

Chemistry

2019 TRIAL HSC EXAMINATION

**General
Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A formulae sheet, data sheet and Periodic Table are provided at the back of this paper
- For questions in Section II, show all relevant working in questions involving calculations

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 in Booklet A and B

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for section II in Booklet A and B

Section I
20 marks

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

Use the multiple-choice answer sheet.

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
A B C D

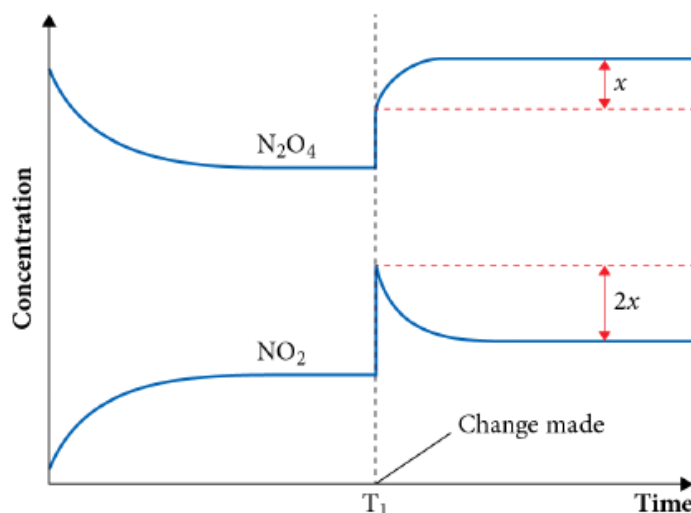
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

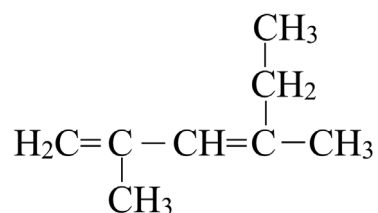
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A B C D
correct

1. Consider the reaction: $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
The imposed change at T_1 is most likely to be:



- (A) an addition of NO_2 .
 (B) an addition of N_2O_4 .
 (C) an increase in the volume of the container.
 (D) a decrease in the volume of the container.
2. Which of the following statements about acids and bases is FALSE?
- (A) Acids are able to produce hydrogen ions in solutions.
 (B) A hydrogen ion attached to water forms a hydronium ion.
 (C) Bases are able to produce hydroxide ions in solution.
 (D) All oxides are basic.
3. The structural formula represents a compound. The IUPAC systematic name for this compound is:

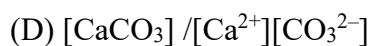
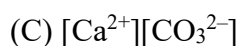
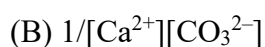
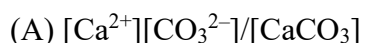


- (A) 3,5-dimethyl-3,5-hexane.
 (B) 2,4-dimethyl-1,3-hexadiene.
 (C) 2-methyl-4-ethyl-1,3-pentadiene.
 (D) 2-ethyl-4-methyl-2,4-pentadiene.

4. Which of following alcohols have been classified correctly?

<i>Names of alcohols and their classification</i>			
	Primary, 1°	Secondary, 2°	Tertiary, 3°
(A)	Propan-1-ol	Pentan-3-ol	2-methylpropan-2-ol
(B)	Butan-2-ol	2-methylpropan-1-ol	2-methylpropan-2-ol
(C)	2,2-dimethylpropan-1-ol	Butan-1,4-diol	Ethanol
(D)	Propan-2-ol	Butan-2-ol	Pentan-3-ol

5. The equilibrium expression for the K_{sp} of CaCO_3 is:



6. For a given weak acid, HA, the numerical value of K_a :

(A) will change with the pH

(B) will change with the temperature

(C) cannot be less than 10^{-7}

(D) cannot be greater than 10^{-7}

7. Which of the following hydrocarbons have the molecular formula $\text{C}_5\text{H}_{10}\text{O}$?

(I) Pentanoic Acid

(II) Pentan-3-ol

(III) Pentanal

(IV) Pentan-3-one

(A) I, II and III.

(B) I, III and IV.

