
Student Number

Gosford High School

2021

Trial HSC Examination

Chemistry

General Instructions	• Reading time – 5 minutes • Working time – 3 hours • Write using black pen • Draw diagrams using pencil • Calculators approved by NESA may be used
Total marks: 100	Section I – 20 marks (pages 3 - 9) • Attempt Questions 1–20 • Allow about 35 minutes for this section
	Section II – 80 marks (pages 11–24) • Attempt Questions 21–32 • Allow about 2 hours and 25 minutes for this section

Section I

20 marks

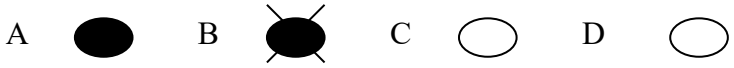
Attempt Questions 1-20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet provided.

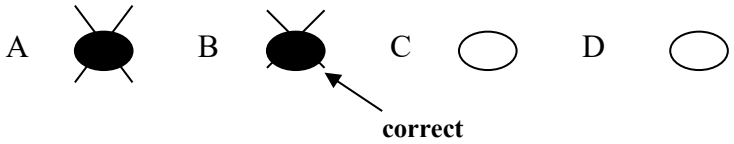
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.



If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

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1. Consider the equilibrium process

$$CH_2CH_{2(g)} + H_{2(g)} \rightleftharpoons CH_3CH_{3(g)} \qquad \Delta H = -136 \text{ mol}^{-1}.$$

Which of the following changes would cause the magnitude of the equilibrium constant for this reaction to increase?

(A) The temperature is decreased.
(B) The pressure is decreased.
(C) The concentration of H_2 in the equilibrium mixture is increased.
(D) The concentration of CH_3CH_3 in the equilibrium mixture is increased.

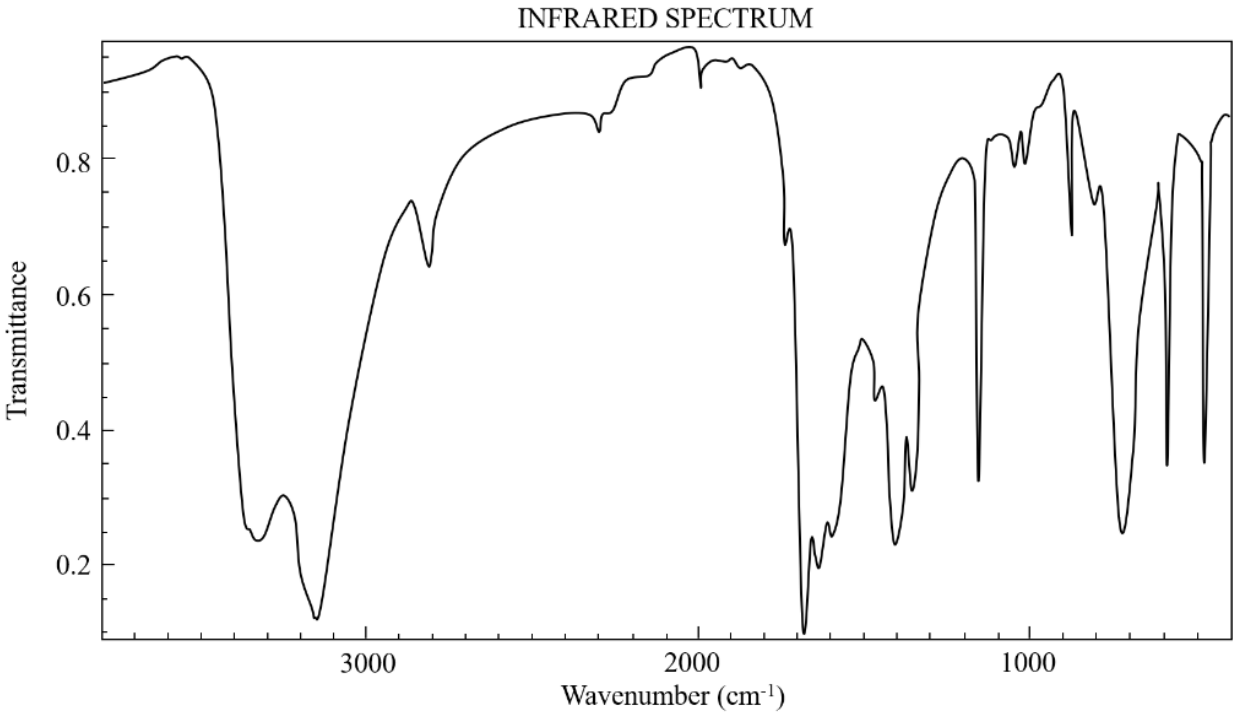
2. Which pair of compounds represents an acid and its conjugate base?

	Acid	Conjugate base
(A)	HSO_4^-	H_2SO_4
(B)	CH_3COO^-	CH_3COOH
(C)	CH_3NH_2	$CH_3NH_3^+$
(D)	$HCrO_4^-$	CrO_4^{2-}

3. Which compound below is NOT an isomer of the others?

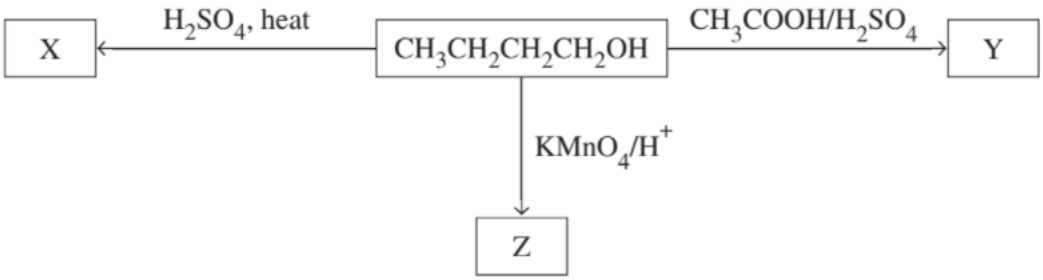
(A) but-1-ene
(B) pent-1-ene
(C) Cyclopentane
(D) 2-methyl-but-2-ene

4. The diagram below shows the infrared spectrum of a compound. What is the compound most likely to be?



(A) Ethene
(B) Ethanol
(C) Ethanamide
(D) Ethanoic Acid

5. Consider the reaction sequence below.



Which row of the table correctly identifies X, Y and Z?

	X	Y	Z
(A)	but-1-ene	(1-butyl) ethanoate	butanoic acid
(B)	butane	hexanoic acid	butan-1-ol
(C)	but-2-ene	ethyl butanoate	butanoate
(D)	cyclobutane	butyl acetate	butanal

6. A solution containing $Co(H_2O)_6^{2+}$ (aq), $CoCl_4^{2-}$ (aq) and Cl^- (aq) at equilibrium at room temperature is initially pink. When heated, the solution turns blue. Then, when Ag+(aq) is added, the solution turns back to pink.

Which statements are correct?

I. $Co(H_2O)_6^{2+}$ (aq) is pink.
II. Formation of $CoCl_4^{2-}$ (aq) from $Co(H_2O)_6^{2+}$ (aq) and Cl^-(aq) is exothermic.

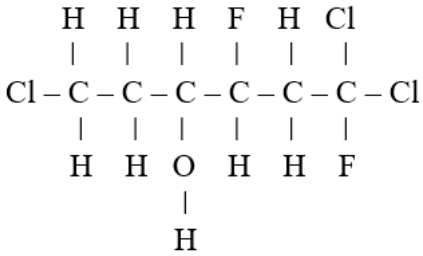
(A) I only
(B) II only
(C) Both I and II
(D) Neither I nor II

7. A student mixed 10.0 mL of 0.0400 mol L^{-1} H_2SO_4 with 40.0 mL of 0.35 mol L^{-1} KOH.

What is the pH of the resulting solution?

(A) 0.26
(B) 0.59
(C) 13.42
(D) 13.45

8. What is the correct I.U.P.A.C. name for the compound with formula shown below?



(A) 1,1,6-trichloro-1,3-difluorohexan-4-ol
(B) 1,3-difluoro-1,1,6-trichlorohexan-4-ol
(C) 1,6,6-trichloro-4,6-difluorohexan-3-ol
(D) 4,6-difluoro-1,6,6-trichlorohexan-3-ol

9. What is the pH of a 0.008 mol L^{-1} solution of barium hydroxide?

(A) 2.10
(B) 8.00
(C) 11.90
(D) 12.20

10. Which of the following organic compounds will produce the aqueous solution which has the highest pH?

(A) Propanoic acid
(B) Propanol
(C) Propanamide
(D) Propanamine

11. The tetrachlorocopper(II) anion forms a green solution and reacts with water to form the blue hexaaquacopper(II) cation according to the following equation:

$$CuCl_4^{2-}(aq) + 6H_2O(l) \rightleftharpoons Cu(H_2O)_6^{2+}(aq) + 4Cl^-(aq) \qquad \Delta H = \text{negative}$$

At a constant pressure and temperature, the appearance of a solution containing these ions remains pale blue.

Which alternative correctly predicts an identified change and its effect on the system?

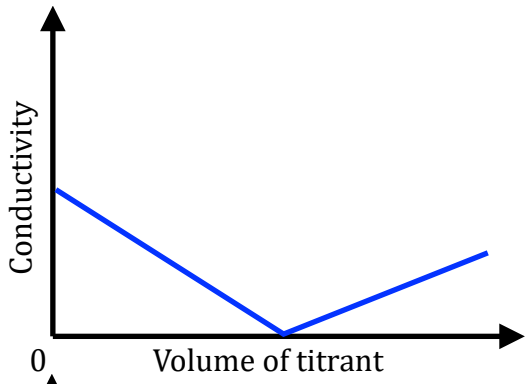
(A) Adding water causes the solution to turn green.
(B) Increasing the temperature causes the solution to turn blue.
(C) Cooling the reaction vessel increases the rate of the reverse reaction.
(D) Adding concentrated hydrochloric acid causes the solution to turn green.

12. A 0.1 mol L^{-1} solution of a weak acid HA is 5% dissociated at 25°C. Calculate the concentration of hydronium ions in the acid solution.

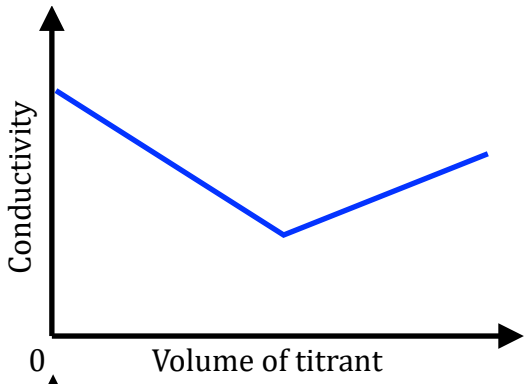
(A) 0.50 mol L^{-1}.
(B) 0.050 mol L^{-1}.
(C) 0.0050 mol L^{-1}.
(D) 0.01 mol L^{-1}.

13. Which of the following conductivity curves correctly depicts the titration of hydrochloric acid against potassium hydroxide?

