Student Number _____

Caringbah High School
Chemistry: HSC Course
Trial 2022

General Instructions

- *Reading time – 5 minutes*
- *Working time – 3 hours*
- *Write using black or blue pen*
- *Draw diagrams and graphs using pencil*
- *NESA approved calculators may be used*

This paper has two parts, Part A and Part B

***Part A** – 20 marks*
- *Attempt Questions 1-20*
- *Allow about 35 minutes for this part*

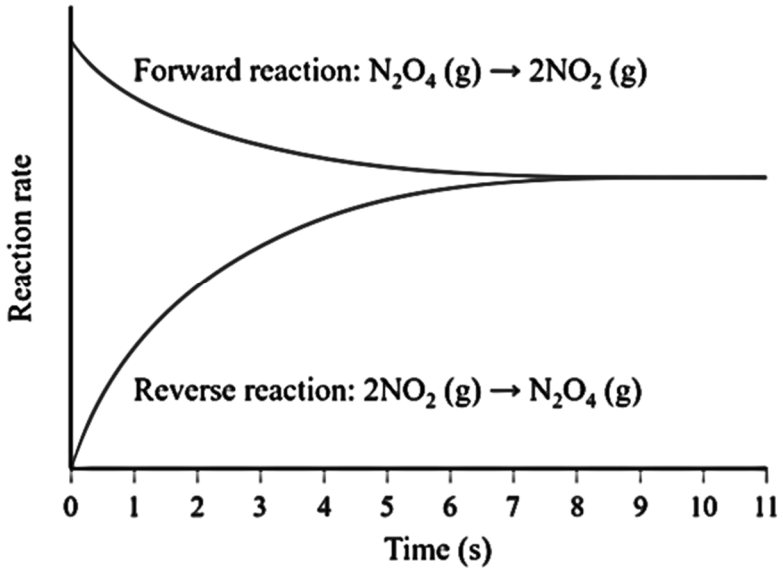
***Part B** – 80 marks*
- *Attempt Questions 21-32*
- *Allow about 2 hour and 25 minutes for this part*

Total marks: 100

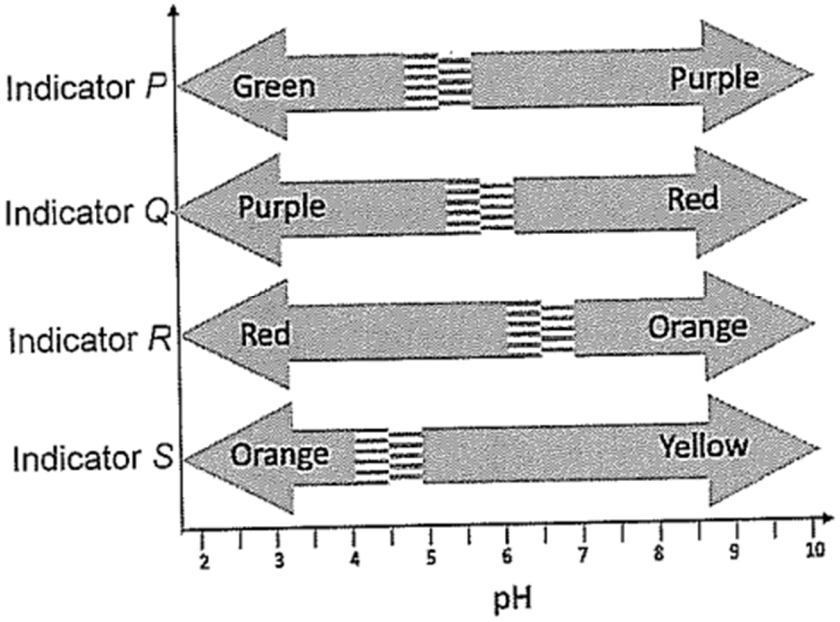
Task Prepared by: K. Wynne

OUTCOME	*MARK*
Knowledge and Understanding	*/81*
Working Scientifically *Q3, 5, 13, 16, 18, 19, 20, 23, 30*	*/19*
Total	*/100*

PART A: Circle the letter of the BEST answer on the grid (20 marks)

1.	Identify the conjugate base of the hydronium ion. A. H_2O B. H_3O^+ C. OH^- D. O^{2-}	
2.	Which of the following compounds has the highest molar solubility in water at 25°C? A. $BaCO_3$ B. $Mg_3(PO_4)_2$ C. $Pb(OH)_2$ D. $CaSO_4$	
3.	The graph below shows how the rates of the forward and reverse reactions, as shown by the balanced equations on the graph, change over time.  Which of the following statements, from the data shown, is correct? A. At equilibrium, the reverse reaction proceeds at its maximum rate. B. After 10 s, the concentration of $NO_{2\,(g)}$ would be double that of $N_2O_{4\,(g)}$. C. The pressure in the reaction vessel would decrease over the first 10 seconds. D. After 10 s, any chemical reactions between the gases in the vessel have ceased.	

4. The graph shows the change in colour of four different indicators over a pH range of 2 to 10.



An unknown solution is tested with indicator P, which turns purple. A fresh sample is tested with indicator R, which turns red.

The likely pH of the unknown solution is:

A. 5

B. 6

C. 7

D. 8

5. Consider the compound represented by the following formula: $CH_3CH_2CONH_2$

What is the name of this compound?

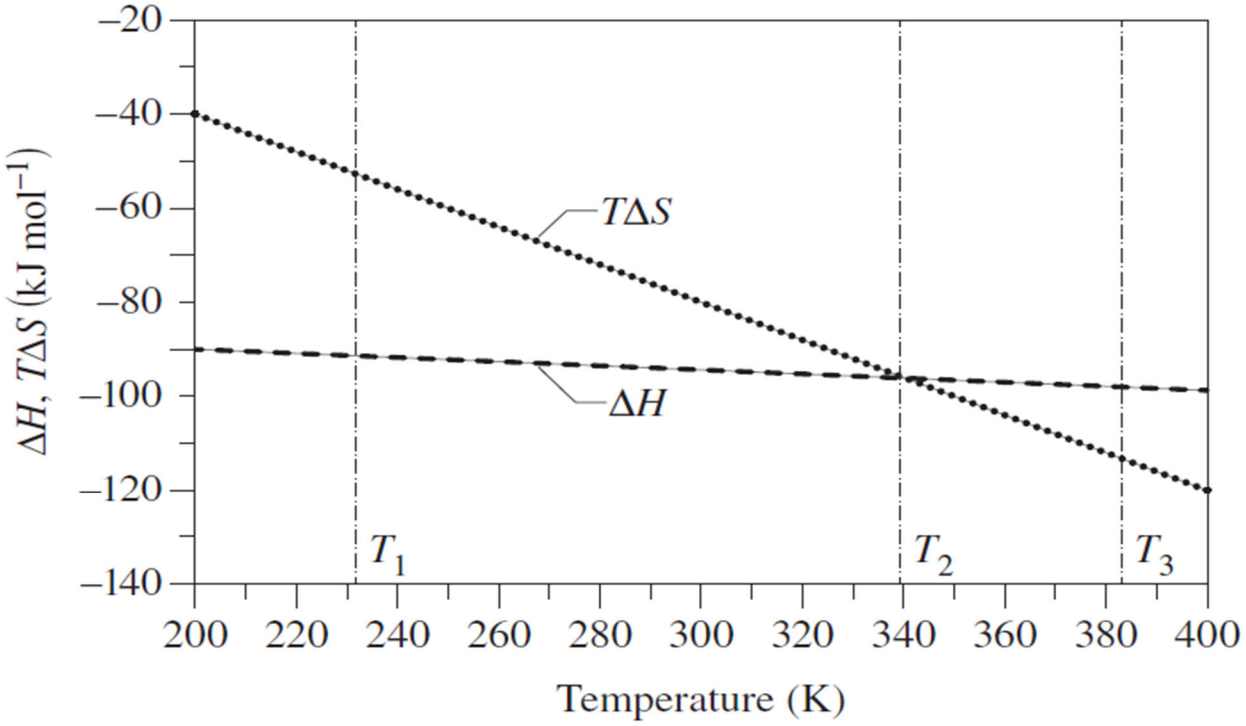
A. 1-propylamine

B. Propanoic acid

C. Propanoic amine

D. Propanamide

6. The graph below shows the relationship between ΔH, TΔS and temperature in a chemical system.



At T_1 the ΔG for the reaction is

A. +20 $kJmol^{-1}$

B. 0 $kJmol^{-1}$

C. -20 $kJmol^{-1}$

D. -40 $kJmol^{-1}$

7. Methane gas was reacted with oxygen in a closed container until the following equilibrium was achieved.

$$2CH_{4(g)} + O_{2(g)} \rightleftharpoons 2CO_{(g)} + 4H_{2(g)} \qquad \Delta H = -76kJ$$

Which alternative correctly predicts how the quantity of hydrogen gas could be increased?

A. Using a catalyst.

B. Decreasing the pressure of the system.

C. Increasing the temperature of the system.

D. Changing the equilibrium constant for the reaction by reducing the methane concentration.

8. Ethanol is an alternative fuel to petrol. The statement below relates to the use of ethanol and petrol as fuel.

I. Ethanol releases more energy per gram when completely combusted than petrol.

II. Ethanol releases less CO_2 per mole of fuel combusted than petrol.

III. Ethanol is less likely to undergo incomplete combustion than petrol.

IV. Ethanol can be produced from non-fossil fuel resources.

Which of the above statements correctly compares ethanol to petrol when used as a fuel?

A. All statements are correct

B. I and II only

C. I, III and IV only

D. II, III and IV only

9. Cloudy ammonia is an ingredient of some household cleaners. It forms an equilibrium mixture when dissolved in water, as shown in the equation below.

$$NH_{3\,(aq)} + H_2O_{\,(l)} \rightleftharpoons NH_4^{+}{}_{(aq)} + OH^{-}{}_{(aq)}$$

Which of the following is the equilibrium expression for the forward reaction?

A. $\dfrac{[NH_4^+][OH^-]}{[NH_3]}$

B. $\dfrac{[NH_4]}{[NH_3^+][OH^-]}$

C. $\dfrac{[NH_3][OH^-]}{[NH_4^+]}$

D. $\dfrac{[NH_3]}{[NH_4^+][OH^-]}$

10. Which of the following statements best explains the cleaning action of soap?

A. The polar head group forms dispersion forces with oils and fats and the non-polar tail group forms hydrogen bonds with water.