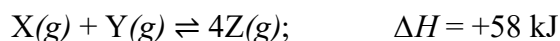
(C) IV only.

(D) III and IV.

8. The purpose of the flame in the flame atomic absorption spectroscopy is to:

- (A) desolvate and atomise the analyte atoms in a sample.
- (B) purify the sample.
- (C) ionise the analyte atoms.
- (D) excite the analyte atoms.

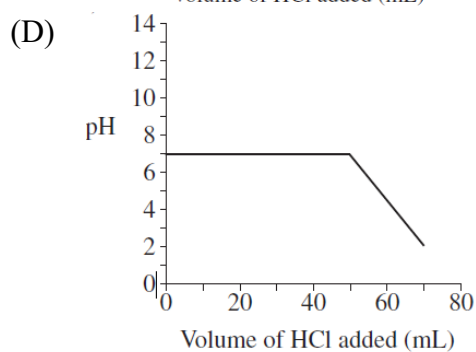
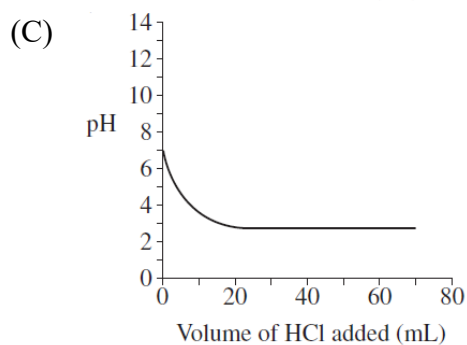
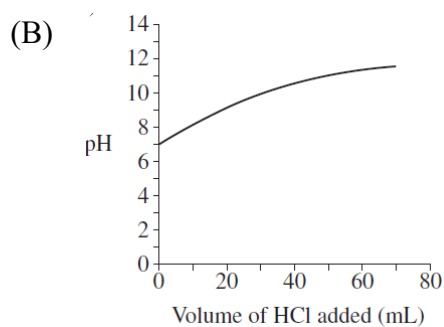
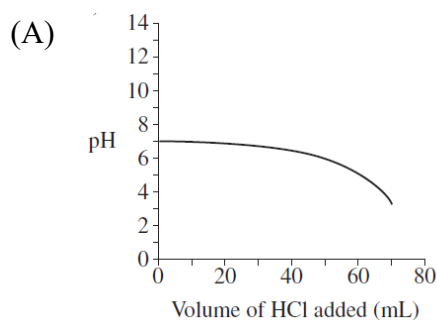
9. The equation describes an equilibrium reaction occurring in a closed system.



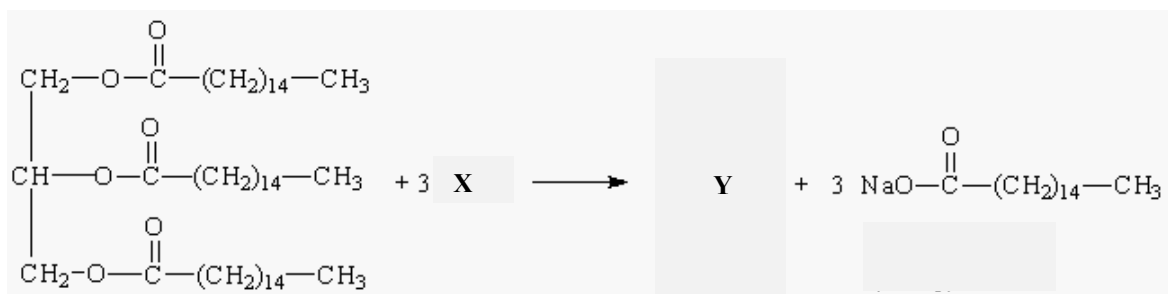
Under which set of conditions would the highest yield of $Z(g)$ be obtained?

	<i>Temperature ($^{\circ}C$)</i>	<i>Pressure (kPa)</i>
(A)	50	100
(B)	50	200
(C)	300	100
(D)	300	200

10. Which of the following graphs shows how pH will vary when dilute HCl is added to 100 mL of dilute natural buffer solution with an initial pH of 7.0?