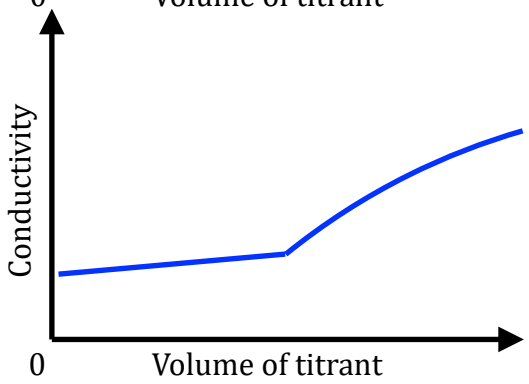
(A)



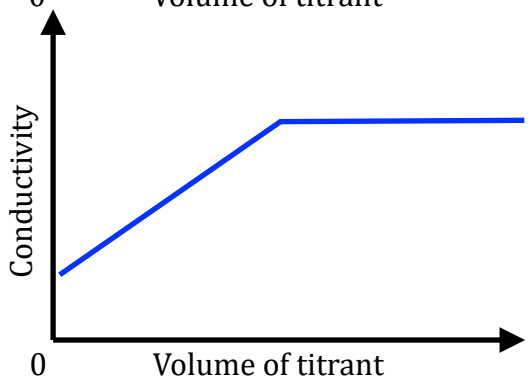
(B)



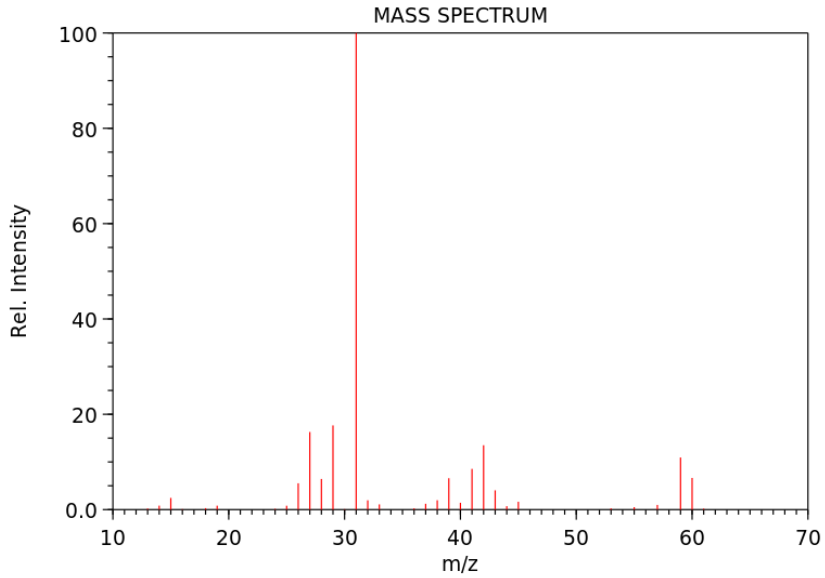
(C)



(D)



14. The mass spectrum for an alkanol is shown below.



Which one of the following alkanols could have the spectrum shown above?

(A) methylpropane-2-ol
(B) propan-1-ol
(C) butan-2-ol
(D) butan-1-ol

15. What will happen to the pH of a buffer solution when a small amount of a strong base is added?

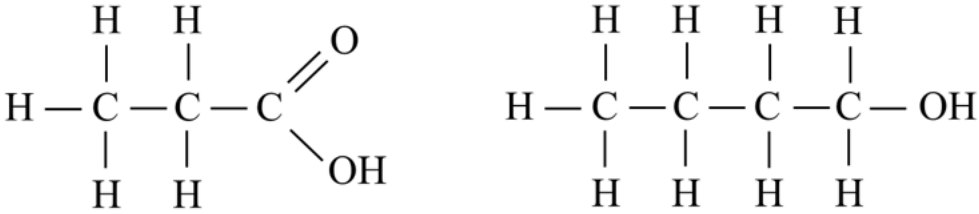
(A) it will increase slightly
(B) it will decrease slightly
(C) it will remain exactly the same
(D) it will become 7.0

16. Nitrous acid, HNO_2, has a K_a of 7.2×10^{-4}.

What is the pH of a 0.40 M solution of the acid?

(A) 1.02
(B) 1.77
(C) 2.14
(D) 3.52

17. What product would be formed through the reaction of the two reactants shown?



(A) Propyl butanoate
(B) Butyl butanoate
(C) Propyl propanoate
(D) Butyl propanoate

18. Which row of the table below correctly matches the reaction type with its correct reactants, catalyst and products??

	Reaction Type	Reactants	Catalyst	Products
(A)	Hydration	$H_2C = CH_2 + H_2O$	H_2SO_4	$HOCH_2CH_2OSO_3H$
(B)	Hydration	$H_2C = CH_2$	concentrated H_2SO_4	CH_3CH_2OH
(C)	Addition	$H_2C = CH_2 + H_2O + Br_2$	nil	$BrCH_2CH_2Br$
(D)	Addition	$H_2C = CH_2 + H_2$	Nickel	CH_3CH_3

19. A student is asked to identify a sample of a straight chain alcohol containing four carbon atoms. They add acidified potassium permanganate to the sample, which **does not** decolourise.

The location of the hydroxyl group

(A) is the first carbon atom.
(B) is the second carbon atom.
(C) is the third carbon atom.
(D) cannot be determined.

20. What is the function of the beam of electrons in a mass spectrometer?

(A) It detects the mass of the particles.
(B) It deflects the stream of positively charged particles.
(C) It bombards the sample causing ionisation to form positive particles.
(D) It removes positive particles from within the spectrometer.

END OF SECTION I

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2021 GOSFORD HIGH SCHOOL HSC
TRIAL EXAMINATION

Student Number

Chemistry

Section II Answer Booklet

80 marks
Attempt Questions 21 - 32
Allow about 2 hours and 25 minutes for this section

Instructions

- Write your Student Number at the top of this page
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the end of this booklet. Clearly indicate which questions are being answered in this space

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Please turn over

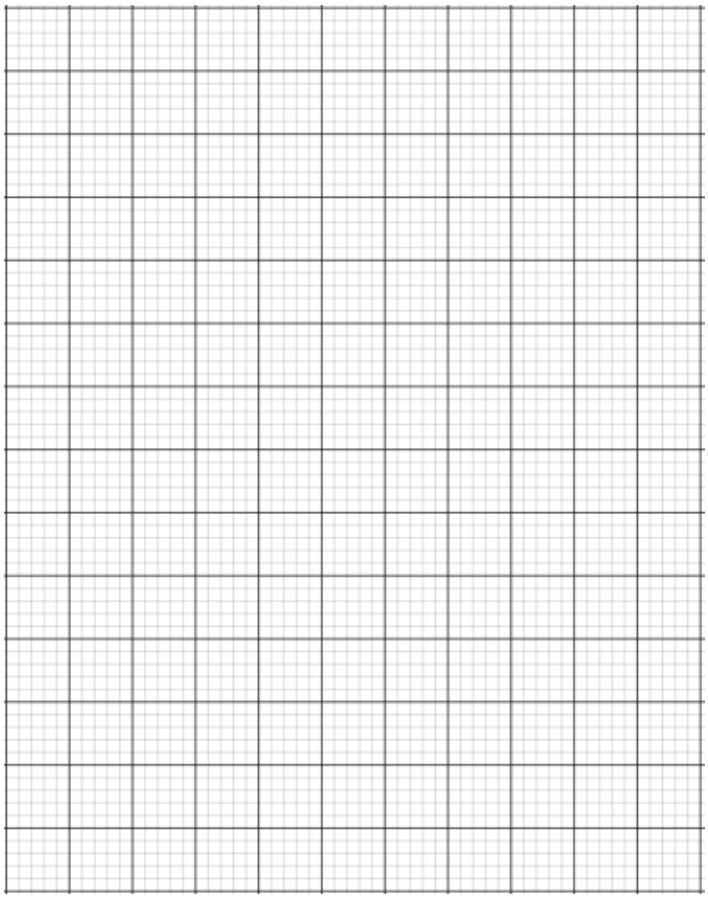
Question 21 (8 marks)

A student wanted to determine the exact concentration of propanoic acid. She decided to use a secondary standard of 0.1186 mol L^{-1} sodium hydroxide solution for the titration. 25.0 mL of propanoic acid was placed into a clean conical flask and the sodium hydroxide was added slowly to the propanoic acid using a graduated burette. A digital pH meter was used to record the pH values as the sodium hydroxide was added to the solution. The results of the titration are shown below.

By graphing the data in the grid provided and performing relevant calculations, determine the concentration of the propanoic acid solution. An equation should be included in your answer.

8 marks

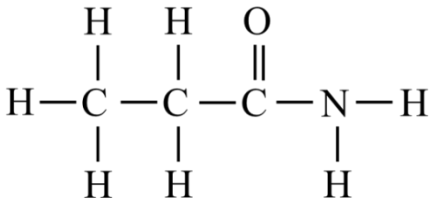
Volume of sodium hydroxide added (mL)	pH of solution
0	3.96
7	4.92
12	5.35
19	6.13
21	6.44
21.5	7.14
21.9	8.72
22	10.3
23	11.29
25	11.75
27	11.96
37	12.36
47	12.52



Question 22 (5 marks)

Amides are organic molecules that are used in the manufacture of many polymers, solvents and pharmaceutical drugs.

(a) Identify the amide shown in the diagram and circle the functional group that allows it to be placed in this category of molecule. *2 marks*



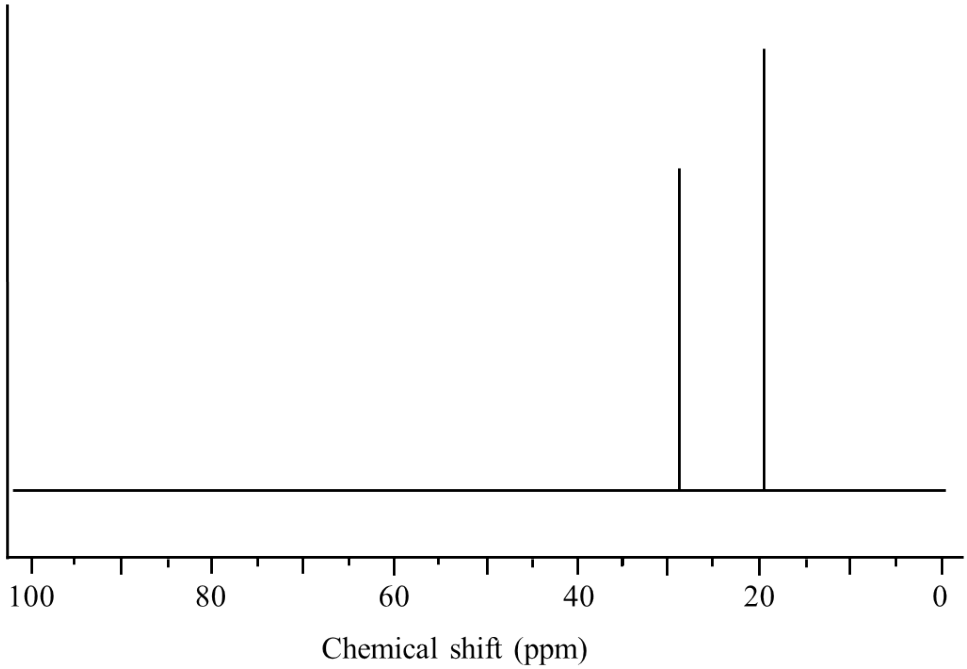
(b) This table shows the boiling points of a variety of organic substances.

Compound	*Type*	*Molar mass* ($g\ mol^{-1}$)	*Boiling point* (°C)
propan-1-amine	amine	59	49
ethanamide	amide	59	210
ethanoic acid	carboxylic acid	60	118

Explain the differences in the boiling points. *3 marks*

Question 23 (6 marks)

Lily carries out carbon-13 NMR testing on an unknown sample that was collected at an industrial work site. She uses the chemical shift information below to determine that the sample is a haloalkane.