B. The non-polar tail group forms dispersion forces with oil and fats, as well as forming dipole–dipole forces with water.

C. The polar head group forms dipole–dipole forces with oil, fats and water.

D. The polar head group forms ion–dipole forces with water and the non-polar tail group forms dispersion forces with oil and fats.

11. Which of the following is correct about the laboratory production of alcohol by the process of fermentation?

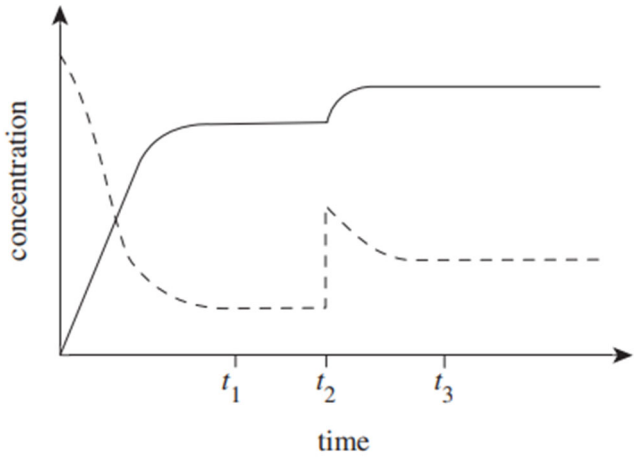
	Requires Oxygen	Produces oxygen	Suitable temperature (°C)
A.	Yes	No	60
B.	No	Yes	60
C.	No	No	30
D.	Yes	No	30

12. A chemist synthesises a substance using the following pathway

What are compounds X, Y and Z?

	X	Y	Z
A.	Propane	Propan-1-ol	Propan-2-one
B.	Propane	Propan-1-ol	Propanoic acid
C.	Prop-1-ene	Propan-2-ol	Propan-2-one
D.	Prop-1-ene	Propan-2-ol	Propanoic acid

13. The graph shows the progress of an equilibrium reaction (reactants ⇋ products)

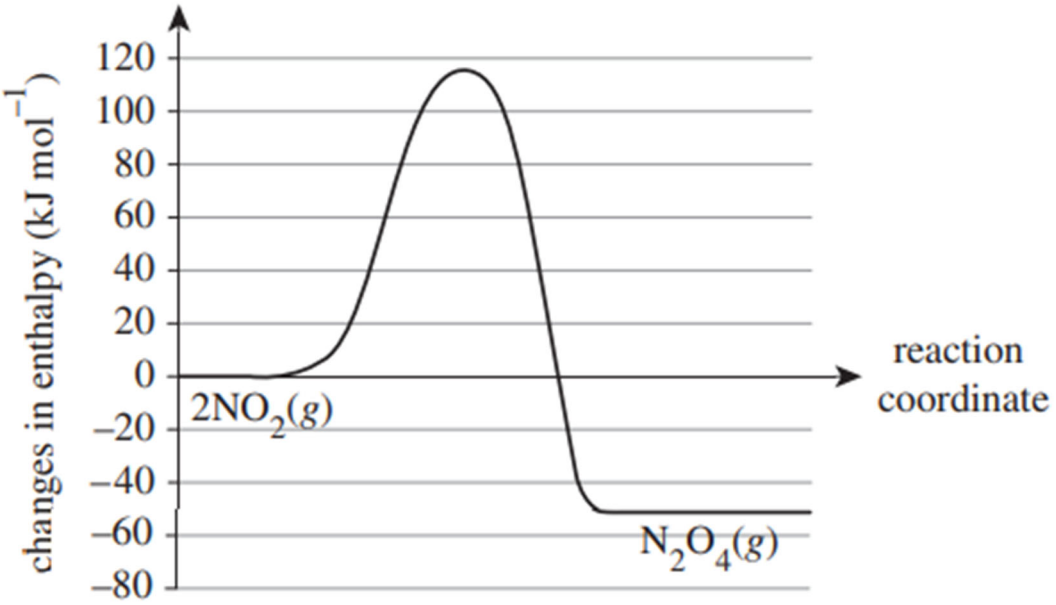


Which row of the table correctly identifies what is happening at t_1, t_2 and t_3?

	t_1	t_2	t_3
A.	At equilibrium	Reactants added	New equilibrium position
B.	At equilibrium	Products added	New equilibrium position
C.	No reaction occurring	Reaction proceeding	Reaction occurring
D.	Only forward reaction occurring	Forward and reverse reactions occurring	Only reverse reaction occurring

14. Below is the energy profile for the equilibrium reaction:

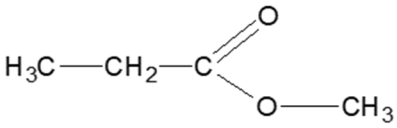
$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$



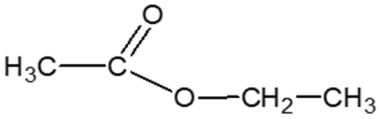
The activation energies of the forward and reverse direction are

	Forward activation energy (kJ mol^{-1})	Reverse activation energy (kJ mol^{-1})
A	50	116
B	116	50
C	116	176
D	176	116

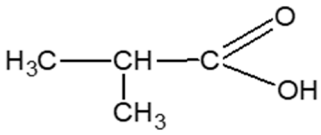
15. The structural formulae of five organic compounds, labelled A-E, are shown below.



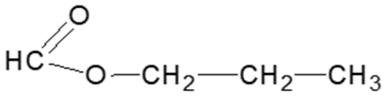
A



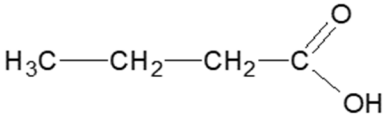
B



C



D



E

Which alternative below identifies a pair of these compounds as examples of each type of isomer?

	Functional group isomers	Position isomers
A.	C and E	B and D
B.	C and D	A and B
C.	A and B	A and B
D.	B and E	B and C

16. Alcohols can be produced in many ways. Which method identified below requires the use of a dilute acid catalyst to yield alcohol?

A. Substitution of a halogenated hydrocarbon with hydroxide ion

B. Substitution of a halogenated hydrocarbon with water

C. Fermentation of glucose by yeast

D. Hydration of an alkene

17. Consider the equation below:

$$N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$$

K_{eq} for this equation is 0.48 at 100°C

In an experiment it was found that the concentration of $N_2O_4(g)$ was 0.20 mol L^{-1}. Calculate the concentration of the $NO_2(g)$ in this equilibrium mixture.

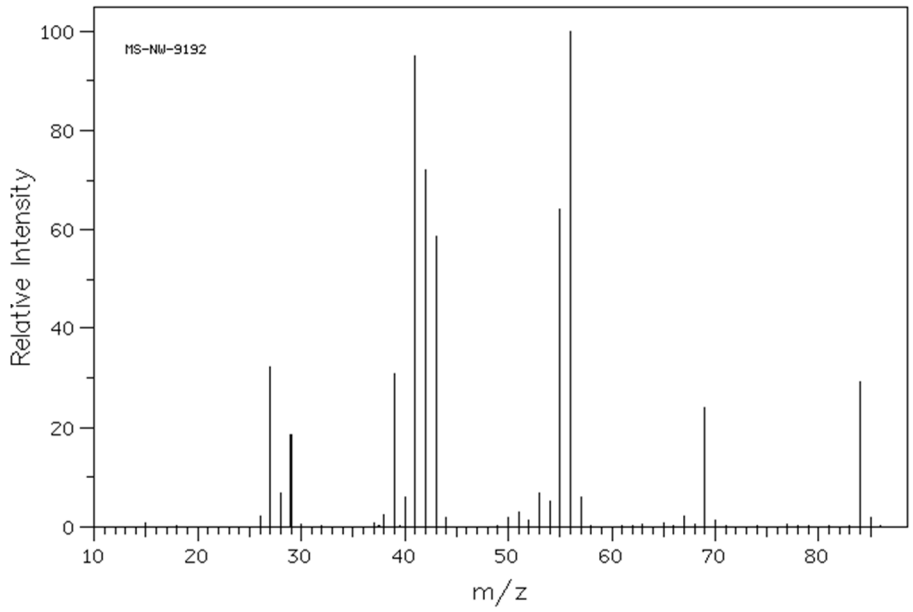
A. 0.10 mol L^{-1}

B. 0.31 mol L^{-1}

C. 0.096 mol L^{-1}

D. 3.23 mol L^{-1}

18. Compound X has the general formula of C_nH_{2n} . Below is the mass spectra for compound X.



Compound X is

A. Methane

B. But-1-ene

C. Hex-1-ene

D. 2,2-dimethylbutane

19. The following incomplete equation describes the oxidation of ethanol to ethanoic acid by potassium permanganate. All coefficients shown are correct, but the coefficient for ethanoic acid has been replaced by the letter "X".

$$3C_2H_5OH_{(l)} + 4KMnO_{4(aq)} \rightarrow X\ CH_3COOH_{(l)} + 4MnO_{2(s)} + 4KOH_{(aq)} + H_2O_{(l)}$$

In a reaction carried out by a chemist, 5.0 g of ethanol yields 5.9 g of ethanoic acid.
What is the percentage yield for the above reaction, as predicted by the correctly balanced equation?

A. 45%

B. 77%

C. 85%

D. 91%

20. A quantity of solid silver nitrate is added to 150.0 mL of 0.120 mol L^{-1} potassium sulfate at 25˚ to produce a precipitate. What mass of silver nitrate is required to cause precipitation to start?

A. 0.0015 g

B. 0.028 g

C. 0.254 g

D. 0.465 g

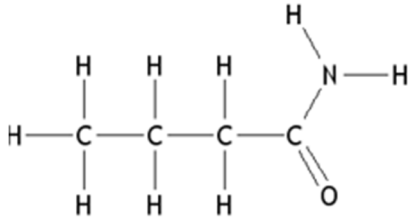
PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

Do NOT detach this page from the rest of the exam.

