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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Scholarship 2016 Chemistry

2.00 p.m. Monday 14 November 2016
Time allowed: Three hours
Total marks: 32

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

Pull out Resource Sheet S-CHEMR from the centre of this booklet.

You should answer ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–20 in the correct order and that none of these pages is blank.

You are advised to spend approximately 45 minutes on each question.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Question	Mark
ONE	
TWO	
THREE	
FOUR	
TOTAL	/32

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- (ii) The stability of the complex ions $[\text{Au}(\text{CN})_2]^-$ is reflected in the size of the formation constant K_f , the equilibrium constant for the following equation:



Determine the concentration of sodium cyanide, NaCN (in mol L⁻¹) that is required to keep 99% of the soluble gold in solution as the complex ion (assume that all the soluble gold is Au(I)).

Comment on the pH dependence of the composition of the equilibrium mixture.

$$\text{p}K_a(\text{HCN}) = 9.5$$

QUESTION TWO

- (a) Compound **A**, has the molecular formula $C_{10}H_{17}O_2Cl$ and has one chiral centre. Compound **A** does not decolourise bromine water. When Compound **A** is reacted with dilute acid solution, two products, Compound **B** and Compound **C**, are formed.

Compound **B** does not have a chiral centre. When subjected to mass spectrometry, it is found to have a molecular ion peak at $m/z = 114$.

Compound **C**, when subjected to mass spectrometry, is found to have a molecular ion peak at $m/z = 108$. There is also a $M+2$ peak present, and the ratio of the heights of the M and $M+2$ peaks is 3:1.

When Compound **C** is treated with thionyl chloride, $SOCl_2$, Compound **D** is produced.

*The ^{13}C NMR spectrum of all Compounds **A** to **D** are available in the Resource Booklet.*

*The IR spectrum of Compound **B** is also available.*

Determine the identity of Compounds **A** to **D**.

Justify your answers by linking your choices to the spectra provided and the information given above.

Compounds **A** to **D**:

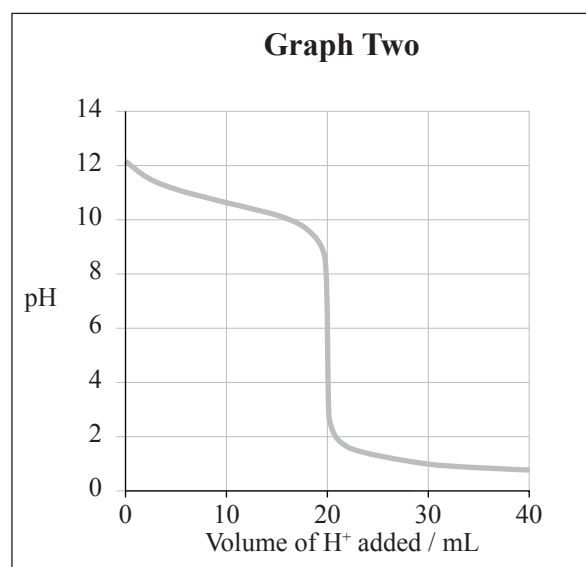
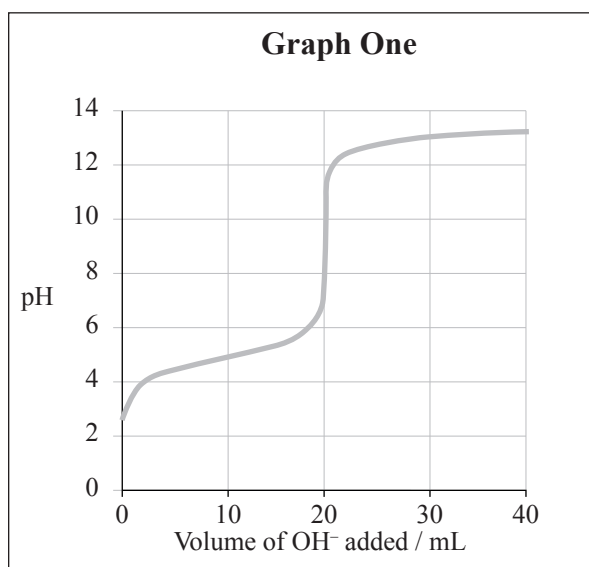
QUESTION THREE

- (a) The pH titration curves for the following reactions are shown below.