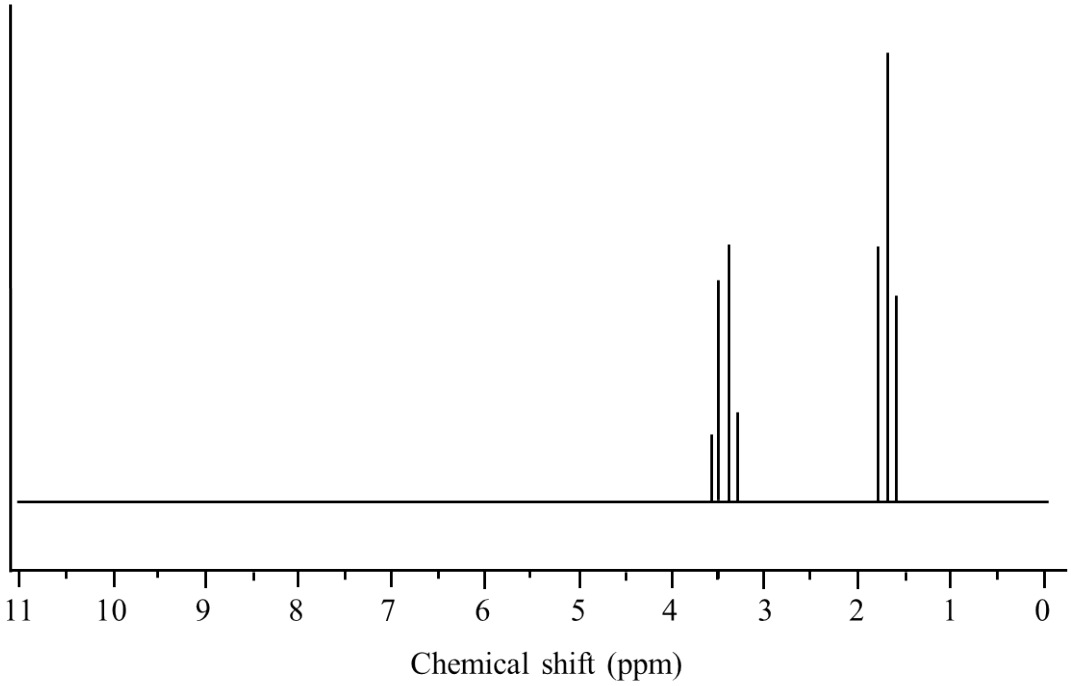


(a) Justify her decision in determining that the sample was a haloalkane and suggest a name for the substance. *3 marks*

Question 23 continues on page 15

Question 23 continued…

(b) Lily also carries out proton NMR testing and generates the spectrum below. She notices that there are multiple peaks where she expected to see single ones.



Explain why the splitting that can be seen in the spectrum has occurred. *3 marks*

Question 24 (8 marks)

(a) Complete the table below comparing an addition polymer to a condensation polymer *6 marks*

	Polymer name	*Monomer name and structural formula*	*Properties*	*Uses*
Addition Polymer				
Condensation Polymer				

(b) Outline the process involved to create ***one*** of the above polymers *2 marks*

Question 25 (13 marks)

(a) Explain why sodium hydroxide should not be used as a primary standard for titrations *2 marks*

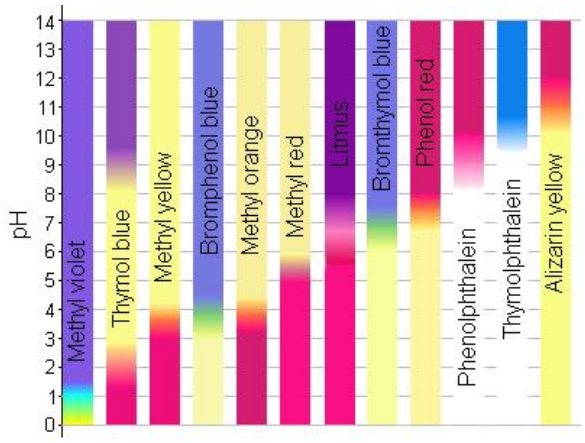
(b) Sodium carbonate (anhydrous) is used as a primary standard for a titration to determine the concentration of a solution of sulfuric acid. Describe the procedure used to prepare the solutions, including a 250mL 0.150M primary standard as well as any glassware needed for an accurate titration. *4 marks*

Question 25 continues on page 18

Question 25 cont…

(c) Determine the concentration of a sulfuric acid solution if 34.50 mL of the acid is required to neutralise 25.0 mL of a solution of 0.150 M sodium carbonate solution *2 marks*

(d) Identify a suitable indicator for use with this titration and explain your response. *2 marks*



(e) Calculate the pH at 25°C after 240 mL of 0.50 mol L^{-1} sodium hydroxide is added to 60 mL of 0.20 mol L^{-1} sulfuric acid solution. *3 marks*

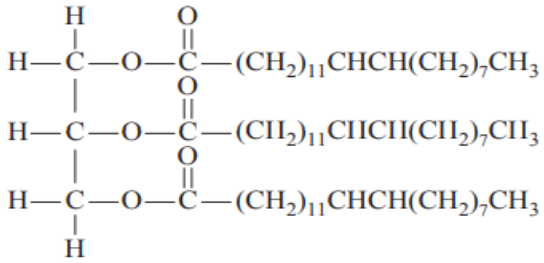
Question 26 (9 marks)

In organic chemistry it is desired to create molecular structures that have exactly the right properties for a particular purpose. This is achieved through converting a readily available starting material (an alkane or alkene) into the desired product.

How would you form butyl ethanoate from an alkane? Draw a flow chart to represent the reaction pathway. Write all chemical equations using structural formulae and include any necessary reagents and conditions. Identify the types of reactions involved in each step and name any reactants and products using IUPAC conventions. *9 marks*

Question 27 (3 marks)

The molecule below can be used as a source of fuel. It is classified as an oil and is found in some plants.



(a) This molecule can be hydrolysed to form glycerol and three long chain carboxylic acids, called erucic acid. Erucic acid will combine with methanol to form an ester, methyl erucate, which can be used as the biofuel known as biodiesel.

Draw a structural formula for methyl erucate in the space below. *1 mark*

(b) Describe TWO advantages of using biodiesel as a fuel rather than petrodiesel, which is produced from crude oil. *2 marks*

Question 28 (10 marks)

The Contact process in the industrial production of sulfuric acid involves the conversion of SO_2 *(g)* into SO_3 *(g)*. This process is exothermic.

0.360 moles of sulfur dioxide and 0.300 moles of oxygen were injected into a 1.00 L vessel and allowed to reach equilibrium at 500°C. At equilibrium, the concentration of sulfur trioxide was found to be 0.240 mol L^{-1}.

(a) Write a balanced equation for the equilibrium process forming 1 mole of sulfur trioxide *1 mark*

(b) Calculate the equilibrium constant for the reaction in part (a) above. *2 marks*

(c) Use Le Chatelier's principle to predict the change in the concentrations of the 3 gases if the total pressure on the system were increased at 500°C. Explain your reasoning. *2 marks*

(d) Predict the impact on the equilibrium constant if the temperature was increased following part (c) *2 marks*

(e) Use the axes below to show the change in concentration of sulfur dioxide, oxygen and sulfur trioxide from the addition of initial reactants and responses to changes identified in (c) and (d) *3 marks*

Question 29 (6 marks)

A student conducted the following experiment using a solution of ethanoic acid and a solution of hydrochloric acid. After measuring the pH, a salt was dissolved into each sample and the pH measured again. The results are summarised in the table below.

	Ethanoic acid	***Hydrochloric acid***
Concentration of acid (mol L^{-1})	1.0	0.0040
Initial pH	2.4	2.4
Substance added	1.0 g solid potassium ethanoate	1.0 g solid potassium chloride
Final pH	2.6	2.4

(a) Use the data in the table to explain all concentration and pH readings recorded during this investigation. *4 marks*

(b) Explain why ethanoic acid is classified as an acid according BOTH to the Brønsted-Lowry and Arrhenius theories of acids. *2 marks*

Question 30 (5 marks)

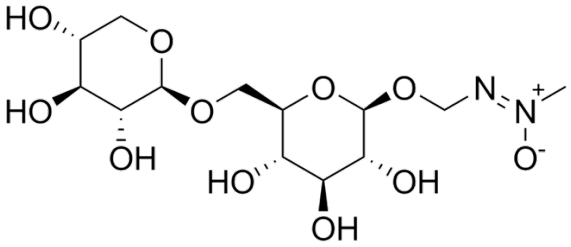
Quantitatively compare the solubility of barium fluoride in water to a solution of 0.03 mol L^{-1} NaF. K_{sp} for barium fluoride is 1.0×10^{-6} at 25°C. *5 marks*

Question 31 (4 marks)

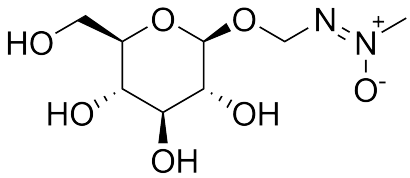
Hydrazine (N_2H_4) is common to rocket fuel, spandex suits, power stations and car airbags. Like ammonia, it is classified as a Bronsted-Lowry base when it reacts with water. A 0.15 mol L^{-1} solution has a pH of 10.70. Calculate the K_b for hydrazine. *4 marks*

Question 32 (3 marks)

The seeds of cycad plants are used by Aboriginal and Torres Strait Islander peoples to make bread. However, these seeds contain toxins, TWO of which are illustrated below.



microzamin



cycasin

Explain the process used to remove these toxins with reference to the features of each molecule *3 marks*

END OF TEST

EXTRA WRITING SPACE

Student Number

CHEMISTRY – MULTIPLE-CHOICE ANSWER SHEET

ATTEMPT ALL QUESTIONS

Question	**1**	A ⬭	B ⬭	C ⬭	D ⬭
	2	A ⬭	B ⬭	C ⬭	D ⬭
	3	A ⬭	B ⬭	C ⬭	D ⬭
	4	A ⬭	B ⬭	C ⬭	D ⬭
	5	A ⬭	B ⬭	C ⬭	D ⬭
	6	A ⬭	B ⬭	C ⬭	D ⬭
	7	A ⬭	B ⬭	C ⬭	D ⬭
	8	A ⬭	B ⬭	C ⬭	D ⬭
	9	A ⬭	B ⬭	C ⬭	D ⬭
	10	A ⬭	B ⬭	C ⬭	D ⬭
	11	A ⬭	B ⬭	C ⬭	D ⬭
	12	A ⬭	B ⬭	C ⬭	D ⬭
	13	A ⬭	B ⬭	C ⬭	D ⬭
	14	A ⬭	B ⬭	C ⬭	D ⬭
	15	A ⬭	B ⬭	C ⬭	D ⬭
	16	A ⬭	B ⬭	C ⬭	D ⬭
	17	A ⬭	B ⬭	C ⬭	D ⬭
	18	A ⬭	B ⬭	C ⬭	D ⬭
	19	A ⬭	B ⬭	C ⬭	D ⬭
	20	A ⬭	B ⬭	C ⬭	D ⬭

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Section I

20 marks

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Use the multiple-choice answer sheet provided.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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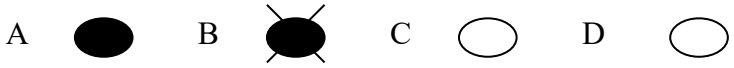

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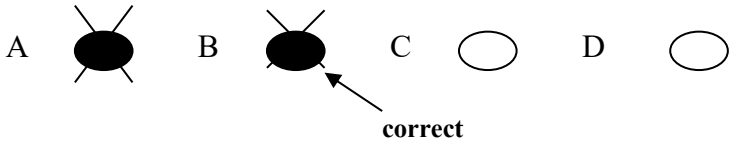

Section I

20 marks
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Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

Qu	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans	A	D	A	C	A	A	C	C	D	D	D	C	B	B	A	B	D	D	C	D

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1. Consider the equilibrium process

$$CH_2CH_{2(g)} + H_{2(g)} \rightleftharpoons CH_3CH_{3(g)} \qquad \Delta H = -136 \text{ mol}^{-1}.$$

Which of the following changes would cause the magnitude of the equilibrium constant for this reaction to increase?