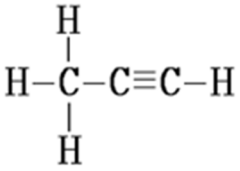
1	**A B C D**	**11**	**A B C D**
2	**A B C D**	**12**	**A B C D**
3	**A B C D**	**13**	**A B C D**
4	**A B C D**	**14**	**A B C D**
5	**A B C D**	**15**	**A B C D**
6	**A B C D**	**16**	**A B C D**
7	**A B C D**	**17**	**A B C D**
8	**A B C D**	**18**	**A B C D**
9	**A B C D**	**19**	**A B C D**
10	**A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

PART B: Longer Answers

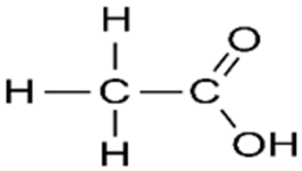
21. a) Using IUPAC nomenclature, name the compounds shown below. **3**



Compound 1



Compound 2



Compound 3

Compound 1: ……..

Compound 2: ……

Compound 3: ……

b) Predict the order of boiling points (lowest to highest) of these molecules. **1**

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c) Explain your prediction. **3**

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22. When ammonia gas (NH_3) is bubbled through water that contains a few drops of phenolphthalein indicator, the water turns pink.

Explain how the Brønsted-Lowry theory of acids and bases can account for this observation. Support your response with a chemical equation. **3**

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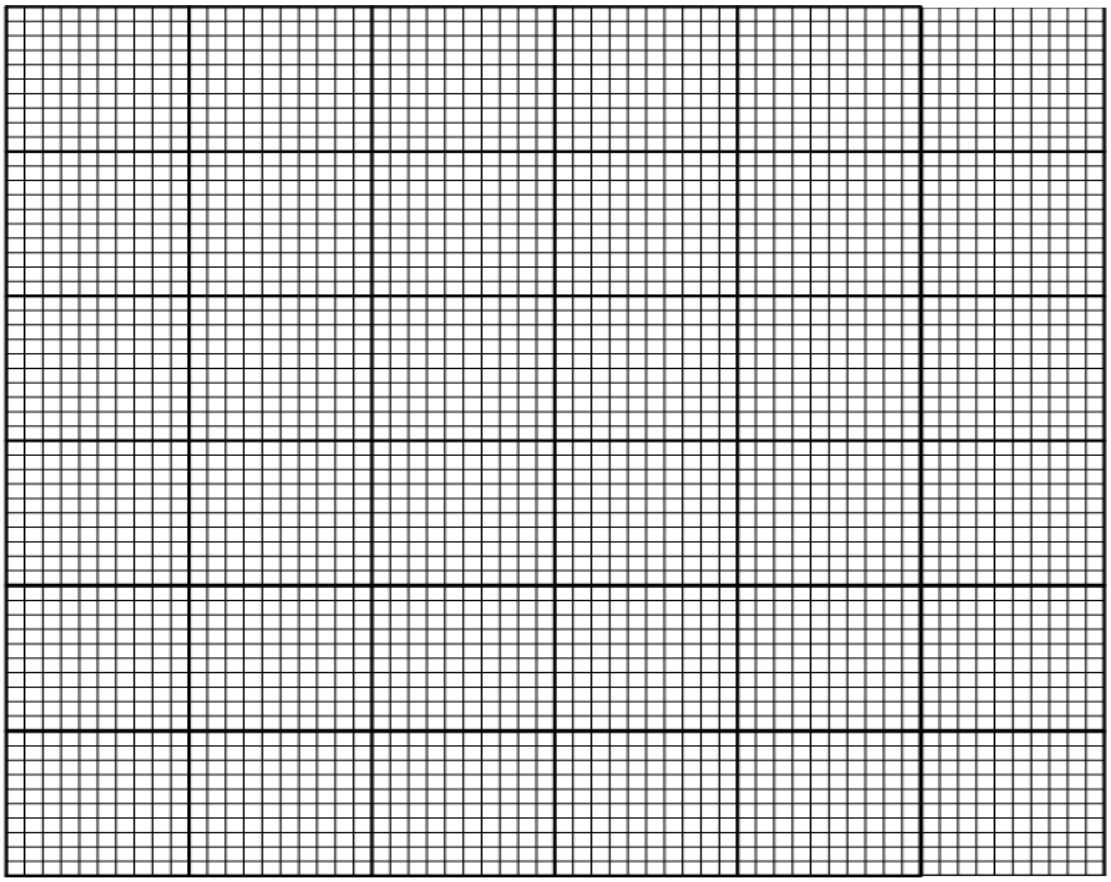
23. A colourimeter with an orange filter was used to analyse the concentration of copper ions in a solution.

To calibrate the colourimeter, a distilled water blank and five standards of Cu^{2+} were prepared. Their absorbances were measured according to the table below.

Concentration (mol L^{-1})	**Absorbance**
0.0000	0.00
0.0005	0.10
0.0010	0.19
0.0020	0.35
0.0025	0.43
0.0030	0.51

a) Graph the calibration curve on the grid below. **4**



b) A 20.0 mL sample of a copper solution of unknown concentration was diluted to a total of volume of 80.0 mL. When analysed with the colorimeter this diluted solution recorded an absorbance of 0.46. **4**

What is the concentration of the copper ions contained in the 20.0 mL sample in ppm?

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24. Initially a 2.00 L vessel contains a mixture of 1.00mol of colourless hydrogen gas and 1.00 mol of purple iodine gas. The gases react as follows:

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)} \qquad \Delta H = +26 \text{ kJ mol}^{-1}$$

A chemical analyst is monitoring the equilibrium system. At 400˚C equilibrium is reached and the concentration of colourless hydrogen iodide gas is found to be 0.760 mol L^{-1}.

a) Describe how the analyst would qualitatively know the system has reached equilibrium. **1**

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b) Calculate the equilibrium constant for this reaction. **4**

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c) Describe what the calculated equilibrium constant from part b indicates about the reaction. **1**

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d) Using Le Châtelier's principle, explain what would happen to the equilibrium if the temperature was increased, with all other conditions remaining the same. **3**

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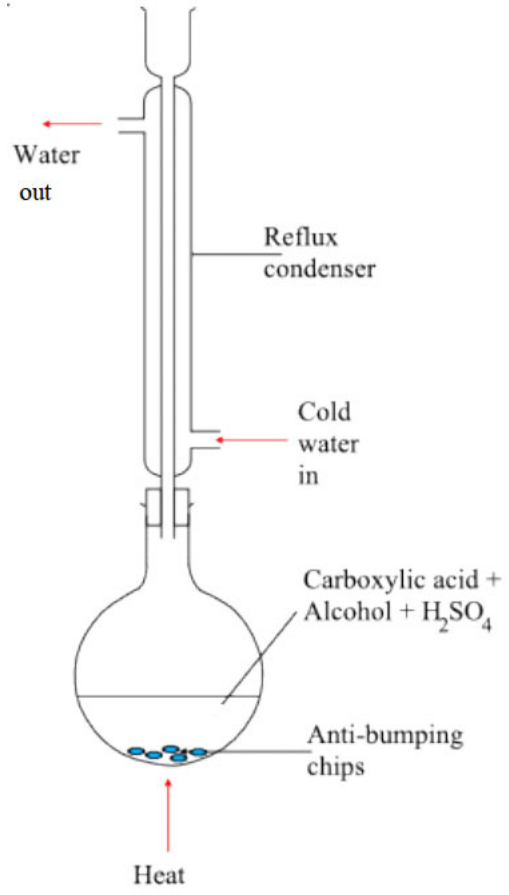
25.	A student in a school laboratory performed a reaction using methanoic acid and pentan-1-ol. a) Draw (using full structural formula) and name the products of the reaction between methanoic acid and pentan-1-ol. The student used the following method to perform the reaction. 1. 10 mL of pentan-1-ol and 12 mL of methanoic acid were added to a 50 mL round bottomed flask. 2. 1mL of concentrated sulfuric acid was added to the flask. 3. The mixture was heated under reflux (apparatus shown below) for 30 minutes.  	**3**

b) Justify this procedure to efficiently produce this ester in a school laboratory. **6**

26. a) Write a balanced chemical equation for the complete combustion of butan-1-ol. **1**

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b) Theoretically, how much heat is released when 1.00 g of butan-1-ol is combusted? The molar heat of combustion of butan-1-ol is -2676 kJ mol^{-1} **2**

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c) Experimentally, 40% of the heat is lost to the environment. If 100mL of water, initially at 25˚C, was heated by the burning of 1.00g of butan-1-ol, what is the final temperature of the water? **3**

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d) The combustion of butan-1-ol is considered a non-equilibrium system. **3**

Discuss why this is a non-equilibrium system with reference to enthalpy and entropy.

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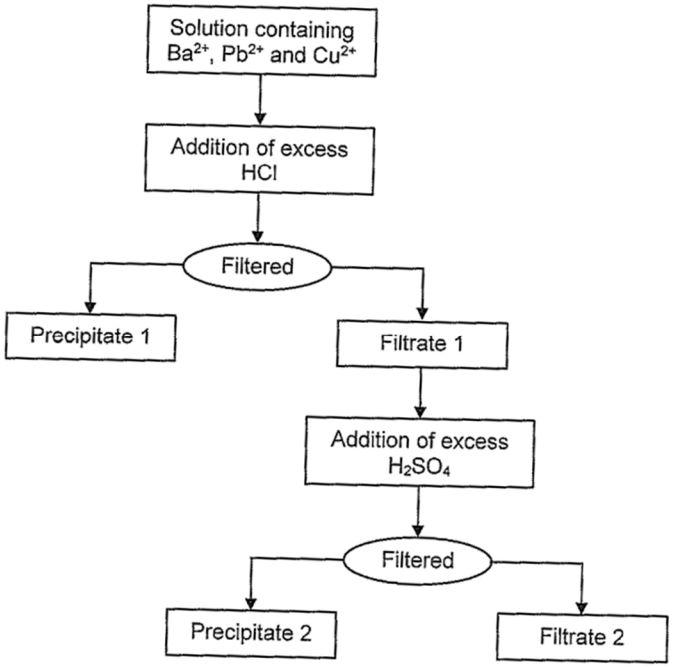
27. A solution contains three cations – barium, lead and copper. The flow chart below indicates the steps used to confirm the identity of these cations.



a) Identify precipitate 1 **1**

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b) Explain why HNO_3 is an inappropriate choice for the first step. **1**

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c) Write a net ionic equation that represents the formation of precipitate 2. **2**