11. The general equation below represents the saponification reaction for the manufacture of soaps. Identify Reagent X and Product Y.



	Reagent X	Product Y
(A)	sodium hydroxide	glycine
(B)	sodium hydroxide	glycerol
(C)	sodium glyceride	triglyceride
(D)	sodium hydroxide	propan-1,2-diol

12. Which of the following statements regarding mass spectroscopy is incorrect?
- (A) Only cations can be detected by a normal mass spectrometer.
- (B) Molecular ion peaks always have an even-numbered values of mass charge ratio (m/z).
- (C) In a normal mass spectrometer, electron impact causes a molecule to lose an electron and become a molecular radical cation which decomposes into fragment cations and radicals.
- (D) A compound whose molecules contain just one bromine atom shows two molecular peaks of similar intensity, one at +1 and one at -1 of the average m/z value.
13. The solubility product expression for tin (II) hydroxide is:
- (A) $[\text{Sn}^{2+}][\text{OH}^-]$
- (B) $[\text{Sn}^{2+}]^2[\text{OH}^-]$
- (C) $[\text{Sn}^{2+}][\text{OH}^-]^2$
- (D) $[\text{Sn}^{2+}]^3[\text{OH}^-]$

14. Bromine, Br₂, dissolves in unsaturated hydrocarbons and reacts immediately.

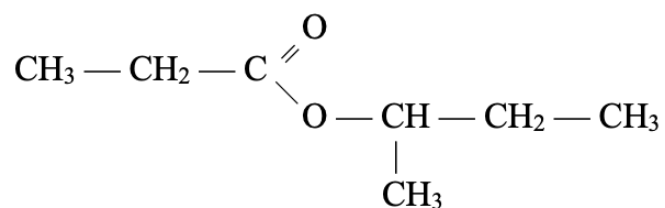
Which of the following is the best description of this process?

- (A) Bromine is polar and reacts by adding bromine atoms across the double bond.
- (B) Bromine is polar and reacts by substituting hydrogen atoms with bromine atoms.
- (C) Bromine is non-polar and reacts by substituting hydrogen atoms with bromine atoms.
- (D) Bromine is non-polar and reacts by adding bromine atoms across the double bond.

15. A student uses their data table to find out that the heat of combustion of 1-propanol is 2021 kJ mol⁻¹. What value would the student calculate for the heat of combustion of 1-propanol in kJ g⁻¹?

- (A) 23.0
- (B) 27.3
- (C) 33.7
- (D) 43.9

16. A compound has the structure shown below:



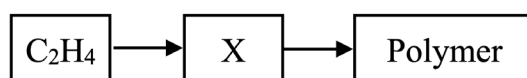
Hydrolysis of this compound will produce:

- (A) butan-2-ol and propanoic acid.
- (B) propan-1-ol and butanoic acid.
- (C) propan-1-ol and 2-methylbutanoic acid.
- (D) butan-1-ol and propanoic acid.

17. Nitric acid completely dissociates in aqueous solutions. 1.0 mL of 10 mol L^{-1} solution was diluted to 1 L with distilled water. 100 mL of this resulting solution was then further diluted to 1 L using distilled water.

What pH is the final solution closest to?

- (A) 1
(B) 2
(C) 3
(D) 4
18. Which of the following compounds is represented by X in the flow chart?



- (A) Cellulose
(B) Styrene
(C) Glucose
(D) Ethanol
19. A student determines the percentage of sodium chloride in a food sample by the following procedure. The food sample is dissolved in water and the chloride ion is precipitated by adding an excess of silver nitrate solution. The precipitate is washed and dried. If the food sample had a mass of 20.0 g and the final precipitate a mass of 0.376 g.

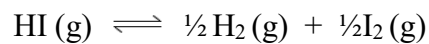
What is the percentage of sodium chloride in the food?

- (A) 0.220%
(B) 0.465%
(C) 0.767%
(D) 1.88%

20. The equilibrium constant for the reaction below has an equilibrium constant K_I .



At the same conditions of temperature and pressure, what is the equilibrium constant for the reaction:



- (A) 0.00629
- (B) 0.0793
- (C) 12.6
- (D) 79.5

Chemistry

2019 TRIAL EXAMINATION

Section II – Booklet A

80 marks

Attempt Questions 21-37

Allow about 2 hour and 25 minutes for this part

Answer the questions in the spaces provided.