(A) The temperature is decreased.
(B) The pressure is decreased.
(C) The concentration of H_2 in the equilibrium mixture is increased.
(D) The concentration of CH_3CH_3 in the equilibrium mixture is increased.

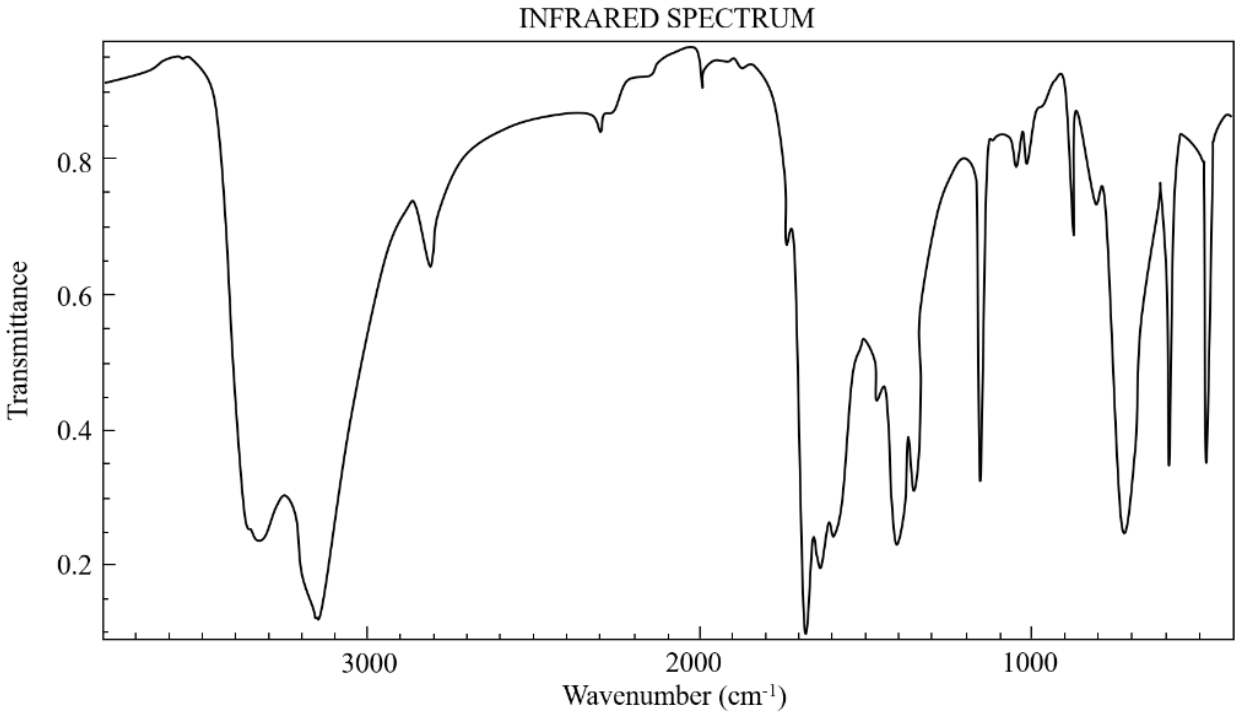
2. Which pair of compounds represents an acid and its conjugate base?

	Acid	Conjugate base
(A)	HSO_4^-	H_2SO_4
(B)	CH_3COO^-	CH_3COOH
(C)	CH_3NH_2	$CH_3NH_3^+$
(D)	**$HCrO_4^-$**	**CrO_4^{2-}**

3. Which compound below is NOT an isomer of the others?

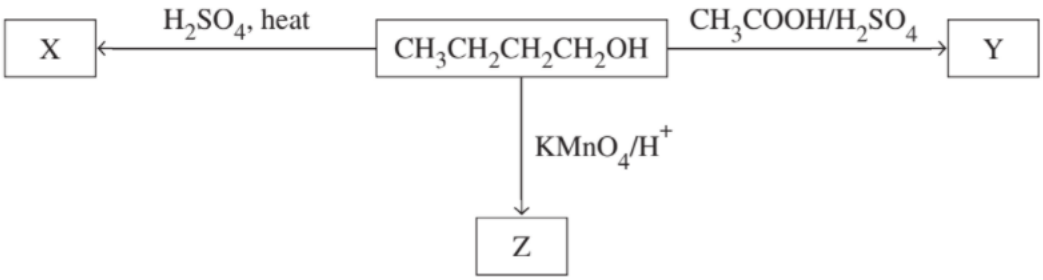
(A) but-1-ene
(B) pent-1-ene
(C) Cyclopentane
(D) 2-methyl-but-2-ene

4. The diagram below shows the infrared spectrum of a compound. What is the compound most likely to be?



(A) Ethene
(B) Ethanol
(C) Ethanamide
(D) Ethanoic Acid

5. Consider the reaction sequence below.



Which row of the table correctly identifies X, Y and Z?

	X	Y	Z
(A)	**but-1-ene**	**(1-butyl) ethanoate**	**butanoic acid**
(B)	butane	hexanoic acid	butan-1-ol
(C)	but-2-ene	ethyl butanoate	butanoate
(D)	cyclobutane	butyl acetate	butanal

6. A solution containing $Co(H_2O)_6^{2+}$ (aq), $CoCl_4^{2-}$ (aq) and Cl^- (aq) at equilibrium at room temperature is initially pink. When heated, the solution turns blue. Then, when Ag+(aq) is added, the solution turns back to pink.

Which statements are correct?

I. $Co(H_2O)_6^{2+}$ (aq) is pink.
II. Formation of $CoCl_4^{2-}$ (aq) from $Co(H_2O)_6^{2+}$ (aq) and Cl^-(aq) is exothermic.

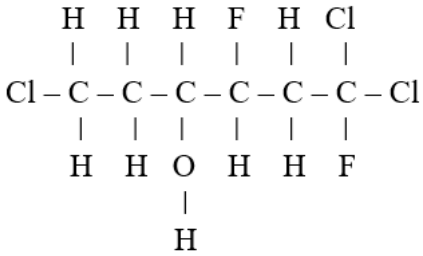
(A) I only
(B) II only
(C) Both I and II
(D) Neither I nor II

7. A student mixed 10.0 mL of 0.0400 mol L^{-1} H_2SO_4 with 40.0 mL of 0.35 mol L^{-1} KOH.

What is the pH of the resulting solution?

(A) 0.26
(B) 0.59
(C) 13.42
(D) 13.45

8. What is the correct I.U.P.A.C. name for the compound with formula shown below?



(A) 1,1,6-trichloro-1,3-difluorohexan-4-ol
(B) 1,3-difluoro-1,1,6-trichlorohexan-4-ol
(C) 1,6,6-trichloro-4,6-difluorohexan-3-ol
(D) 4,6-difluoro-1,6,6-trichlorohexan-3-ol

9. What is the pH of a 0.008 mol L^{-1} solution of barium hydroxide?

(A) 2.10
(B) 8.00
(C) 11.90
(D) 12.20

10. Which of the following organic compounds will produce the aqueous solution which has the highest pH?

(A) Propanoic acid
(B) Propanol
(C) Propanamide
(D) Propanamine

11. The tetrachlorocopper(II) anion forms a green solution and reacts with water to form the blue hexaaquacopper(II) cation according to the following equation:

$$CuCl_4^{2-}(aq) + 6H_2O(l) \rightleftharpoons Cu(H_2O)_6^{2+}(aq) + 4Cl^-(aq) \qquad \Delta H = \text{negative}$$

At a constant pressure and temperature, the appearance of a solution containing these ions remains pale blue.

Which alternative correctly predicts an identified change and its effect on the system?

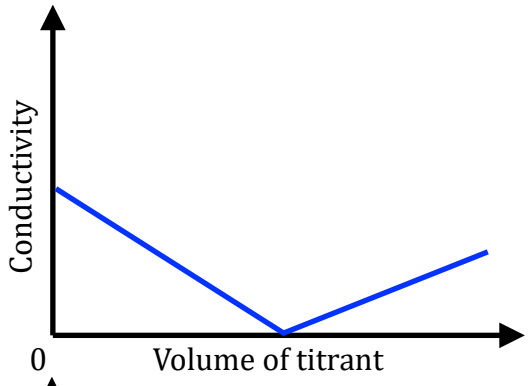
(A) Adding water causes the solution to turn green.
(B) Increasing the temperature causes the solution to turn blue.
(C) Cooling the reaction vessel increases the rate of the reverse reaction.
(D) Adding concentrated hydrochloric acid causes the solution to turn green.

12. A 0.1 mol L^{-1} solution of a weak acid HA is 5% dissociated at 25°C. Calculate the concentration of hydronium ions in the acid solution.

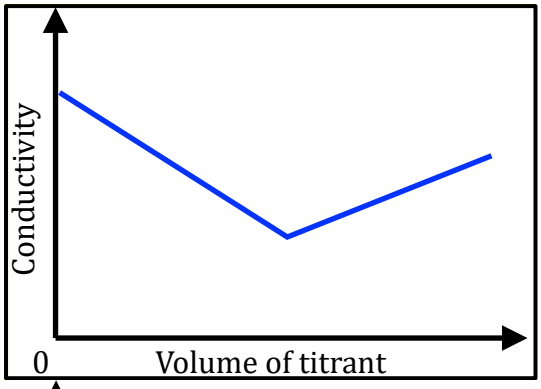
(A) 0.50 mol L^{-1}.
(B) 0.050 mol L^{-1}.
(C) 0.0050 mol L^{-1}.
(D) 0.01 mol L^{-1}.

13. Which of the following conductivity curves correctly depicts the titration of hydrochloric acid against potassium hydroxide?