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d) What colour would you expect filtrate 2 to be? **1**

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e) Describe an additional test you could conduct, and the expected results, that would confirm the identity of the cation in filtrate 2. **2**

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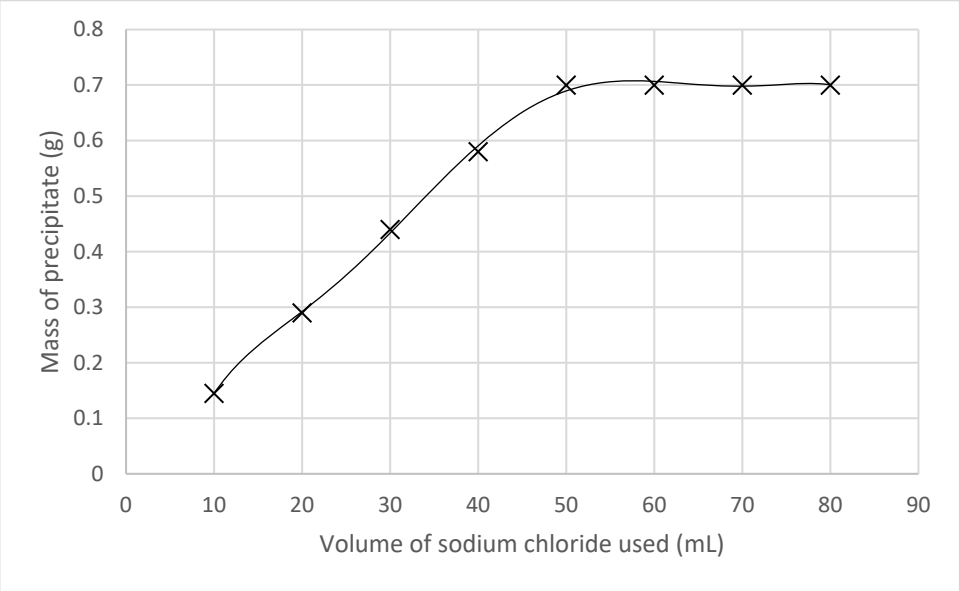
28.	The Gunwinggu people of Arnhem Land eat the roots of a bitter yam plant, which contains toxic salts called oxalates. Using this, or another example, identify at least two steps used in the preparation of these foods and outline how these steps demonstrate chemical principles to make the food safe to eat. …… …… …… …… …… …… …… ……	**3**
29.	Using the data provided on the data sheet, quantitatively and qualitatively compare the solubility of silver chloride in water with its solubility in a 0.10 mol L^{-1} solution of sodium chloride, at 25°C. …… …… …… …… …… …… …… …… …… …… …… …… ……	**4**

30. A chemist was investigating mass and concentration relationships between sodium chloride and silver nitrate. Different volumes of sodium chloride solution were reacted with separate 50mL samples of silver nitrate solution. After each reaction the silver chloride precipitate was filtered, dried and weighed. The relationship between volume of sodium chloride used and the mass of the precipitate formed is shown in the graph below.



a) Explain the shape of the graph from 50mL to 80mL of sodium chloride used. **2**

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b) Calculate the concentration of the silver nitrate solution in mol L^{-1}. **3**

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31.

Two differently coloured complex ions of cobalt (II), $[Co(H_2O)_6]^{2+}$ (pink) and $[CoCl_4]^{2-}$ (blue), exist in equilibrium in solution when chloride ions are present. The equilibrium is represented by the equation below.

$$[Co(H_2O)_6]^{2+}_{(aq)} + 4Cl^-_{(aq)} \rightleftharpoons [CoCl_4]^{2-}_{(aq)} + 6H_2O_{(l)}$$

pink blue

a) Recount how you tested the reversibility of this equilibrium in class. **2**

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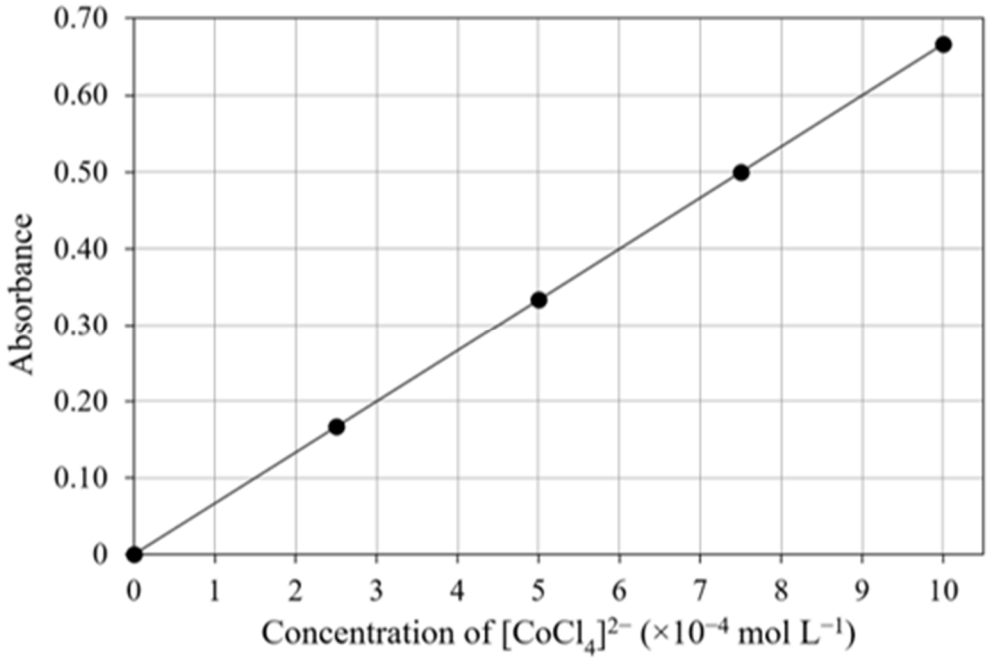
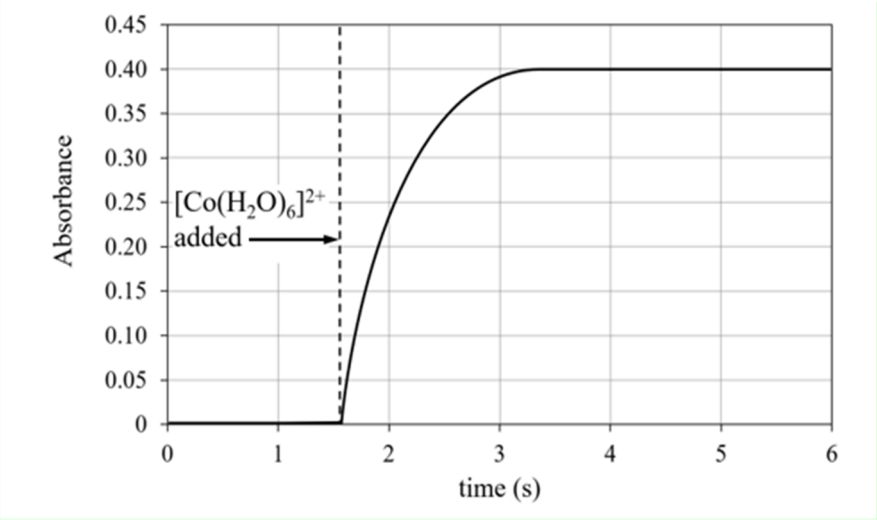
Various concentrations of $[CoCl_4]^{2-}$ were placed in a cuvette. A UV-Vis spectrometer tuned to a blue wavelength recorded the following calibration graph.



An identical cuvette was filled with an aqueous 0.9900 mol L^{-1} sodium chloride solution and placed in the UV-Vis spectrometer. Note: Sodium ions play no part in this equilibrium. The spectrometer continuously recorded the absorbance at the same blue wavelength. The temperature was held constant.

After about 1.6 seconds, $[Co(H_2O)_6]^{2+}$ was added so that the initial concentration in the cuvette was 0.3600 mol L^{-1}. The results are shown on the graph below.



b) Account for the use of sodium chloride solution in the cuvette. **2**

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c) Calculate K_{eq} for the cobalt (II) complex equilibrium reaction. **4**