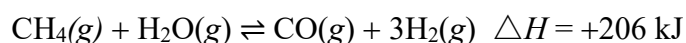
Show all relevant working in questions involving calculations.

Question 21 (3 marks)

Consider the following mixture of gases in a closed 3.0L vessel at 730°C.

<i>Gas</i>	<i>Quantity (mol)</i>
CH ₄	2.00
H ₂ O	1.25
CO	0.75
H ₂	0.75

The following reaction occurs:



The equilibrium constant, K , is 0.26 at 1003K.

Determine whether the system is at equilibrium.

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Question 22 (2 marks)

Models are often used to help explain complex concepts.

You performed a first-hand investigation to model a dynamic equilibrium reaction.

Outline the procedure used and the results you obtained.

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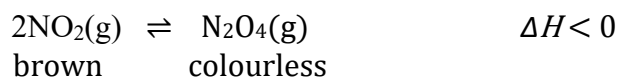
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Question 23 (8 marks)

A student is investigating the following reaction system.



The reaction system can be observed in a sealed test tube, which allows the student to investigate the impact of temperature on the equilibrium position of the reaction.

- (a) State the colour change expected when the student places the sealed test tube of the gas mixture in a beaker of hot water. Explain why this colour change occurs.

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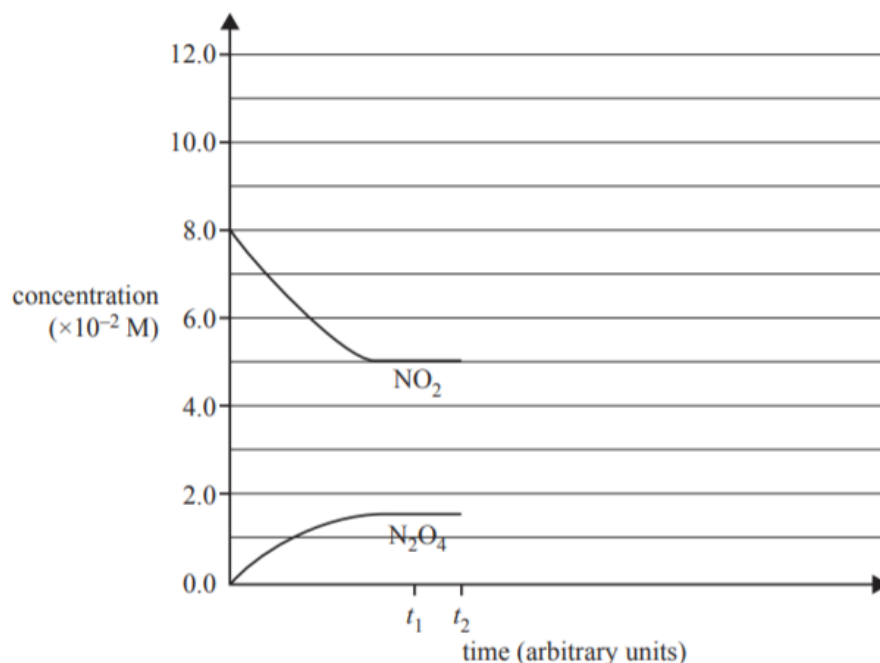
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- (b) Below is the concentration versus time graph for the reaction system. The graph was produced using secondary data at a temperature of 22°C.



Time t_1 is shown on the graph above.

- i) Calculate the equilibrium constant at time t_1 .

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At time t_2 the volume of the system was halved, keeping the temperature at 22°C.

- ii)

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Continue the graph to show how this change would affect the reaction system and how the system would respond to this change until equilibrium was restored. Exact concentration of the gases at the new equilibrium are not required.

Question 24 (7 marks)

- (a) Lead (II) chloride is sparingly soluble in water, and this equilibrium is set up between the solid and its ions in solution. Calculate the concentration of Pb^{2+} and Cl^- in the solution at 25°C .