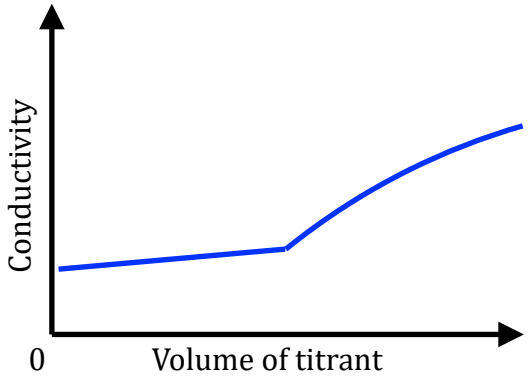
(A)



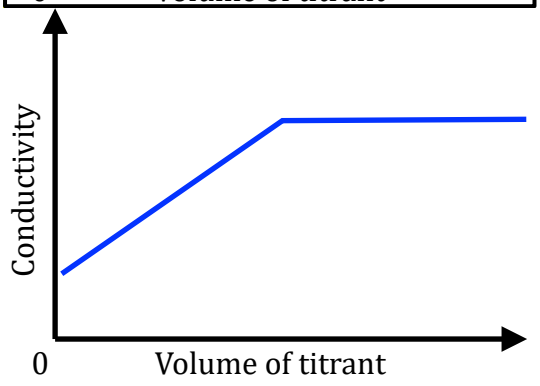
(B)



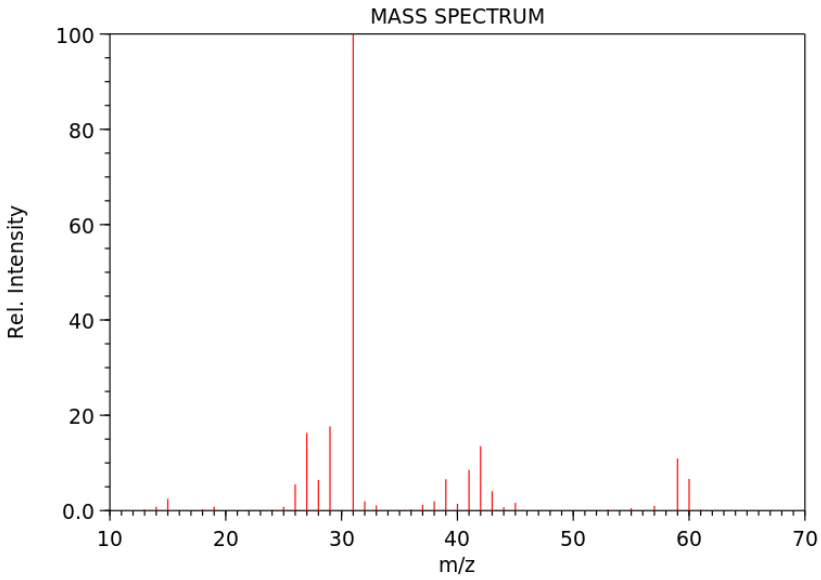
(C)



(D)



14. The mass spectrum for an alkanol is shown below.



Which one of the following alkanols could have the spectrum shown above?

(A) methylpropane-2-ol
(B) propan-1-ol
(C) butan-2-ol
(D) butan-1-ol

15. What will happen to the pH of a buffer solution when a small amount of a strong base is added?

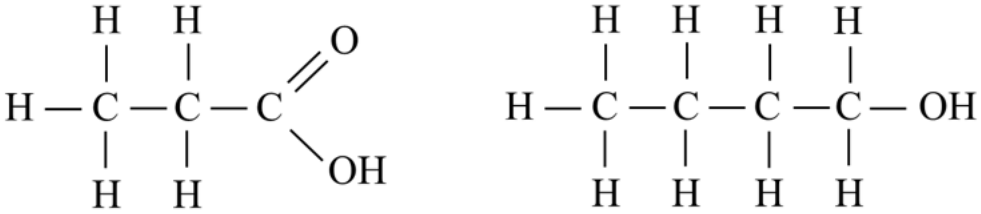
(A) it will increase slightly
(B) it will decrease slightly
(C) it will remain exactly the same
(D) it will become 7.0

16. Nitrous acid, HNO_2, has a K_a of 7.2×10^{-4}.

What is the pH of a 0.40 M solution of the acid?

(A) 1.02
(B) 1.77
(C) 2.14
(D) 3.52

17. What product would be formed through the reaction of the two reactants shown?



(A) Propyl butanoate
(B) Butyl butanoate
(C) Propyl propanoate
(D) Butyl propanoate

18. Which row of the table below correctly matches the reaction type with its correct reactants, catalyst and products??

	Reaction Type	Reactants	Catalyst	Products
(A)	Hydration	$H_2C = CH_2 + H_2O$	H_2SO_4	$HOCH_2CH_2OSO_3H$
(B)	Hydration	$H_2C = CH_2$	concentrated H_2SO_4	CH_3CH_2OH
(C)	Addition	$H_2C = CH_2 + H_2O + Br_2$	nil	$BrCH_2CH_2Br$
(D)	**Addition**	**$H_2C = CH_2 + H_2$**	**Nickel**	**CH_3CH_3**

19. A student is asked to identify a sample of a straight chain alcohol containing four carbon atoms. They add acidified potassium permanganate to the sample, which **does not** decolourise.

The location of the hydroxyl group

(A) is the first carbon atom.
(B) is the second carbon atom.
(C) is the third carbon atom.
(D) cannot be determined.

20. What is the function of the beam of electrons in a mass spectrometer?

(A) It detects the mass of the particles.
(B) It deflects the stream of positively charged particles.
(C) It bombards the sample causing ionisation to form positive particles.
(D) It removes positive particles from within the spectrometer.

END OF SECTION I

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2021 GOSFORD HIGH SCHOOL HSC
TRIAL EXAMINATION

Student Number

Chemistry

Section II Answer Booklet

80 marks
Attempt Questions 21 - 32
Allow about 2 hours and 25 minutes for this section

Instructions

- Write your Student Number at the top of this page
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the end of this booklet. Clearly indicate which questions are being answered in this space

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Please turn over

Question 21 (8 marks)

A student wanted to determine the exact concentration of propanoic acid. She decided to use a secondary standard of 0.1186 mol L^{-1} sodium hydroxide solution for the titration. 25.0 mL of propanoic acid was placed into a clean conical flask and the sodium hydroxide was added slowly to the propanoic acid using a graduated burette. A digital pH meter was used to record the pH values as the sodium hydroxide was added to the solution. The results of the titration are shown below.

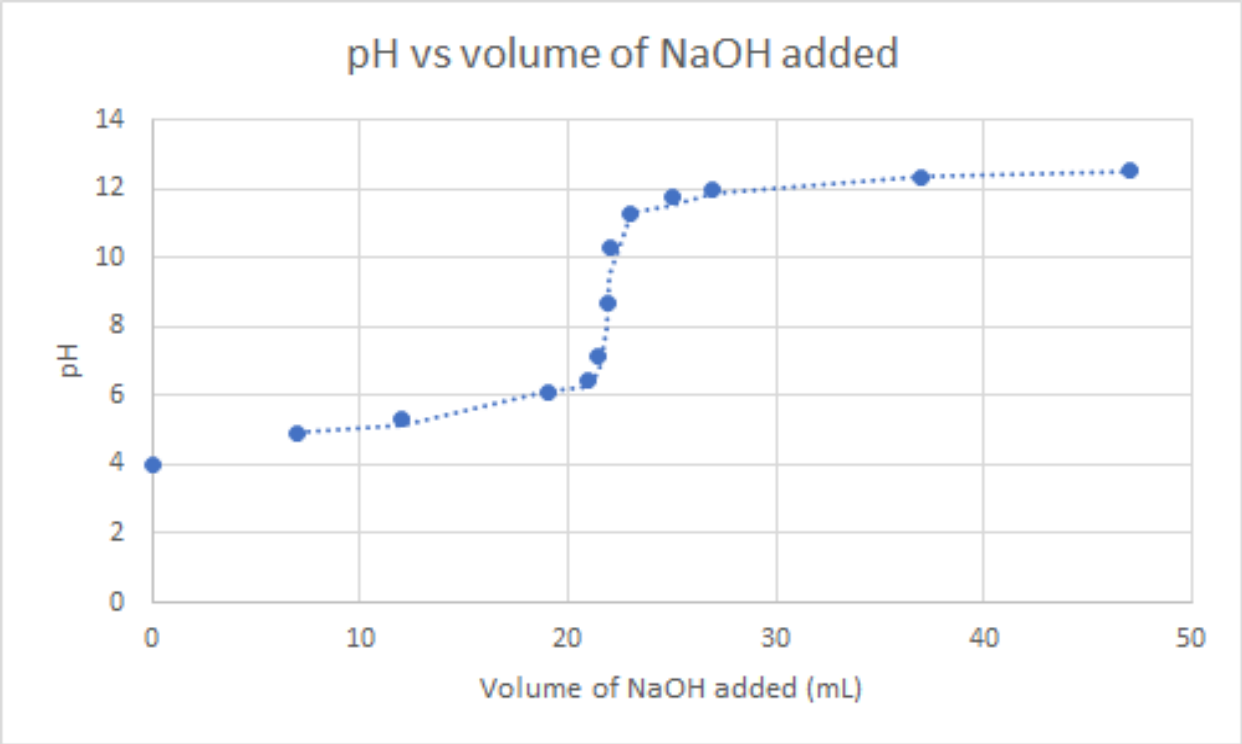
By graphing the data in the grid provided and performing relevant calculations, determine the concentration of the propanoic acid solution. An equation should be included in your answer.

8 marks

Volume of sodium hydroxide added (mL)	pH of solution
0	3.96
7	4.92
12	5.35
19	6.13
21	6.44
21.5	7.14
21.9	8.72
22	10.3
23	11.29
25	11.75
27	11.96
37	12.36
47	12.52

Marking Criteria	Marks
● Provides graph with: ○ Correctly labelled axes including units ○ Appropriate scales ○ Correctly plotted points ○ Line graph showing titration curve ● Correctly calculates the concentration of propanoic acid with units which includes the correct equivalence point read off the graph and a correct chemical equation	8

• Provides a correct graph and most of the steps for calculating the concentration of propanoic acid OR • Correctly calculates the concentration of propanoic acid with units which includes the correct equivalence point read off the graph and a correct chemical equation and a substantially correct graph	6-7
• Provides a substantially correct graph and at least one step for calculating the concentration of propanoic acid	4-5
• Provides a graph with some correct features AND/OR • Provides some steps for calculating the concentration of sodium hydroxide	2-3
• Provides some relevant information	1



$NaOH_{(aq)} + CH_3CH_2COOH_{(aq)} \rightarrow H_2O_{(l)} + CH_3CH_2COONa_{(aq)}$

Equivalence point (read off the graph) = 21.9 mL

$n_{NaOH} = 0.1186 \times 0.0219$
$= 2.597 \times 10^{-3}$

$c_{\text{propanoic acid}} = \frac{n}{V} = \frac{2.597 \times 10^{-3}}{0.025} = 0.1039 \text{ mol L}^{-1}$

Question 22 (5 marks)

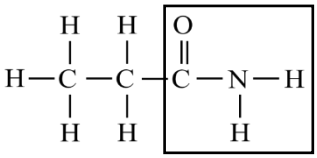
Amides are organic molecules that are used in the manufacture of many polymers, solvents and pharmaceutical drugs.

(a) Identify the amide shown in the diagram and circle the functional group that allows it to be placed in this category of molecule. *2 marks*

Criteria	Marks
• Identifies name of compound AND correctly circles amide functional group	2
• Identifies name of compound OR correctly circles amide functional group	1

Sample answers:

propanamide



(b) This table shows the boiling points of a variety of organic substances.