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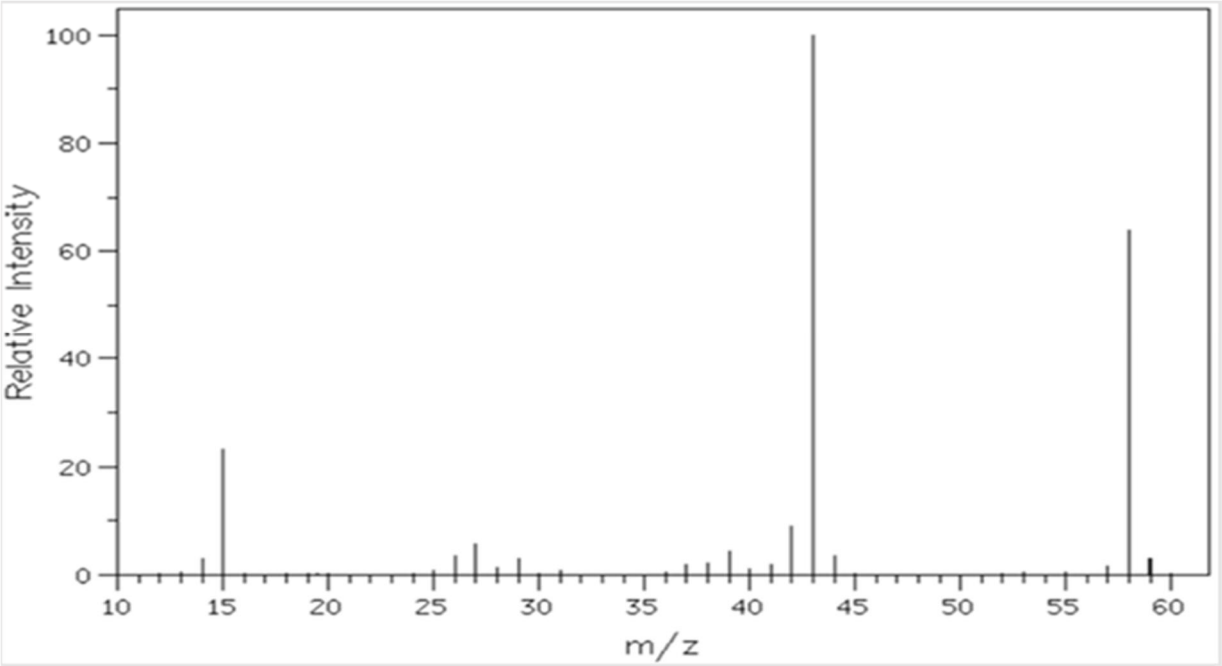
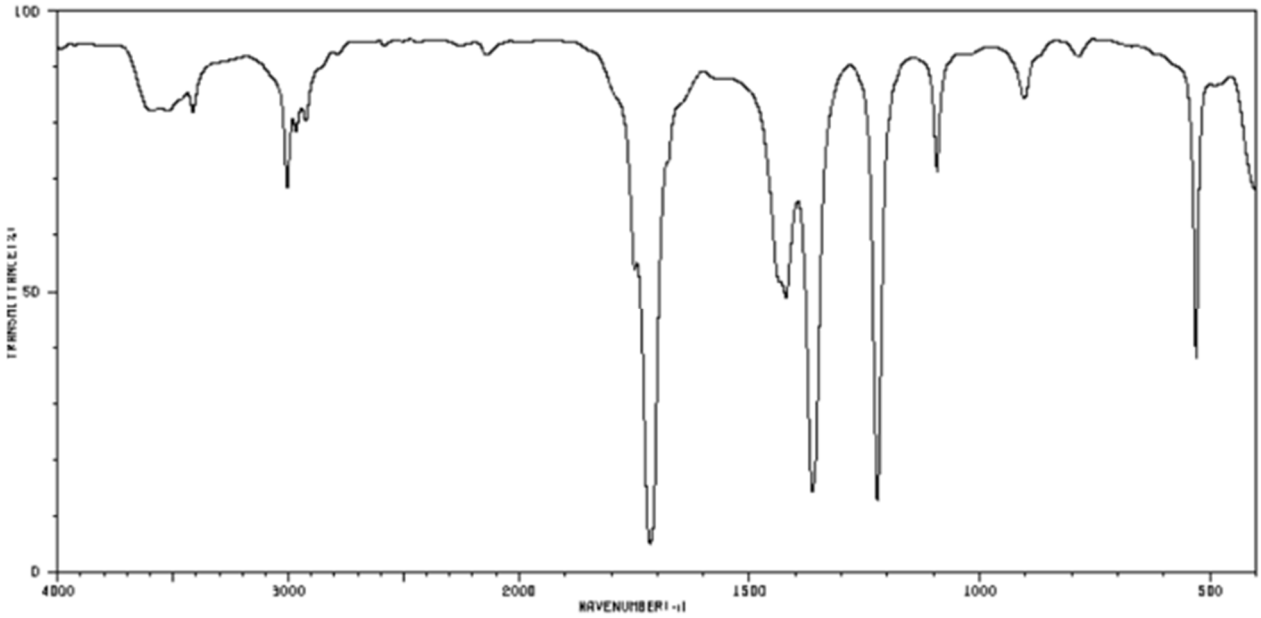
32. Information on the reactivity and spectra of an unknown organic compound are given below.

Test	Result
Acidified potassium dichromate added to sample	Orange colour remains
Bromine water added to sample	Orange/Brown colour remains
Sodium carbonate added to sample	No bubbles

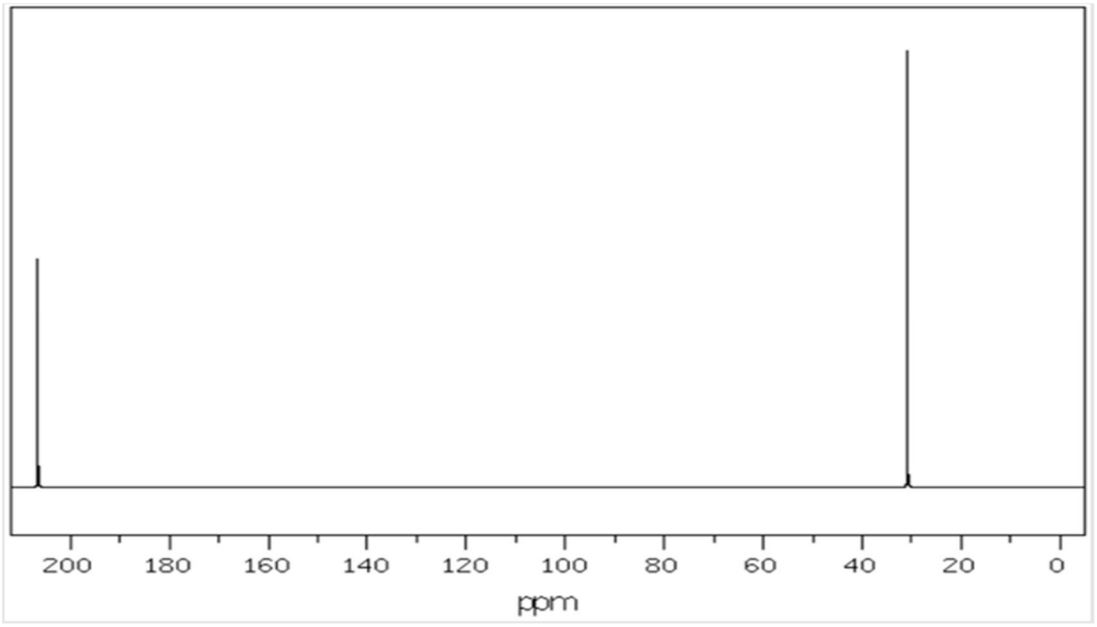
Graph 1 – Mass Spectrum



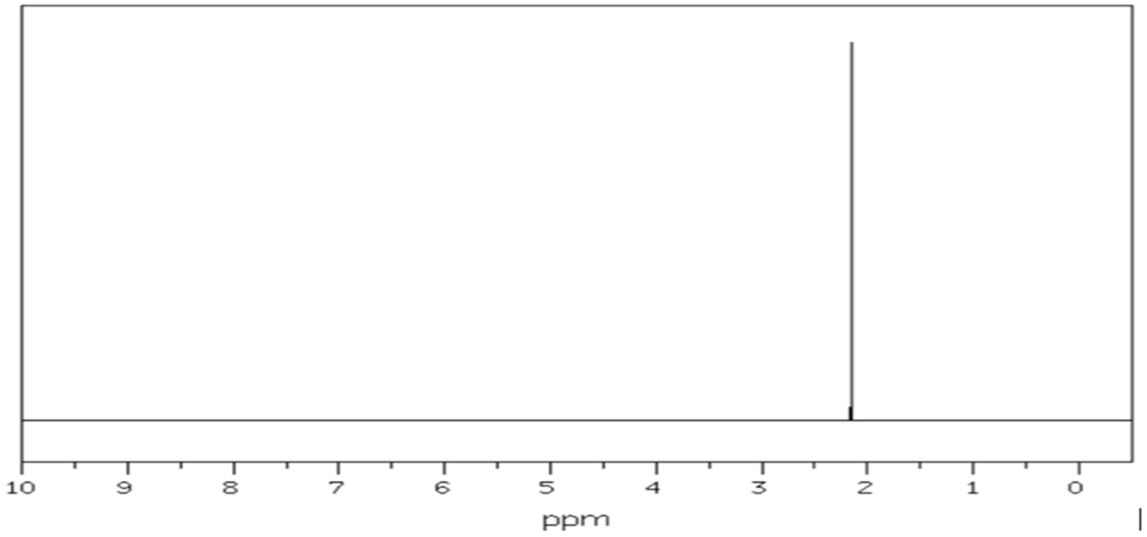
Graph 2 – Infrared Spectrum



Graph 3 – Carbon -13 NMR



Graph 4 – Proton NMR



a) Identify the unknown organic compound. **1**

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b) Draw the structural formula that represents this compound. **1**

c) Justify the identification of this compound by referring to the reactivity data and spectra provided.

6

Student Number _____

MARKING CRITERIA

Caringbah High School
Chemistry: HSC Course
Trial 2022

General Instructions

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- *Working time – 3 hours*
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- *Draw diagrams and graphs using pencil*
- *NESA approved calculators may be used*

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- *Allow about 35 minutes for this part*

***Part B** – 80 marks*
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- *Allow about 2 hour and 25 minutes for this part*

Total marks: 100

Task Prepared by: K. Wynne

OUTCOME	*MARK*
Knowledge and Understanding *Q*	*/81*
Working Scientifically *Q3, 5, 13, 16, 18, 19, 20, 23, 30*	*/19*
Total	*/100*