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- (b) Calculate and compare the solubility of the lead chloride when dissolved in 0.25 mol L^{-1} of NaCl .

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Question 25 (4 marks)

A green solution was made containing a weak acid, HA (which is a yellow molecule) and its conjugate base, A^- (which is blue).

- (a) Write an equation for the reaction which occurs when a strong base such as sodium hydroxide is added to this solution. **1**

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- (b) Write an equation for the reaction which occurs when a strong acid such as hydrochloric acid is added to this solution. **1**

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- (c) Use your equations from part (a) and (b) to explain why this solution can act as an indicator. **2**

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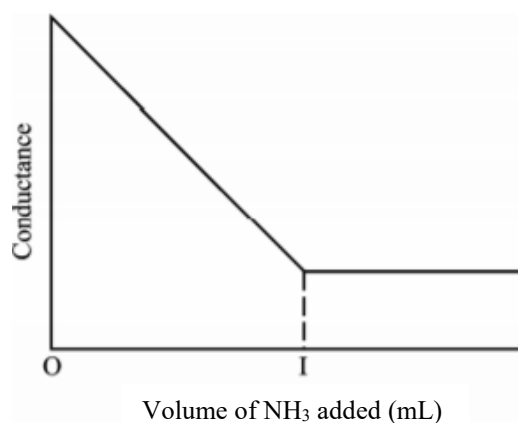
Question 26 (3 marks)

Outline the differences between condensation and addition polymerisation, using an example of each polymerisation process, **3**

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Question 27 (4 marks)

The figure below shows the conductivity graph for a reaction between sulfuric acid and ammonia solution.



- (a) What does the point labelled “ I ” on the x-axis signify? 1

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- (b) Explain the shape of the conductivity curve. 3

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Question 28 (4 marks)

Calculate the pOH of 0.20 M H_2CO_3 . ($K_a = 4.3 \times 10^{-7}$).

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Student Number:

SYDNEY BOYS HIGH SCHOOL
CHEMISTRY
2019 TRIAL HSC EXAMINATION

Section II - Booklet B
Answer questions 30-35

Part B Total:

Question 31 (5 marks)

During a school camp, a student uses a spirit burner which contains C_2H_5OH as a source of energy to boil his drinking water.

- (a) Write a balanced equation for the complete combustion of ethanol. **1**

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- (b) Calculate the amount of energy released when 1.0 g of ethanol is completely burnt in excess oxygen. Assume the enthalpy of combustion of ethanol is 1364 kJ mol^{-1} . **1**