Compound	*Type*	*Molar mass* (g mol^{-1})	*Boiling point* (°C)
propan-1-amine	amine	59	49
ethanamide	amide	59	210
ethanoic acid	carboxylic acid	60	118

Explain the differences in the boiling points. *3 marks*

Criteria	Marks
• Describes the structure of amines and alcohols which results in the presence of hydrogen bonds • Compares the structure of amines and amides to explain differences in boiling point	3
• Describes the structure of amines and alcohols which results in the presence of hydrogen bonds	2
• Provides some relevant information	1

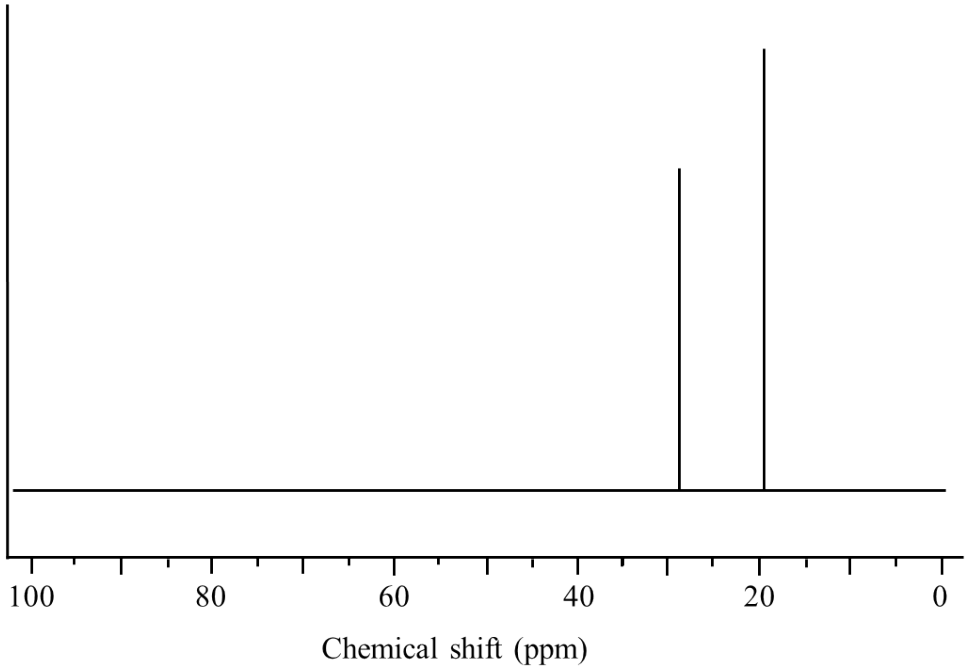
Sample answer:

The N-H bonds in amines and amides are highly polar, meaning that hydrogen bonds can form between the non-bonding pair of electrons on the nitrogen atom and the partially positive hydrogen atom on the other molecule.

Amides have much higher boiling points than amines as they contain more atoms that can form hydrogen bonds. Hydrogen bonds also form between non-bonding electron pairs on the oxygen atom of one molecule and the partially positive hydrogen atom on a neighbouring molecule.

Question 23 (6 marks)

Lily carries out carbon-13 NMR testing on an unknown sample that was collected at an industrial work site. She uses the chemical shift information below to determine that the sample is a haloalkane.



(a) Justify her decision in determining that the sample was a haloalkane and suggest a name for the substance. *3 marks*

Criteria	Marks
• Justifies identification as haloalkane using chemical shift data for C-C group AND presence of halogen • Suggests a name for the substance • Justifies name/chain length using number of carbon environments	3
• Suggests a name for the substance AND • Justifies identification as haloalkane using chemical shift data for C-C group OR presence of halogen OR • Justifies name/chain length using number of carbon environments	2
• Provides some relevant information	1

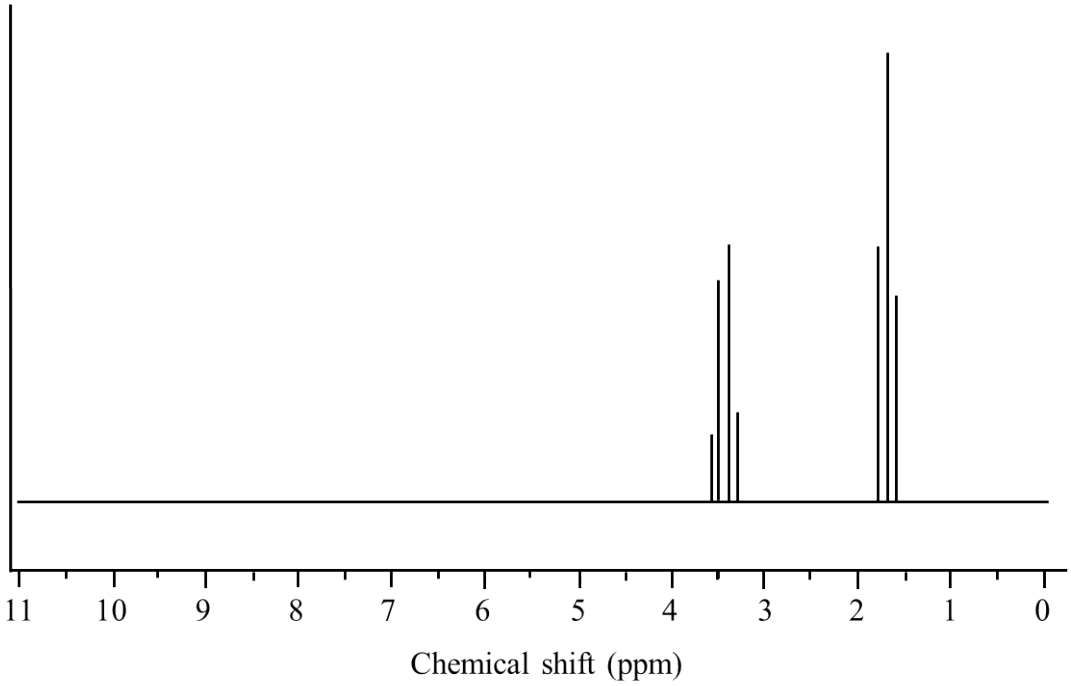
Sample answer:

The sample may be a haloalkane such as bromoethane (or chloroethane) as:

- there is a peak with a chemical shift near 20 ppm, which suggest the presence of a C-C group
- there is a peak with a chemical shift near 30 ppm, which suggests the presence of a halogen (chlorine or bromine)
- there are two peaks on the spectra, which tells him that there are two different carbon environments

Question 23 continued…

(b) Lily also carries out proton NMR testing and generates the spectrum below. She notices that there are multiple peaks where she expected to see single ones.



Explain why the splitting that can be seen in the spectrum has occurred. *3 marks*

Criteria	Marks
• Identifies that splitting occurs due to the presence of neighbouring hydrogen atoms • Explains the presence of the triplet and quartet peaks	3
• Identifies that splitting occurs in high resolution proton NMR testing • Identifies that splitting occurs due to the presence of neighbouring hydrogen atoms	2
• Identifies that splitting occurs in high resolution proton NMR testing OR • Identifies that splitting occurs due to the presence of neighbouring hydrogen atoms	1

Sample answer:

Splitting occurs when using high resolution proton NMR testing. Signals are split into clusters of peaks due to the effect of neighbouring hydrogen atoms. The triplet between 1.5 and 2 ppm is likely caused by the $–CH_2–$ group found in the haloalkane where the halogen is attached. The quartet at 3.5 ppm is likely caused by the $–CH_3$ group found at one end of the haloalkane.

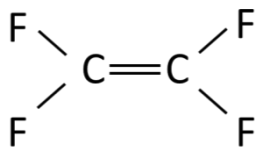
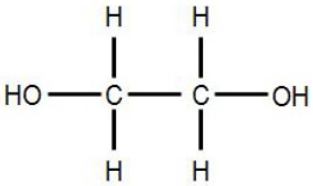
Question 24 (8 marks)

(a) Complete the table below comparing an addition polymer to a condensation polymer *6 marks*

Criteria	Marks
• Identifies all of the features listed below for both polymers ○ polymer name ○ monomer name ○ monomer structural formula ○ properties ○ application AND both polymers are correct for their category	6
• Identifies all of the features correctly, but has polymer in wrong category	5
• Identifies four of the features listed correctly for either polymer	4
• Identifies three of the features listed correctly for either polymer	3
• Identifies two of the features listed correctly for either polymer	2
• Identifies one of the features correctly	1

Sample answer:

Answers will vary.

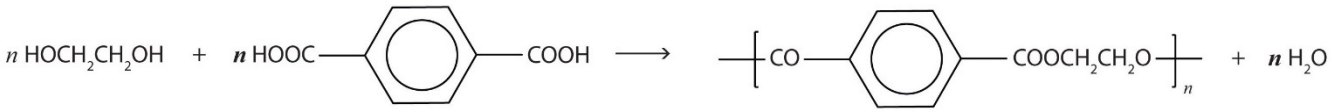
Polymer	*Monomer*	*Properties*	*Application*
polytetrafluoroethene (PTFE)	tetrafluoroethene 	• non-stick • high melting point	• frying pan coatings • plumber's tape • waterproof fabrics
Polyester	ethandiol 	• High elasticity • Resistant to acids	• Clothing • Fabrics

(b) Outline the process involved to create ***one*** of the above polymers *2 marks*

Criteria	**Marks**
• Outlines polymerisation process including chemical equation with correct reactants and products	2
Some relevant information about the reaction process	1

Sample Answer:

Polyester is created through condensation polymerisation where a reaction between monomer units of a diol (e.g. ethan-1,2-diol) and a dicarboxylic acid (e.g. benzene-1,4, dicarboxylic acid) to produce water and a polyester (e.g. polyethylbenzene-1,4-dicarboxylate).



Ethylene glycol Terephthalic acid Polyethylene terephthalate

Question 25 (13 marks)

(a) Explain why sodium hydroxide should not be used as a primary standard for titrations *2 marks*

Criteria	Marks
• Explains thoroughly the reasons why sodium hydroxide cannot be used as a primary standard	2
• Outlines at least 1 significant reason why the concentration of sodium hydroxide is inaccurate unless it has been standardised	1

Sample answer

Sodium hydroxide, if solid or in an open container as a solution, will react with carbon dioxide from air and absorb water from air. Therefore its mass and concentration are not accurately known. Titration is a technique which is very accurate if the concentrations of the reactants used are accurate.

Standards used in titrations must be able to be weighed out accurately, not contain impurities, not gain or lose mass as they are being weighed or used and be of high molar mass so that errors in measurements involve only small fractions of a mole.

Sodium hydroxide is standardised just before use by reacting a solution with an acid of known concentration. Sodium hydroxide is standardised by reacting it with an acid which meets the criteria of a primary standard. Oxalic acid is often used for this standardisation step.

(b) Sodium carbonate (anhydrous) is used as a primary standard for a titration to determine the concentration of a solution of sulfuric acid. Describe the procedure used to prepare the solutions, including a 250mL 0.150M primary standard as well as any glassware needed for an accurate titration. *4 marks*

• Describes the steps in weighing out the primary standard, identifies the glassware and describes the techniques in preparing the solution with correct calculations • Describes the steps in preparing a burette and transferring the sulfuric acid of known concentration into it • Describes the steps in preparing the conical flask and cleaning the pipette for transfer of the sodium carbonate into the flask • Describes the technique of titrating, measuring the titre and use of a suitable indicator	4
• THREE of the above	3
• TWO of the above	2
• ONE of the above	1

Sample answer

To make a standard solution of a base:

- Weigh out accurately the required mass of the basic primary standard (anhydrous sodium carbonate).
  For 250mL 0.150M solution: n(Na_2CO_3) = 0.0375mol
  MM (Na_2CO_3) = 105.99g mol^{-1}
  m (Na_2CO_3) = 3.97g
- Transfer the mass exactly to a volumetric flask (previously cleaned with water). Use a funnel; wash into the volumetric flask with wash bottle of de-ionised water. Make up to calibration mark.

The unknown solution of sulfuric acid needs to be measured out using a burette. This burette after cleaning with water needs to be washed out with some of the sulfuric acid solution.

To use the sodium carbonate base in a titration:

- A pipette (say 25.0 mL) should be cleaned with water and rinsed with the solution it will transfer to the conical flask.
- Pipette out of the volumetric flask an exact volume (say 25.0 mL) of known concentration base into a clean, rinsed with de-ionised water, conical flask.
- Fill a 50.00 mL burette with the unknown acidic solution (burette should have been rinsed with a small quantity of this acidic solution).
- Add 3 drops of suitable indicator (probably methyl orange) to the conical flask.
- Titrate known base (sodium carbonate) with unknown acid until the indicator just changes (from yellow to pink if methyl orange is used).
- Calculate moles of sodium carbonate in conical flask and hence (from balanced equation) calculate moles of acidic solution transferred from burette (from a known volume).
- Calculate the concentration of acidic solution.