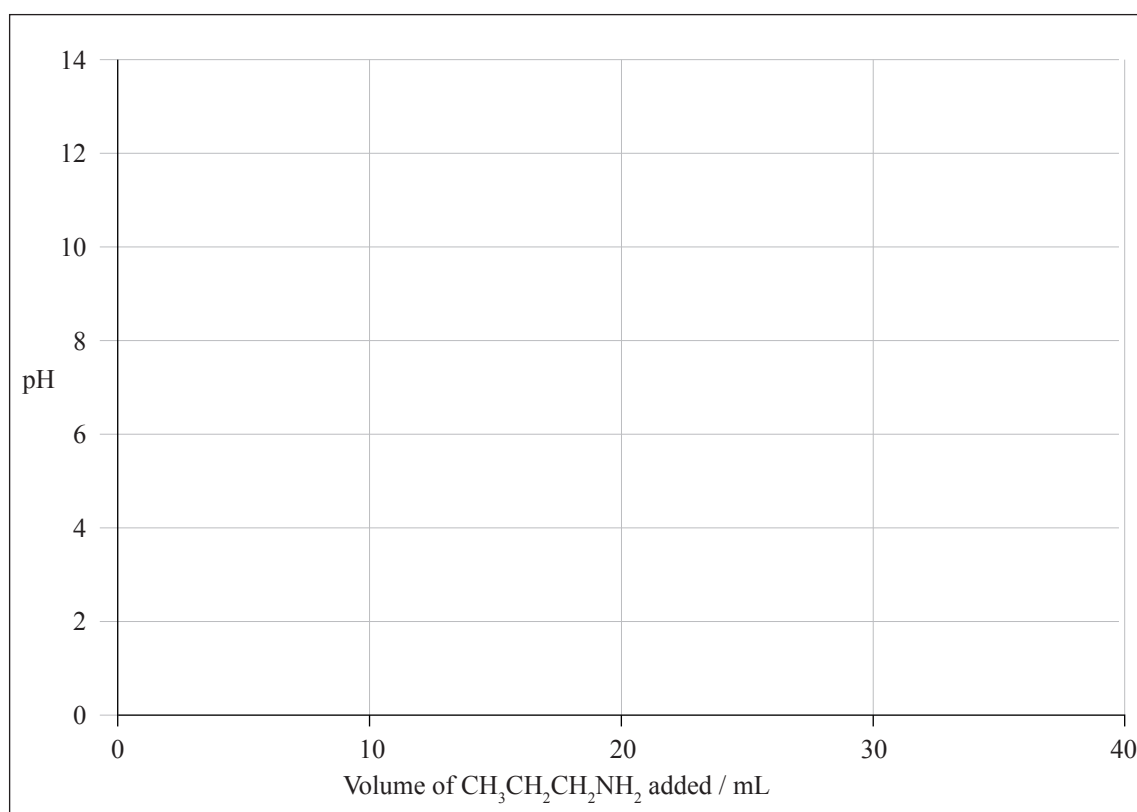
20 mL of 0.5 mol L⁻¹ propanoic acid, CH₃CH₂COOH, titrated with 0.5 mol L⁻¹ sodium hydroxide (Graph One)

20 mL of 0.5 mol L⁻¹ propan-1-amine, CH₃CH₂CH₂NH₂, titrated with 0.5 mol L⁻¹ hydrochloric acid (Graph Two)

$$pK_a(\text{CH}_3\text{CH}_2\text{COOH}) = 4.88 \quad pK_a(\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_3^+) = 10.71$$



- (i) Sketch the titration curve for the reaction of 20 mL of 0.5 mol L
- ⁻¹
- propanoic acid, CH
- ₃
- CH
- ₂
- COOH, titrated with 0.5 mol L
- ⁻¹
- propan-1-amine, CH
- ₃
- CH
- ₂
- CH
- ₂
- NH
- ₂
- .



- (ii) Discuss the **trend** in the melting points of the hydrides of the elements of Group 15 (NH_3 to SbH_3).

**Question Four continues
on the following page.**

Extra paper if required.
Write the question number(s) if applicable.

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QUESTION
NUMBER

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