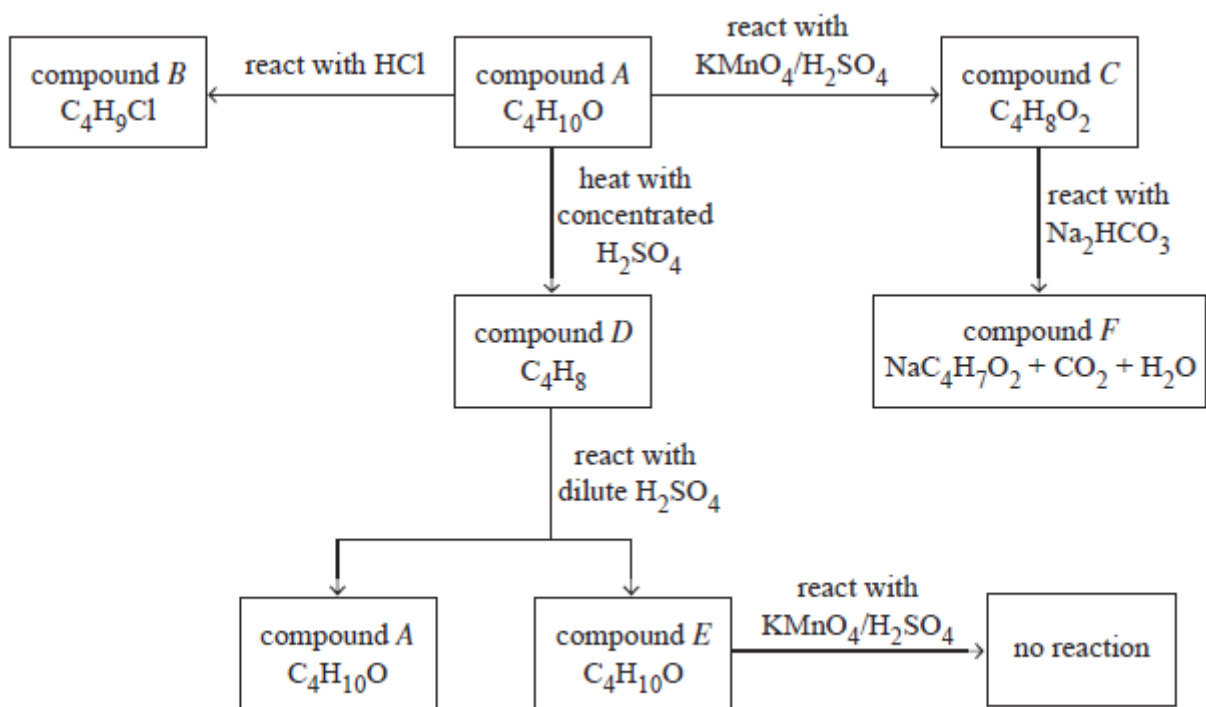
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- (c) A camping stove that uses ethanol as its fuel source heats a kettle containing 950 ml of water at 12°C . What mass of ethanol must be burnt to heat the water to its normal boiling temperature? Assume only 40% of the energy provided by the combustion reaction of the ethanol is used to heat the water. **3**

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Question 32 (7 marks)

The flow chart shows the reactions of six different organic compounds.



- (a) Complete the table by drawing the structural formulae for the compounds and justifying your answers with reference to the information provided.

6

<i>Compound</i>	<i>Structural formula</i>	<i>Justification</i>
Compound A $C_4H_{10}O$		
Compound B C_4H_9Cl		

Question 32 continues on page 23

Question 32 Continued

<i>Compound</i>	<i>Structural formula</i>	<i>Justification</i>
Compound C $C_4H_8O_2$		
Compound D C_4H_8		
Compound E $C_4H_{10}O$		
Compound F $NaC_4H_7O_2$		

(b) Identify the systematic name of compound E.

1

Compound E:.....

Question 33 (9 marks)

An unknown organic compound with a molecular formula $C_4H_8O_2$ was supplied to a laboratory spectroscopist for identification.

An infrared absorption spectrum (Image A), mass spectrum (Image B) and a C-13 NMR spectra (Image C) for the compound were produced.

These are shown below.