(c) Determine the concentration of a sulfuric acid solution if 34.50 mL of the acid is required to neutralise 25.0 mL of a solution of 0.150 M sodium carbonate solution *2 marks*

• Calculates correctly the concentration of sulfuric acid solution	2
• Writes a correct equation for the reaction OR • Determines the correct no. of moles of sodium carbonate used	1

Sample answer

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

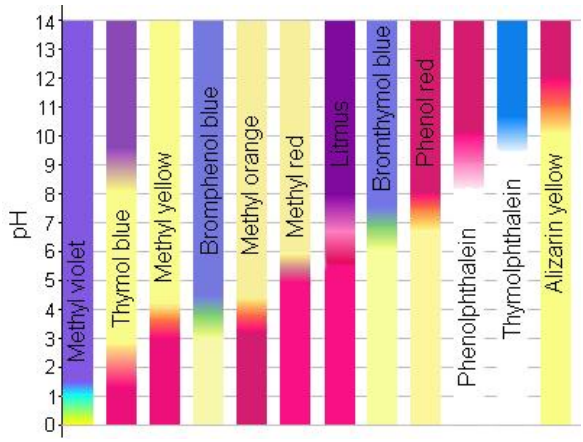
1 mole 1 mole

Moles sodium carbonate = (25.0/1000) x 0.150 = 0.00375 mol

Hence moles sulfuric acid needed = 0.00375 mol

Concentration sulfuric acid = n/V = 0.00375/0.0345 = 0.109 mol/L

(d) Identify a suitable indicator for use with this titration and explain your response. *2 marks*



Criteria	Marks
• Identifies a suitable indicator AND • Explains correctly the reason for the choice	2
• Identifies a suitable indicator OR • Explains correctly the reason for the choice	1

Sample answer

Methyl orange is the best indicator, as it changes from red to yellow in the pH range 3-5. The salt formed at the equivalence point of this titration is sodium sulfate which will NOT affect the pH of the resultant solution. However, since carbon dioxide is produced the resultant solution will be slightly acidic because of the reaction of carbon dioxide with water to form carbonic acid.

(e) Calculate the pH at 25°C after 240 mL of 0.50 mol L^{-1} sodium hydroxide is added to 60 mL of 0.20 mol L^{-1} sulfuric acid solution. *3 marks*

Criteria	Marks
• Calculates pH correctly	3
• Makes 1 error only in calculations	2
• Show some correct calculations	1

Sample answer

Moles NaOH added = (240/1000) x 0.50 = 0.120 mol

Moles H_2SO_4 added = (60/1000) x 0.20 = 0.012 mol

Moles H^+ added = 2 x 0.012 = 0.024 mol

Excess moles OH^- after neutralisation = 0.120 – 0.024 = 0.096 mol

Volume of final solution = 300 mL

Conc NaOH in final mixture = 0.096/0.300 = 0.320 mol/L

pOH = 0.495

pH = 14.000 – 0.495 = 13.51

Question 26 (9 marks)

In organic chemistry it is desired to create molecular structures that have exactly the right properties for a particular purpose. This is achieved through converting a readily available starting material (an alkane or alkene) into the desired product.

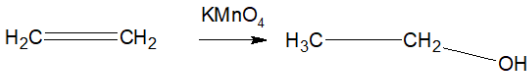
How would you form butyl ethanoate from an alkane? Draw a flow chart to represent the reaction pathway. Write all chemical equations using structural formulae and include any necessary reagents and conditions. Identify the types of reactions involved in each step and name any reactants and products using IUPAC conventions. *9 marks*

Succinct response with well-structured and clear flow chart Reagents, reaction conditions provided for all reactions/steps Correct balanced chemical equations with states Structural formulae provided for reactants and products in all steps Detailed knowledge of all reactions	**8-9**
Clear flow chart-use of arrows Reagents, reaction conditions provided for all reactions/steps Correct balanced chemical equations with states Structural formulae provided for reactants and products in all steps Detailed knowledge of all reactions	**7**
Flow chart-use of arrows Reagents, reaction conditions provided for most reactions/steps Correct balanced chemical equations with states for most steps Structural formulae provided for reactants and products for most steps Detailed knowledge of most reactions	**6**
Flow chart-use of arrows Reagents, reaction conditions provided for most reactions/steps At least one Correct balanced chemical equations with states Structural formulae provided for reactants and products for most steps Detailed knowledge of most reactions	**5**
Flow chart-use of arrows Reagents, reaction conditions provided for most reactions/steps At least one Correct balanced chemical equations with states OR Structural formulae provided for reactants and products for most steps Sound knowledge of most reactions	**4**
Flow chart-use of arrows AND Reagents, reaction conditions provided for most reactions/steps OR	**3**

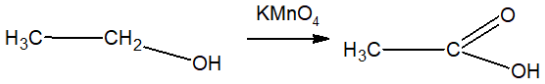
At least one Correct balanced chemical equations with states OR Structural formulae provided for reactants and products for most steps Some knowledge of some reactions	
Flow chart-use of arrows OR Reagents, reaction conditions provided for most reactions/steps OR At least one Correct balanced chemical equations with states OR Structural formulae provided for reactants and products for most steps OR Some knowledge of some reactions	**2**
Correct formula for butyl ethanoate- structural or molecular OR some relevant information.	**1**

Sample answer:

The ester shown could be synthesised by the oxidation of butene using a strong oxidising agent such as KMnO4¬, which would form butanol as an intermediate and upon further oxidation butanoic acid. This is one of the reagents needed to synthesise the ester.

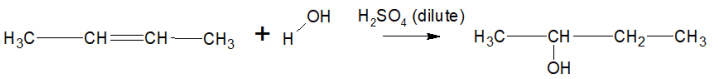


ethene ethanol



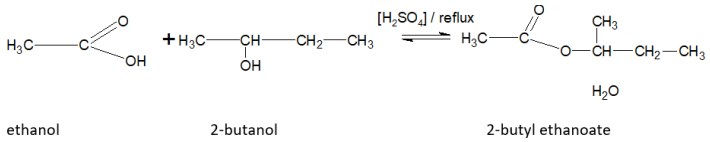
ethanol ethanoic acid

The 2-butene could be reacted with water, with dilute sulfuric acid acting as a catalyst to increase the reaction rate. An addition reaction (hydration) would occur as the water adds across the double bond, forming 2-butanol.



2-butene (but-2-ene) 2-butanol (butan-2-ol)

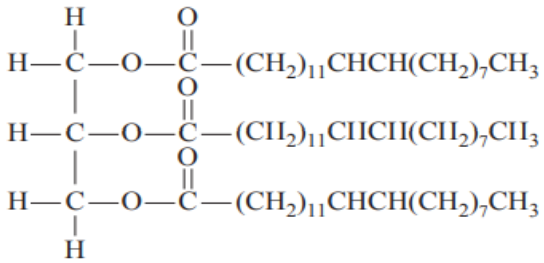
The ethanoic acid and 2-butanaol can be heated under reflux with concentrated sulfuric acid added as as a catalyst to increase the reaction rate, and also as a dehydrating agent, which favours the forward reaction in the esterification reaction, increasing the yield of the desired product.



ethanol 2-butanol 2-butyl ethanoate

Question 27 (3 marks)

The molecule below can be used as a source of fuel. It is classified as an oil and is found in some plants.



(a) This molecule can be hydrolysed to form glycerol and three long chain carboxylic acids, called erucic acid. Erucic acid will combine with methanol to form an ester, methyl erucate, which can be used as the biofuel known as biodiesel.

Draw a structural formula for methyl erucate in the space below. *1 mark*

Criteria	Mark
• Draws the correct structural formula for methyl erucate	1

Sample answer

$CH_3(CH_2)_7CHCH(CH_2)_{11}COOCH_3$

(b) Describe TWO advantages of using biodiesel as a fuel rather than petrodiesel, which is produced from crude oil. *2 marks*

Criteria	Marks
• Describes TWO environmental advantages of using biodiesel rather than petrodiesel AND • Contrasts each advantage with a disadvantage of using petrodiesel	2

• Describes ONE environmental advantage of using biodiesel rather than petrodiesel AND • Contrasts that advantage with a disadvantage of using petrodiesel	1

Sample answer (a range of answers possible but must be contrasted with use of petrodiesel)

There is a lower environmental impact of plant growth for biodiesel production compared to crude oil extraction (oil spills) and refining for petrodiesel production.

Biodiesel combustion releases recently extracted CO_2 back into the atmosphere, whereas petrodiesel adds to current atmospheric CO_2 levels.

Biodiesel production is less harmful to marine life that is affected by oil spills during extraction and transport of crude oil for the production of petrodiesel.

Question 28 (10 marks)

The Contact process in the industrial production of sulfuric acid involves the conversion of SO_2 *(g)* into SO_3 *(g)*. This process is exothermic.

0.360 moles of sulfur dioxide and 0.300 moles of oxygen were injected into a 1.00 L vessel and allowed to reach equilibrium at 500°C. At equilibrium, the concentration of sulfur trioxide was found to be 0.240 mol L^{-1}.

(a) Write a balanced equation for the equilibrium process forming 1 mole of sulfur trioxide *1 mark*

Criteria	Mark
• Writes a correctly balanced equation for formation of 1 mole of sulfur trioxide	1

Sample answer

SO_2 *(aq)* + ½O_2 *(g)* $\rightleftharpoons$ SO_3 *(g)*

(b) Calculate the equilibrium constant for the reaction in part (a) above. *2 marks*

Criteria	Marks
• Calculates equilibrium constant for the reaction as written in part (a) above	2
• Uses a correct method but with mathematical error	1

Sample answer

$$Keq = \frac{[SO3]}{[SO2][O2]^{1/2}}$$

	SO_2	O_2	SO_3
Initially	0.360 mol	0.300 mol	0.000 mol
Change	-0.240 mol	-0.120 mol	+0.240 mol
At equilibrium	0.120 mol	0.180 mol	0.240 mol

In 1 L vessel:

$$K_{eq} = \frac{[SO_3\,(g)]}{[SO_2\,(g)]\,[O_2\,(g)]^{½}} = \frac{(0.240)}{(0.120)\,(0.180)^{½}} = \frac{0.240}{(0.120)\,(0.424)} = 4.72$$

(c) Use Le Chatelier's principle to predict the change in the concentrations of the 3 gases if the total pressure on the system were increased at 500°C. Explain your reasoning. *2 marks*

Criteria	Marks
• Predicts that $[SO_3]$ will increase and $[O_2]$ and $[SO_2]$ will decrease AND • Explains the prediction in terms of Le Chatelier's principle	2
• Predicts that $[SO_3]$ will increase and $[O_2]$ and $[SO_2]$ will decrease	1

Sample answer

Le Chatelier's principle states that if a system is at equilibrium and the conditions are changed by increasing the pressure, volume or temperature of the system, then the equilibrium will shift to compensate for the applied change.

Here, since the pressure only is increased, the equilibrium will shift to the right, to the side which has fewer molecules (1 mole of SO_3 by comparison with a total of 1.5 moles of gas on the LHS).

