in many fruits, especially citrus fruits. It is very soluble and is often used as an additive to improve flavour and as a preservative. To determine the exact citric acid content in a popular energy drink, a titration with sodium hydroxide solution was used. The average citric acid content in energy drinks is 11.7 gL^{-1}.

The standardised sodium hydroxide had a concentration of 0.0204 $molL^{-1}$.

The formula for citric acid is $C_6H_8O_7$ and the structure of citric acid is shown below. It is triprotic and contains three carboxylic acid groups;



a) Using a calculation, determine if the energy drink requires dilution before titration. If dilution is required, provide a brief procedure outlining how you would perform this dilution using standard laboratory equipment.

_____

(6 marks)

b) In a separate experiment, a student carried out a titration on some lemonade using standardised sodium hydroxide (concentration 0.097 $molL^{-1}$). He found that 25.00 mL of lemonade had a mass of 27.90 g. He carried out the analysis on 25.00 mL aliquots of undiluted lemonade and obtained the following results using phenolphthalein as the indicator:

	Volume of sodium hydroxide (mL)				
	Rough	1	2	3	4
Initial volume (mL)	0.90	1.55	0.70	0.20	1.45
Final volume (mL)	19.35	19.75	19.00	18.80	19.70
Titre volume (mL)					

c) Using the results above, calculate the average titre volume: _____

(1 mark)

d) Assuming all the acid present is citric acid and using your average titre volume, calculate the acid content of the lemonade in gL^{-1} and as a percentage by mass. Use the appropriate number of significant figures to express your final answer.

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(6 marks)

e) Given that the lemonade is carbonated with CO_2, is this a valid experiment? Use equations to justify your answer.

_____

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(2 mark)

f) State the effect of rinsing the following equipment with the solution given on the apparent % acid in the lemonade.

	Equipment	Rinsed with	Effect on apparent acid content
(i)	Burette	distilled water	
(ii)	Pipette	distilled water	
(iii)	Conical flask	lemonade	

(3 marks)

g) Explain your response to part f) (iii)

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(2 marks)

Question 2 **(10 marks)**

An average titre volume of 14.85 mL was obtained when 0.204 (± 0.001) $molL^{-1}$ of NaOH was used to standardise a 20.00 (± 0.03) mL hydrochloric acid solution.

a) Calculate the percentage uncertainty associated with the average titre volume.

_____

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(1 mark)

b) Calculate the percentage uncertainty of the pipette used.

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(1 mark)

c) Calculate the concentration of HCl and the actual error uncertainty associated with the determined concentration.

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(6 marks)

d) The sodium hydroxide in the above experiment was not a primary standard. It had to be prepared and then standardised. Give 2 reasons why NaOH is a poor primary standard.

1. _____
2. _____

(2 marks)

Question 3 **7 marks**

Marble is composed mainly of calcium carbonate, $CaCO_3$, with some impurities.

A 1.20 g sample of marble was dissolved in 500.0 mL of the standardised hydrochloric acid determined above. The mixture fizzed as carbon dioxide was produced. After the mixture finished reacting, the solution was then titrated with 20.00 mL of 0.100 $molL^{-1}$ NaOH solution. The average titre volume required was determined as 18.6 mL.

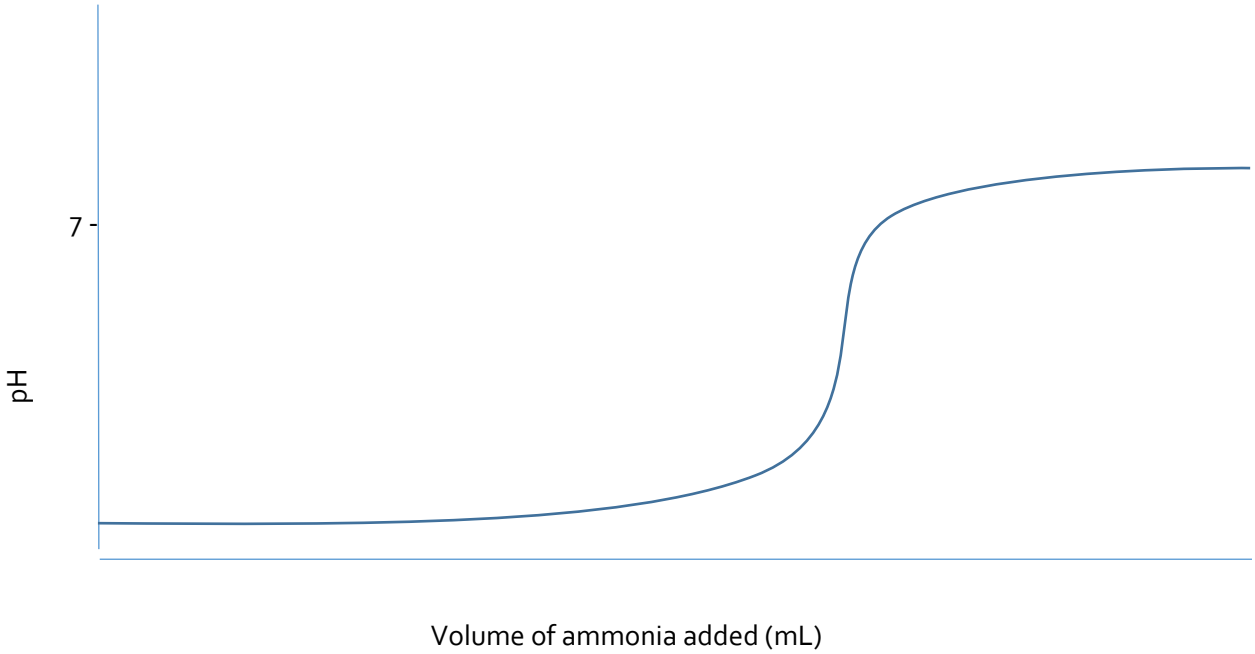
Calculate the percentage by mass of calcium carbonate in the sample of marble.

Question 4 **4 marks**

A sample of river water has a density of 1.01 gmL^{-1} and contains 3.50% by mass of ethanoic acid. What volume of 0.600 $molL^{-1}$ sodium hydroxide is required to neutralise 20.00 mL of the river water?

Question 5 **5 marks**

A known concentration of ammonia solution is added to a nitric acid solution to determine the concentration of acid present.
The titration curve of the reaction is shown below.



a) Methyl orange was correctly chosen as an appropriate indicator for the titration. Mark an approximate range for its colour change on the graph above. (1 mark)

b) Using chemical equations to support your answer, explain why methyl orange is an appropriate choice for this reaction. Include the term 'equivalence point' and 'end point' in your response.

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(4 marks)

END OF TEST