Image A

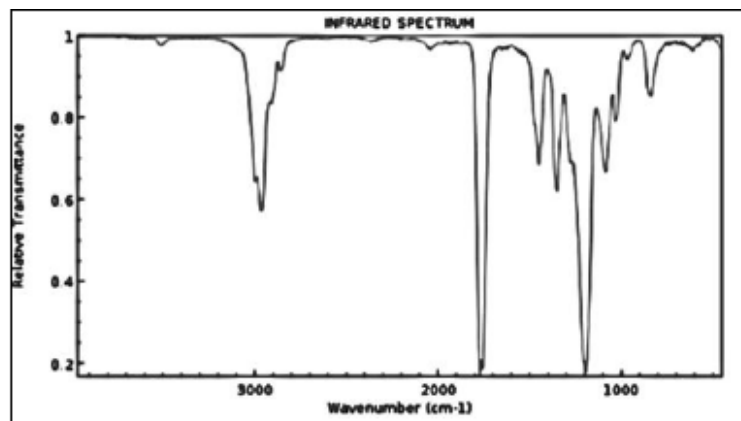


Image B

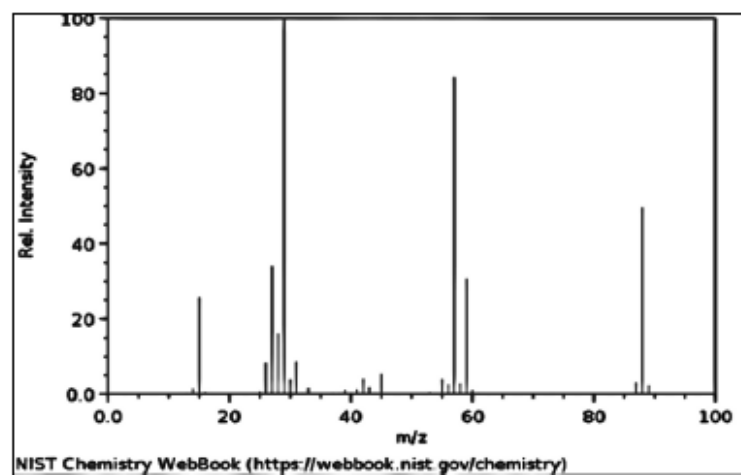
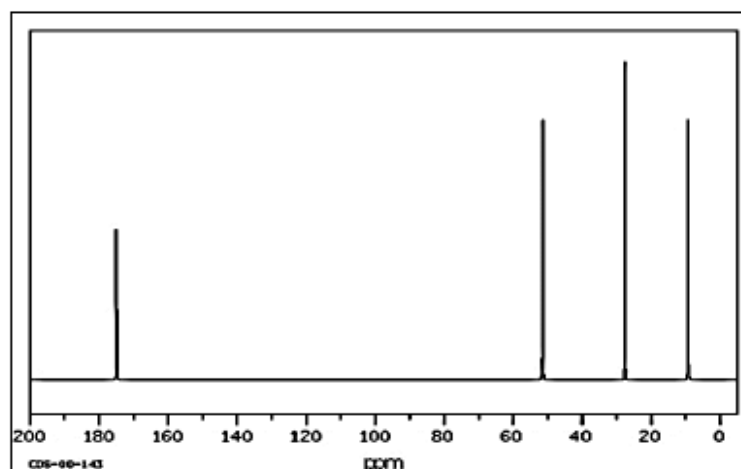


Image C



Question 33 continues on page 25

Question 33 (continued)

The analytical chemist concluded that the compound was *methyl propanoate* using various characteristics of each spectra produced in the analysis.

- (a) Draw the structural formula of methyl propanoate in the box below

1

- (b) Complete the table below and explain how information from each spectrum supports the conclusion that the compound is methyl propanoate.

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Spectroscopic technique	Information from spectrum which supports the identification as methyl propanoate
IR spectra	
Mass spectra	
C-13 Nuclear Magnetic Resonance Spectra	

Question 33 (continued)

- (c) A sample of the same compound was decomposed into its constituent elements and found to contain 54.5% carbon, 9.1% hydrogen, the remainder being oxygen, by mass.

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Does this data support the chemist's conclusion that the compound is methyl propanoate? Justify your answer.

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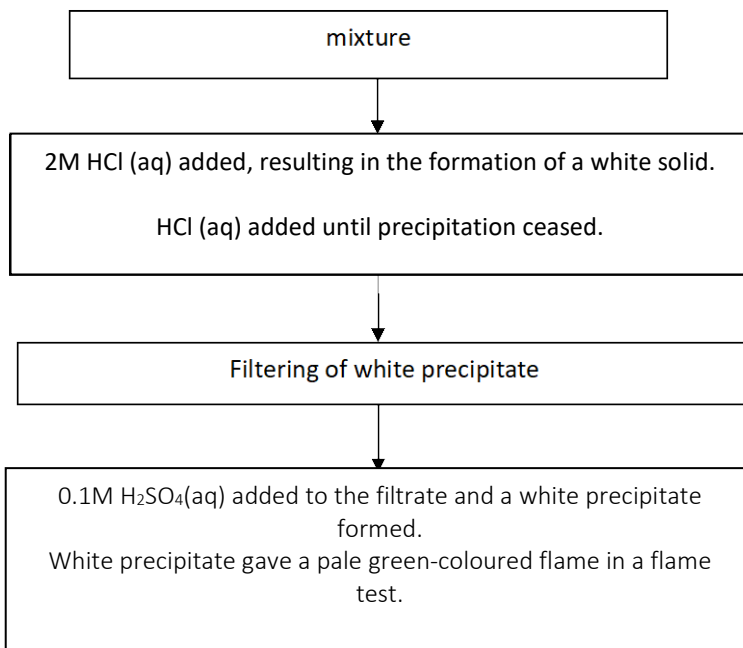
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Section II continues on page 27

Question 34 (5 marks)

An aqueous solution was known to contain two of the following cations: Ca^{2+} ; Ba^{2+} ; Cu^{2+} ; Pb^{2+} ; Fe^{2+} .