Marking Allocation

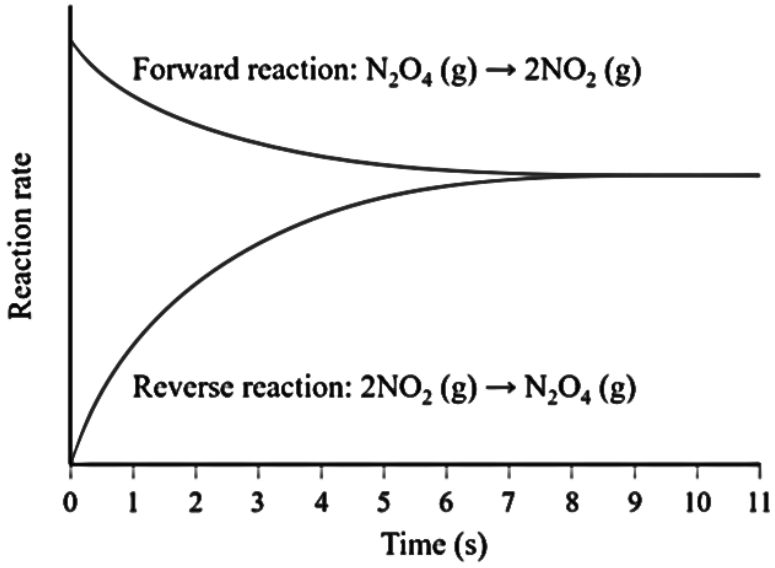
Q 21-23 18 marks TUDBERRY

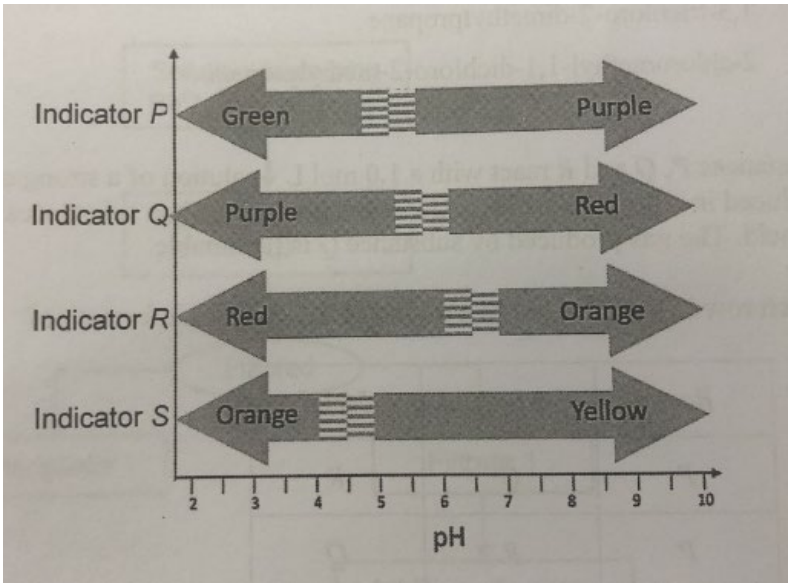
Q 24-25 18 marks HODSON

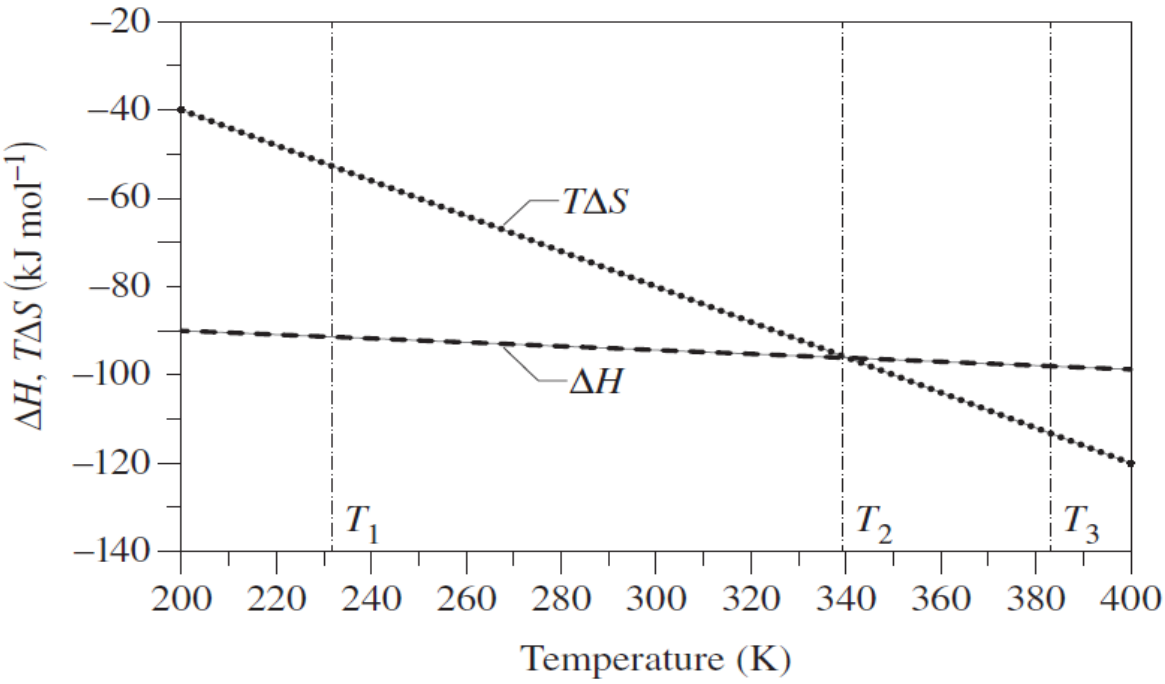
Q 26-29 23 marks CANTOR

Q 30-32 21 marks WYNNE

PART A: Circle the letter of the BEST answer on the grid (20 marks)

1.	Identify the conjugate base of the hydronium ion. A. H_2O B. H_3O^+ C. OH^- D. O^{2-}	
2.	Which of the following compounds has the highest molar solubility in water at 25°C? A. $BaCO_3$ B. $Mg_3(PO_4)_2$ C. $Pb(OH)_2$ D. $CaSO_4$	
3.	The graph below shows how the rates of the forward and reverse reactions, as shown by the balanced equations on the graph, change over time.  Which of the following statements, from the data shown, is correct? A. At equilibrium, the reverse reaction proceeds at its maximum rate. B. After 10 s, the concentration of $NO_{2\,(g)}$ would be double that of $N_2O_{4\,(g)}$. C. The pressure in the reaction vessel would decrease over the first 10 seconds.	

	D. After 10 s, any chemical reactions between the gases in the vessel have ceased.	
4.	The graph shows the change in colour of four different indicators over a pH range of 2 to 10.  An unknown solution is tested with indicator P, which turns purple. A fresh sample is tested with indicator R, which turns red. The likely pH of the unknown solution is: A. 5 B. 6 C. 7 D. 8	
5.	Consider the compound represented by the following formula: $CH_3CH_2CONH_2$ What is the name of this compound? A. 1-propylamine B. Propanoic acid C. Propanoic amine D. Propanamide	
6.	The graph below shows the relationship between ΔH, TΔS and temperature in a chemical system.	



At T_1 the ΔG for the reaction is

A. +20 Joules

B. 0 Joules

C. -20 Joules

D. -40 Joules

7. Methane gas was reacted with oxygen in a closed container until the following equilibrium was achieved.

$$2CH_{4(g)} + O_{2(g)} \rightleftharpoons 2CO_{(g)} + 4H_{2(g)} \qquad \Delta H = -76kJ$$

Which alternative correctly predicts how the quantity of hydrogen gas could be increased?

A. Using a catalyst.

B. Decreasing the pressure of the system.

C. Increasing the temperature of the system.

D. Changing the equilibrium constant for the reaction by reducing the methane concentration.

8. Ethanol is an alternative fuel to petrol. The statement below relates to the use of ethanol and petrol as fuel.

I. Ethanol releases more energy per gram when completely combusted than petrol.

II. Ethanol releases less CO_2 per mole of fuel combusted than petrol.

III. Ethanol is less likely to undergo incomplete combustion than petrol.

IV. Ethanol can be produced from non-fossil fuel resources.

Which of the above statements correctly compares ethanol to petrol when used as a fuel?

A. All statements are correct

B. I and II only

C. I, III and IV only

D. II, III and IV only

9. Cloudy ammonia is an ingredient of some household cleaners. It forms an equilibrium mixture when dissolved in water, as shown in the equation below.

$$NH_{3\,(aq)} + H_2O_{\,(l)} \rightleftharpoons NH_4^{+}{}_{(aq)} + OH^{-}{}_{(aq)}$$

Which of the following is the equilibrium expression for the forward reaction?

A. $\dfrac{[NH_4^+][OH^-]}{[NH_3]}$

B. $\dfrac{[NH_4]}{[NH_3^+][OH^-]}$

C. $\dfrac{[NH_3][OH^-]}{[NH_4^+]}$

D. $\dfrac{[NH_3]}{[NH_4^+][OH^-]}$

10. Which of the following statements best explains the cleaning action of soap?

A. The polar head group forms dispersion forces with oils and fats and the non-polar tail group forms hydrogen bonds with water.

B. The non-polar tail group forms dispersion forces with oil and fats, as well as forming dipole–dipole forces with water.

C. The polar head group forms dipole–dipole forces with oil, fats and water.

D. The polar head group forms ion–dipole forces with water and the non-polar tail group forms dispersion forces with oil and fats.

11. Which of the following is correct about the laboratory production of alcohol by the process of fermentation?

	Requires Oxygen	Produces oxygen	Suitable temperature (°C)
A.	Yes	No	60
B.	No	Yes	60
C.	No	No	30
D.	Yes	No	30

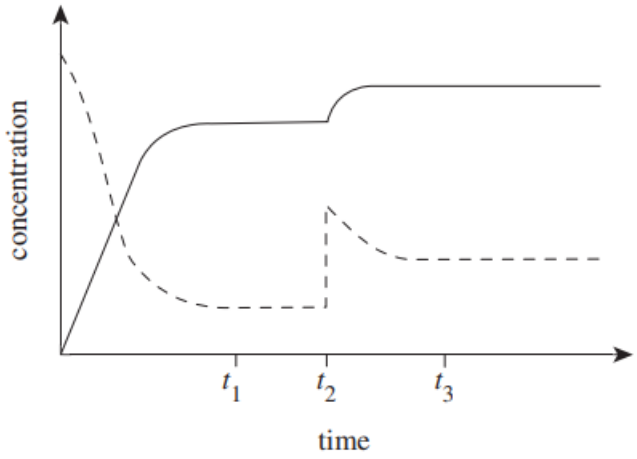
12. A chemist synthesises a substance using the following pathway

$$X \xrightarrow{\text{hydration}} Y \xrightarrow{\text{oxidation}} Z$$

What are compounds X, Y and Z?