Hence the $[SO_3]$ will increase and $[O_2]$ and $[SO_2]$ will decrease

(d) Predict the impact on the equilibrium constant if the temperature was increased following part (c). *2 marks*

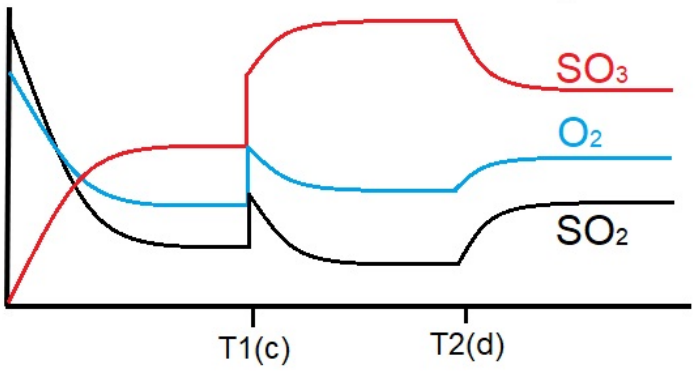
Criteria	Marks
• Predicts that the equilibrium constant will change AND justifies the direction of the change	2
• Predicts that the equilibrium constant will change OR • States the K_{eq} will decrease without justification	1

Sample answer

The equilibrium constant will decrease as this is an exothermic process. Any increase in heat will favour the reverse reaction, increasing the concentration of reactants.

(e) Use the axes below to show the change in concentration of sulfur dioxide, oxygen and sulfur trioxide from the addition of initial reactants and responses to changes identified in (c) and (d) *3 marks*

Criteria	Marks
• Correct initial concentrations and labels (in appropriate ratios) • Correct changes at T1 (for (c)) and T2 (for (d)) • Appropriate size of changes, i.e. changes in O_2 is half the changes of SO_2 and SO_3	3
Two of the above	2
One of the above	1



Question 29 (6 marks)

A student conducted the following experiment using a solution of ethanoic acid and a solution of hydrochloric acid. After measuring the pH, a salt was dissolved into each sample and the pH measured again. The results are summarised in the table below.

	Ethanoic acid	***Hydrochloric acid***
Concentration of acid (mol L^{-1})	1.0	0.0040
Initial pH	2.4	2.4
Substance added	1.0 g solid potassium ethanoate	1.0 g solid potassium chloride
Final pH	2.6	2.4

(a) Use the data in the table to explain all concentration and pH readings recorded during this investigation. *4 marks*

Criteria	**Marks**
• Analyses and explains all concentrations and pH readings, demonstrating a thorough knowledge of pH, equilibrium, acid strength and the related degree of ionisation	4
• Analyses and explains all concentrations and pH readings, demonstrating a sound knowledge of pH, equilibrium, acid strength and the related degree of ionisation	3
• Explains some aspects of concentrations AND pH readings	2
• Relates a feature in the table to equilibrium or acid strength	1

Sample answer:
Despite having the same initial pH of 2.4, which indicates the $[H^+]$ in both were equal, the actual concentrations of the acids were very different.

This reflects the different strengths of the two acids. Hydrochloric acid is strong and totally ionises whereas ethanoic acid is weak and only ionises partially. Therefore, despite the ethanoic acid having a much higher acid concentration of 1.0 mol L^{-1}, the $[H^+]$ in ethanoic acid must be only 0.0040 mol L^{-1}.

After addition of the salts the hydrochloric acid pH remained the same whilst the ethanoic acid pH rose to 2.6, indicating a drop in $[H^+]$.

As ethanoic acid is a weak acid it only partially ionises according to the following equilibrium:
$CH_3COOH\ (aq) + H_2O\ (l) \rightleftharpoons CH_3COO^-\ (aq) + H_3O^+\ (aq)$

The addition of potassium ethanoate increases the concentration of ethanoate ions.

Le Chatelier's Principle states:
If a chemical system at equilibrium experiences a change in concentration, temperature, volume or pressure, then the equilibrium shifts to counteract the imposed change.

According to this principle, the equilibrium shown in the above equation would shift to the left to reduce the concentration of acetate ions.

This would reduce the concentration of H_3O^+ and hence would raise the pH.

As hydrochloric acid is a strong acid it ionises completely:
$HCl\ (aq) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + Cl^-(aq)$

The addition of potassium chloride ions will produce more chloride ions. As there is no equilibrium, the addition of these ions will have no effect. The pH will remain unchanged.

(b) Explain why ethanoic acid is classified as an acid according BOTH to the Brønsted-Lowry and Arrhenius theories of acids. *2 marks*

Criteria	Marks
• Explains the classification of ethanoic acid BOTH by Lowry-Brønsted and Arrhenius theories of acids	2
• Explains the classification of ethanoic acid by ONE of Lowry-Brønsted and Arrhenius theories of acids	1

Sample answer
Ethanoic acid is classified as an acid by the Arrhenius theory of acids because it forms hydrogen (hydronium) ions in aqueous solution as the only positive ions.

Ethanoic acid is classified as an acid by the Lowry-Brønsted theory because ethanoic acid is capable of donating a proton (H^+) to a base. This definition is independent of state; water does not need to be present.

Question 30 (5 marks)

Quantitatively compare the solubility of barium fluoride in water to a solution of 0.03 mol L^{-1} NaF. K_{sp} for barium fluoride is 1.0 x 10^{-6} at 25°C. *5 marks*

Criteria	Marks
• Provides balanced equation • Calculates solubility of BaF_2 in water • Calculates solubility of BaF_2 in NaF • Calculates difference in solubility between NaF and water • Makes a comparative statement about solubility in NaF and water	5
• Provides balanced equation • Calculates solubility of BaF_2 in water • Calculates solubility of BaF_2 in NaF	4
• Provides balanced equation • Calculates solubility of BaF_2 in water	3
• Provides balanced equation AND • Identifies molar ratio OR • Identifies common ion OR • Identifies correct equilibrium expression	2
• Provides some relevant information	1

Sample answer:

$BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2F^-(aq)$
molar ratio 1 : 1 : 2

when dissolved in NaF, F^- is the common ion, reverse reaction is favoured, thus more precipitate forms

$[Ba^{2+}] = s$ mol L^{-1}
$[F^-] = 2s$ mol L^{-1}

$K_{sp} = [Ba^{2+}][F^-]^2$
$K_{sp} = s \times (2s)^2$
$K_{sp} = 4s^3$
$s^3 = \frac{1.0 \times 10^{-6}}{4}$
$s = \sqrt[3]{\frac{1.0 \times 10^{-6}}{4}}$
$s = 0.0063$ mol L^{-1}

$[NaF] = [F^-] = 0.03$ mol L^{-1}
$s << 0.03 \therefore s + 0.03 \approx 0.03 \therefore$ overall $[F^-] = 0.03$ mol L^{-1}

$K_{sp} = s \times (0.03)^2$

$1.0 \times 10^{-6} = s \times 0.0009$

$$s = \frac{1.0 \times 10^{-6}}{0.0009}$$

$s = 0.0011$ mol L^{-1}

compare: $\frac{\text{water}}{\text{NaF}}$ $\frac{0.0063}{0.0011}$ = 5.73

∴ BaF_2 is 5.73 times less soluble in NaF than it is in water

Question 31 (4 marks)

Hydrazine (N_2H_4) is common to rocket fuel, spandex suits, power stations and car airbags. Like ammonia, it is classified as a Bronsted-Lowry base when it reacts with water. A 0.15 mol L^{-1} solution has a pH of 10.70. Calculate the K_b for hydrazine. *4 marks*

Marking guidelines	Marks
• Provides balanced equation • Calculates concentration of [OH-] • Provides *K*b expression • Calculates *K*b	4
• Correctly addresses THREE of the above criteria OR • Address ALL of the criteria with a calculation error	3
• Correctly addresses at least TWO of the above criteria	2
• Calculates $[H^+]$	1

Sample answer

$N_2H_4\ (aq) + H_2O\ (l) \rightleftharpoons N_2H_5\ (aq) + OH^-\ (aq)$

$[H^+] = 10^{-pH}$

$= 10^{-10.70}$

$= 1.995 \times 10^{-11}$

$[H^+][OH^-] = 1.0 \times 10^{-14}$

$$[OH^-] = \frac{1.0 \times 10^{-14}}{1.995 \times 10^{-11}}$$

$= 5.0119 \times 10^{-4}$

$$Kb = \frac{[N_2H_5][OH^-]}{[N_2H_5]}$$

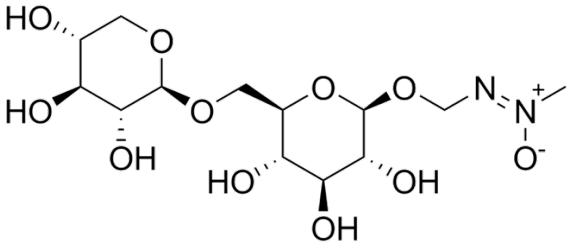
$$= \frac{x^2}{0.15}$$

$$= \frac{(5.0119 \times 10^{-4})^2}{0.15}$$

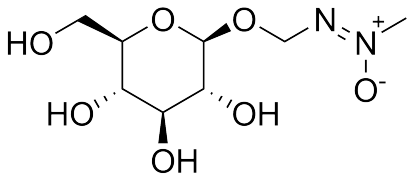
$= 1.67 \times 10^{-6}$

Question 32 (3 marks)

The seeds of cycad plants are used by Aboriginal and Torres Strait Islander peoples to make bread. However, these seeds contain toxins, TWO of which are illustrated below.



microzamin



cycasin

Explain the process used to remove these toxins with reference to the features of each molecule *3 marks*

Marking guidelines	Marks
• Describes the process of leaching. AND • Explains structural features from each molecule that allows it to be soluble in water	3
• Describes the process of leaching. OR • Identifies structural features from each molecule that allows it to be soluble in water	2
• Identifies that either compound is soluble in water OR • Describes the process of leaching	1

Sample answer

Leaching involves submerging the grounded up powder from the cycad seeds inside a bag in running water for up to 4 weeks, depending on the type of seed. Each molecule is polar due to the OH functional groups, hence allow them to be soluble in water. Furthermore, grinding the seeds increases the surface area available for the water to pass through. The remaining carbohydrate is insoluble and can be cooked to make bread.

END OF TEST

EXTRA WRITING SPACE

Student Number

CHEMISTRY – MULTIPLE-CHOICE ANSWER SHEET

ATTEMPT ALL QUESTIONS

Question	**1**	A ⬭	B ⬭	C ⬭	D ⬭
	2	A ⬭	B ⬭	C ⬭	D ⬭
	3	A ⬭	B ⬭	C ⬭	D ⬭
	4	A ⬭	B ⬭	C ⬭	D ⬭
	5	A ⬭	B ⬭	C ⬭	D ⬭
	6	A ⬭	B ⬭	C ⬭	D ⬭
	7	A ⬭	B ⬭	C ⬭	D ⬭
	8	A ⬭	B ⬭	C ⬭	D ⬭
	9	A ⬭	B ⬭	C ⬭	D ⬭
	10	A ⬭	B ⬭	C ⬭	D ⬭
	11	A ⬭	B ⬭	C ⬭	D ⬭
	12	A ⬭	B ⬭	C ⬭	D ⬭
	13	A ⬭	B ⬭	C ⬭	D ⬭
	14	A ⬭	B ⬭	C ⬭	D ⬭
	15	A ⬭	B ⬭	C ⬭	D ⬭
	16	A ⬭	B ⬭	C ⬭	D ⬭
	17	A ⬭	B ⬭	C ⬭	D ⬭
	18	A ⬭	B ⬭	C ⬭	D ⬭
	19	A ⬭	B ⬭	C ⬭	D ⬭
	20	A ⬭	B ⬭	C ⬭	D ⬭