The procedure a student used to identify the two cations is shown in the following flowchart.



(a) Identify the cation responsible for the white precipitate formed upon addition of HCl.

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(b) Write a net ionic equation for the reaction which produced the white precipitate upon addition of H_2SO_4 .

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(c) Justify the procedure used to identify the two unknown cations.

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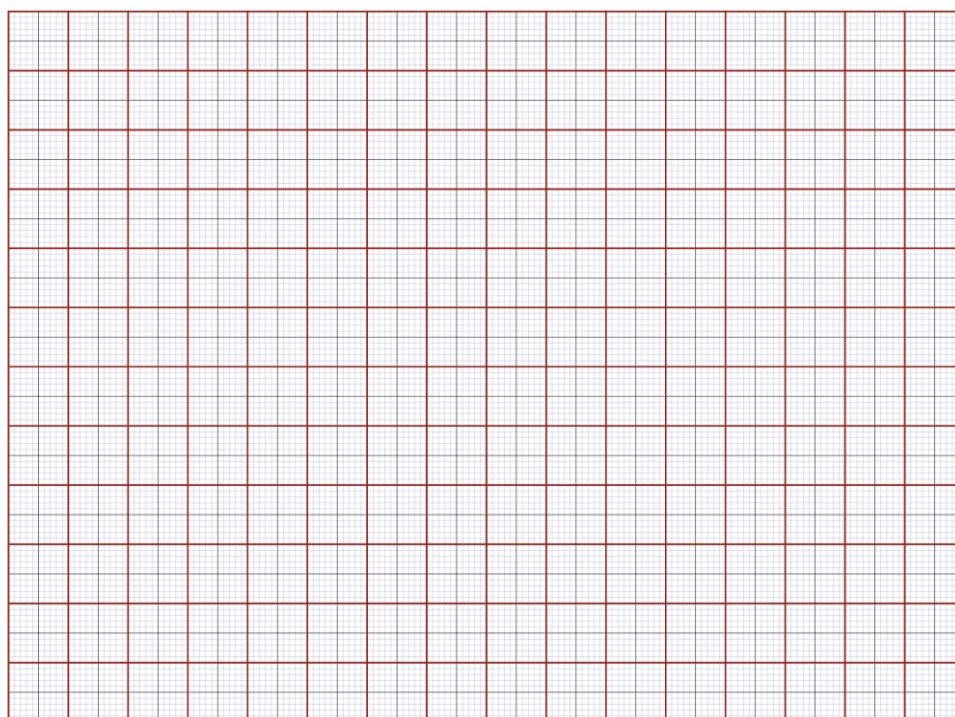
Question 35 (6 marks)

In monitoring the effect of discharge effluent on river quality, a chemist uses *atomic absorption spectroscopy* to compare the sodium ion concentrations above and below the discharge point in the Lachlan River. The table below shows the absorption values at a wavelength of 589 nm, for water samples, and also for a range of standard solutions.

<i>Solution</i>	<i>Na⁺ concentration (mg L⁻¹)</i>	<i>Absorbance at 589 nm (%)</i>
Standard	10	16
Standard	20	34
Standard	40	63
Standard	60	98
Up river sample 1		4
Up river sample 2		5
Down river sample 1		54
Down river sample 2		43

- (a) Plot the standards on the grid below. (Label axes)

3



- (b) Complete the entries for Na⁺ concentrations of water samples **in the table above**.

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Question 35 continues on page 29

Question 35 (continued)

- (c) Assess the downstream water quality for the fresh water organisms, considering the tolerance limit for sodium ion concentration is 100 ppm. **1**

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End of Section II

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