	X	Y	Z
A.	Propane	Propan-1-ol	Propan-2-one
B.	Propane	Propan-1-ol	Propanoic acid
C.	Prop-1-ene	Propan-2-ol	Propan-2-one
D.	Prop-1-ene	Propan-2-ol	Propanoic acid

13. The graph shows the progress of an equilibrium reaction (reactants ⇋ products)

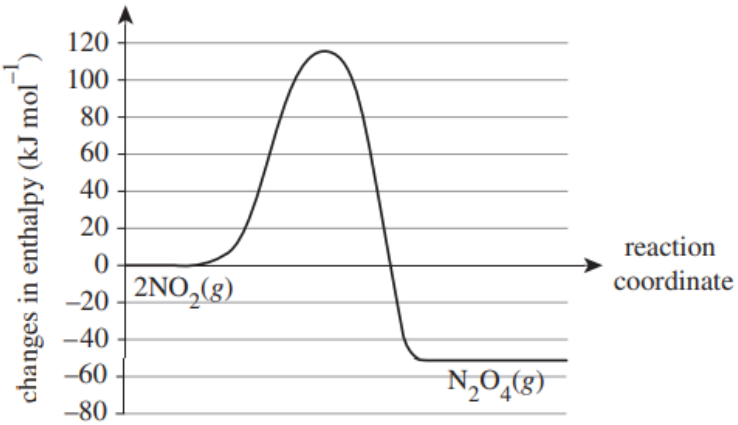


Which row of the table correctly identifies what is happening at t_1, t_2 and t_3?

	t_1	t_2	t_3
A.	At equilibrium	Reactants added	New equilibrium position
B.	At equilibrium	Products added	New equilibrium position
C.	No reaction occurring	Reaction proceeding	Reaction occurring
D.	Only forward reaction occurring	Forward and reverse reactions occurring	Only reverse reaction occurring

14. Below is the energy profile for the equilibrium reaction:

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

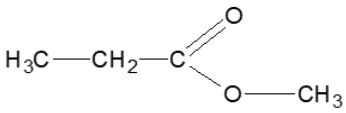


The activation energies of the forward and reverse direction are

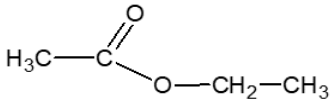
Forward activation energy (kJ mol^{-1})	Reverse activation energy (kJ mol^{-1})

A	50	116
B	116	50
C	116	176
D	176	116

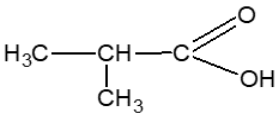
15. The structural formulae of five organic compounds, labelled A-E, are shown below.



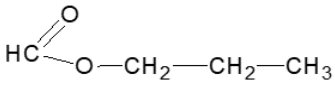
A



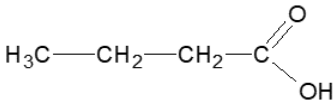
B



C



D



E

Which alternative below identifies a pair of these compounds as examples of each type of isomer?

	Functional group isomers	Position isomers
A.	C and E	B and D
B.	C and D	A and B
C.	A and B	A and B
D.	B and E	B and C

16. Alcohols can be produced in many ways. Which method identified below requires the use of an dilute acid catalyst to yield alcohol?

A. Substitution of a halogenated hydrocarbon with hydroxide ion

B. Substitution of a halogenated hydrocarbon with water

C. Fermentation of glucose by yeast

D. Hydration of an alkene

17. Consider the equation below:

$$N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$$

K_{eq} for this equation is 0.48 at 100°C

In an experiment it was found that the concentration of $N_2O_4(g)$ was 0.20 $molL^{-1}$. Calculate the concentration of the $NO_2(g)$ in this equilibrium mixture.

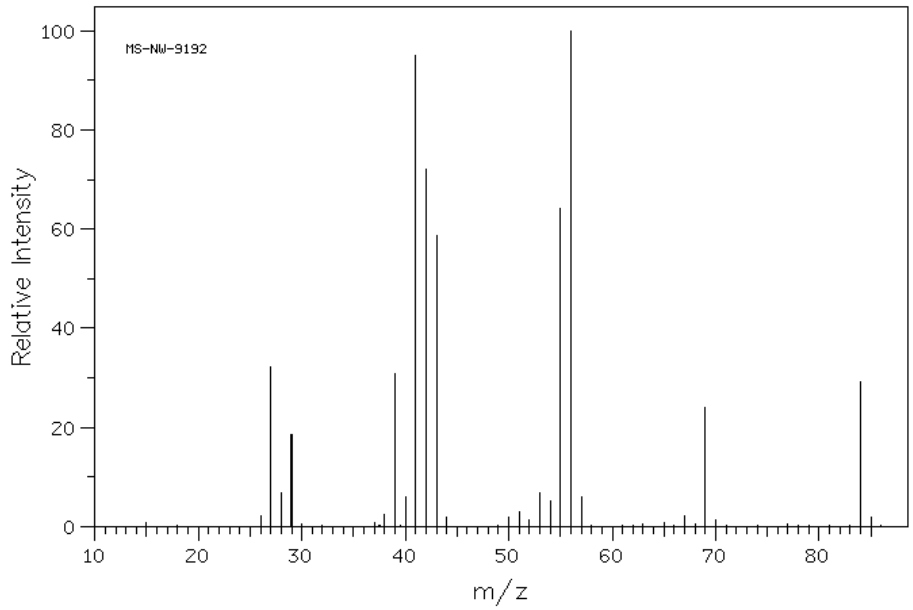
A. 0.10 mol L^{-1}

B. 0.31 mol L^{-1}

C. 0.096 mol L^{-1}

D. 3.23 mol L^{-1}

18. Compound X has the general formula of C_nH_{2n} . Below is the mass spectra for compound X.



Compound X is

A. Methane

B. But-1-ene

C. Hex-1-ene

D. 2,2-dimethylbutane

19.	The following incomplete equation describes the oxidation of ethanol to ethanoic acid by potassium permanganate. All coefficients shown are correct, but the coefficient for ethanoic acid has been replaced by the letter "X". $$3C_2H_5OH_{(l)} + 4KMnO_{4(aq)} \rightarrow X\ CH_3COOH_{(l)} + 4MnO_{2(s)} + 4KOH_{(aq)} + H_2O_{(l)}$$ In a reaction carried out by a chemist, 5.0 g of ethanol yields 5.9 g of ethanoic acid. What is the percentage yield for the above reaction, as predicted by the correctly balanced equation? A. 45% B. 77% C. 85% D. 91%	
20.	A quantity of solid silver nitrate is added to 150.0 mL of 0.120 mol L^{-1} potassium sulfate at 25˚ to produce a precipitate. What mass of silver nitrate is required to cause precipitation to start? A. 0.0015g B. 0.028g C. 0.254g D. 0.465g	

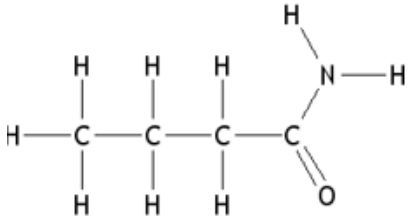
PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

Do NOT detach this page from the rest of the exam.

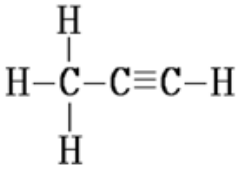
1	**A B C D**	**11**	**A B C D**
2	**A B C D**	**12**	**A B C D**
3	**A B C D**	**13**	**A B C D**
4	**A B C D**	**14**	**A B C D**
5	**A B C D**	**15**	**A B C D**
6	**A B C D**	**16**	**A B C D**
7	**A B C D**	**17**	**A B C D**
8	**A B C D**	**18**	**A B C D**
9	**A B C D**	**19**	**A B C D**
10	**A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

PART B: Longer Answers

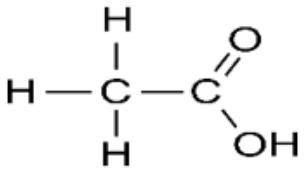
21. a) Using IUPAC nomenclature, name the compounds shown below. **3**



Compound 1



Compound 2



Compound 3

Marking Criteria	*Marks*
• *Names THREE compounds correctly*	*3*
• *Names TWO compounds correctly*	*2*
• *Names ONE compounds correctly*	*1*

Only answer: Compound 1 = butanamide Compound 2 = propyne Compound 3 = ethanoic acid or acetic acid

Student were only penalised once for using 1 in the name unnecessarily.

b) Predict the order of boiling points (lowest to highest) of these molecules. **1**

Marking Criteria	*Marks*
• *Predicts the correct order of boiling points (Compound 2 < Compound 3 < Compound 1)*	*1*

c) Explain your prediction. **3**

Marking Criteria	*Marks*
• *Outlines the impact of the different intermolecular forces* • *Identifies that Compound 1 has very strong hydrogen bonding and greater mass and chain length than Compound 3* • *Identifies that Compound 2 has dispersion only* • *Identifies that Compound 3 has hydrogen bonding*	*3*
• *Outlines the impact of the different intermolecular forces (relative strength)* • *Identifies the intermolecular forces in 2 of the 3 compounds*	*2*
• *Provides some relevant information*	*1*

Sample Answer:

The stronger the intermolecular forces, the higher the boiling point as more energy is needed to separate molecules.

Compound 2 is non-polar and has only weak dispersion forces.

Compound 3 has weak dispersion forces as well as the polar –COOH functional group which can form hydrogen bonds. The hydrogen atom of the –COOH can form a hydrogen bond with an oxygen of the neighbouring acid molecule. This holds the molecules closer together and requires more energy to separate.

Similar to compound 3, Compound 1 is polar and has strong hydrogen bonding forces, as well as weak dispersion forces. Hydrogen bonds form between the oxygen of 1 molecule and the hydrogen of the -NH_2 group in another molecule. The boiling point of compound 1 is higher than that of Compound 3, as Compound 1 has greater mass and chain length, which increases its overall dispersion force and therefore more energy is required to overcome.

Many students are still attributing boiling point to intramolecular forces.

22. When ammonia gas (NH_3) is bubbled through water that contains a few drops of phenolphthalein indicator, the water turns pink.

Explain how the Brønsted-Lowry theory of acids and bases can account for this observation. Support your response with a chemical equation.

3

Marking Criteria	***Marks***
• *Explains how the Bronsted-Lowry Theory explains the basic nature of ammonia, i.e. correct description of proton transfer.* • *includes a balanced equation with correct states* • *relates this to a knowledge of the pH range of phenolphthalein.*	***3***
• *Explains how the Bronsted-Lowry Theory explains the basic nature of ammonia, including a balanced equation (states not needed) OR* • *Explains how the Bronsted-Lowry Theory explains the basic nature of ammonia and relates this to a knowledge of the pH range of phenolphthalein.*	***2***
• *Provides some relevant information. E.g states B-L definition of a base.*	***1***

Sample Answer:

Phenolphthalein is an indicator that is colourless in acidic solutions and pink in basic solutions. According to the Bronsted-Lowry theory, bases are substances that accept protons. Therefore, bubbling ammonia through water allows the proton to transfer from water to ammonia (which becomes $NH4^+$) and causes the formation of OH^- ions according to the equation:

$NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

The excess OH^- ions increase the pH of the solution (becomes basic) and this results in the phenolphthalein turning from colourless to pink.

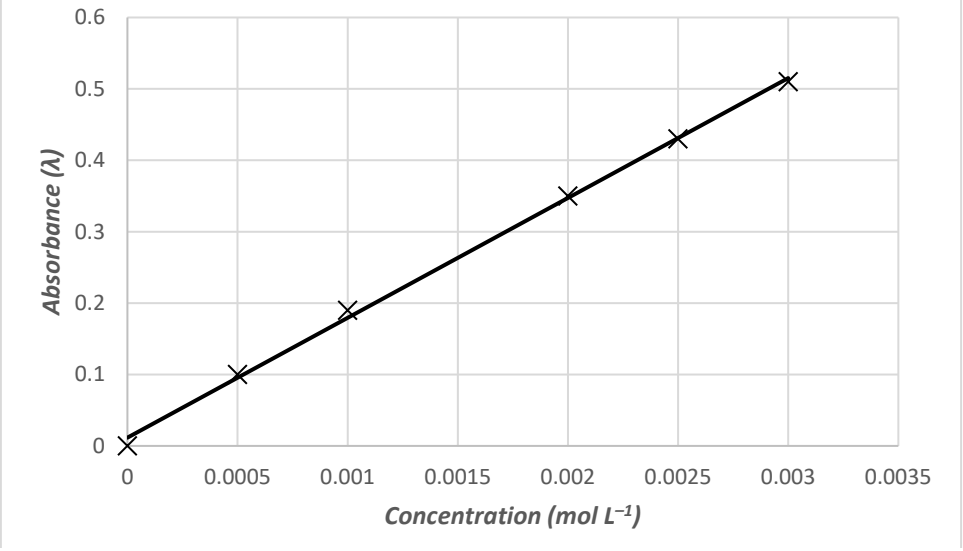
23. A colourimeter with an orange filter was used to analyse the concentration of copper ions in a solution. To calibrate the colourimeter, a distilled water blank and five standards of Cu^{2+} were prepared. Their absorbances were measured according to the table below.

Concentration (mol L^{-1})	**Absorbance (λ)**
0.0000	0.00
0.0005	0.10
0.0010	0.19
0.0020	0.35
0.0025	0.43
0.0030	0.51

a) Graph the calibration curve on the grid below.

4

Marking Criteria	Marks
• *Draws a correctly formatted graph to display the data shown in the table, including axes titles, units for concentration, variables plotted on correct axes, points plotted accurately, correctly drawn line-on-best-fit.*	***4***
• *Draws a well-formatted graph to display the data shown in the table, including most of the features identified above, with a major error or omission.*	***3***
• *Draws a graph to display the data shown in the table, including most of the features identified above, with more than one major error or omission.*	***2***
• *Attempts to display the data provided in the form of a graph, with limited demonstration of formatting conventions.*	***1***



b) A 20.0 mL sample of a copper solution of unknown concentration was diluted to a total of volume of 80.0 mL. This diluted solution recorded an absorbance of 0.46.

What is the concentration of the copper ions contained in the 20.0 mL sample in ppm? **4**

Marking Criteria	Marks
• *Correct answer with relevant working*	***4***
• *Shows most relevant steps*	***3***
• *Shows some relevant steps*	***2***
• *Shows one relevant step*	***1***

Relevant Steps

- *Interpolates concentration of diluted sample using LOBF.*
- *Applies dilution ratio of x4 to determine concentrated sample.*
- *Calculates the mass of copper ions.*
- *Converts to ppm*

Sample Answer
From interpolation, the concentration of Cu^{2+}in diluted sample is = 0.0027 $molL^{-1}$
0.0027 $molL^{-1}$ x 4 = 0.0108… $molL^{-1}$ in concentrated sample
m (Cu^{2+}) = n x MM = 0.0108…x 63.55 = 0.68634 g in 1L
c (Cu^{2+}) = 0.68634 g = 686mg = 686ppm

24. Initially a 2.00L vessel contains a mixture of 1.00mol of colourless hydrogen gas and 1.00mol of purple iodine gas. The gases react as follows:

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)} \qquad \Delta H = +26\ kJmol^{-1}$$

A chemical analyst is monitoring the equilibrium system. At 400˚C equilibrium is reached and the concentration of colourless hydrogen iodide gas is found to be 0.760 $molL^{-1}$.

a) Describe how the analyst would qualitatively know the system has reached equilibrium. **1**

Marking Criteria	***Marks***
• *Describes a qualitative observation of equilibrium*	***1***

Sample answer: The solution will stop changing colour.

Marking Criteria	***Marks***
• *Coverts mol to initial conc of H_2 and I_2 by dividing by the volume.* • *Applies mole ratio to determine equilibrium conc of H_2 and I_2* • *States equilibrium expression* • *Correctly calculates Keq*	***4***
• *Shows most relevant steps*	***3***
• *Shows some relevant steps*	***2***
• *Shows one relevant step*	***1***

4

	$[H_2]$	*I_2*	*HI*
I	*0.5*	*0.5*	*0*
C	*0.38*	*0.38*	*+0.760*
E	*0.12*	*0.12*	*0.760*

$K_{eq} \frac{[HI]^2}{[H_2][I_2]} = \frac{0.76^2}{0.12^2} = 40.1$

1

Marking Criteria	***Marks***
• *Describes equilibrium by interpreting Keq*	***1***

Sample Answer: The equilibrium lies on the right/products favoured.

d) Using Le Châtelier's principle, explain what would happen to the equilibrium if the temperature **3**

Marking Criteria	***Marks***
• *Correctly states what will happen to the position of equilibrium (shifts right).* • *Identifies the forward reaction as endothermic* • *Gives a detailed explanation explicitly framed by LCP including heat absorbed*	*3*
• *Correctly states what will happen to the position of equilibrium (shifts right)* • *Provides an explanation*	*2*
• *Provides some relevant information*	*1*

Sample Answer:

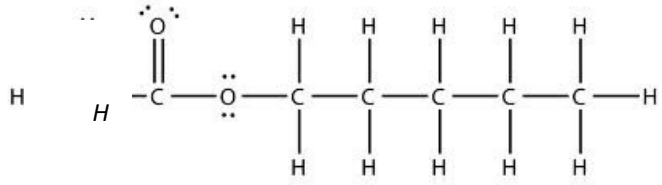
The forward reaction is endothermic. Le Châtelier's principle states that the system will shift in such a way to minimise the change; that is, it will shift to minimise the increase in temperature. By shifting the reaction right, the extra heat energy is absorbed in the bonds of HI as it is produced. This will proceed until equilibrium is re-established.

27/9/2

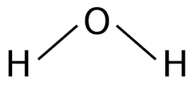
Students needed to explain what was happening in the reaction as heat was increased

25. a) Draw and name the products of the reaction between methanoic acid and pentan-1-ol. **3**

Marking Criteria	*Marks*
• *Correctly draws and names pentyl methanoate and water.*	*3*
• *draws and/or names pentyl methanoate and/or water.*	*2*
• *Provides some relevant information*	*1*



Pentyl methanoate



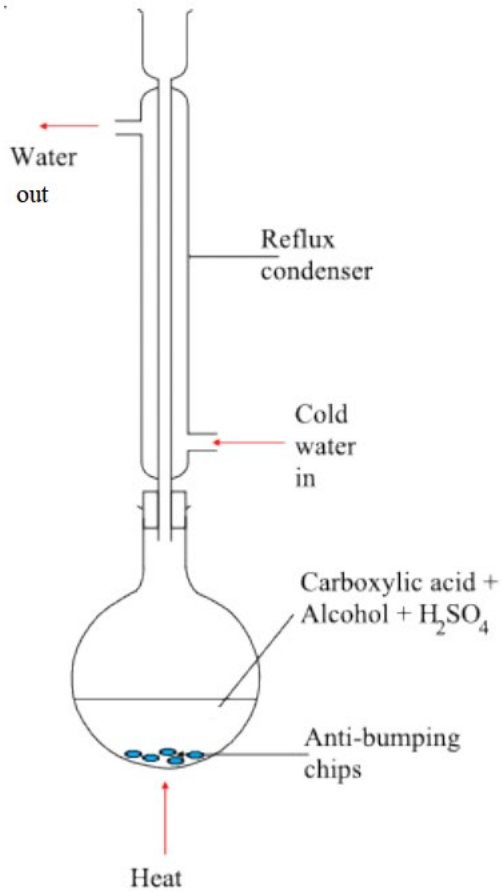
water

The student used the following method to perform the reaction.

1. 10 mL of pentan-1-ol and 12 mL of methanoic acid were added to a 50 mL round bottomed flask.

2. 1mL of concentrated sulfuric acid was added to the flask.

3. The mixture was heated under reflux (apparatus shown below) for 30 minutes.



b) Justify this procedure to efficiently produce this ester in a school laboratory. **6**

Marking Criteria	***Marks***
• *Describes and explains why reflux is required (heat increases reaction rate AND prevents loss of volatile reactants)* • *Describes and explains the use of the catalyst (speed up reaction rate, lowers activation energy)* • *Describes and explains one other aspect of esterification (methanoic acid in excess, drives equilibrium right, sulfuric acid is a dehydrator, removal of water shifts equilibrium right)* • *Logical and concise response*	*5- 6*
• *Describes and explains why reflux is required OR describes and explains the use of the catalyst* • *Describes and explains one other aspect of esterification (methanoic acid in excess, drives equilibrium, catalyst is a dehydrator)*	*4*
• *Describes and explains one aspect of esterification well.* *OR* *Outlines two aspects of esterification.*	*2-3*
• *Provides some relevant information*	*1*

A lot of students forgot to:

- *Explain what effect heat has on the reaction*
- *Relate how the excess carboxylic acid or sulfuric acid had an effect on the equilibrium using LCP.*

26. a) Write a balanced chemical equation for the complete combustion of butan-1-ol. **1**

Marking Criteria	*Marks*
• *Correct equation*	***1***

Only Answer: $C_4H_9OH_{(l)} + 6O_{2(g)} \rightarrow 4CO_{2(g)} + 5H_2O_{(l)}$

b) Theoretically, how much heat is released when 1.00 g of butan-1-ol is combusted? The molar heat of combustion of butan-1-ol is -2676 kJ mol^{-1} **2**

Marking Criteria	*Marks*
• *Calculates heat released with correct unit*	*2*
• *Shows one relevant step*	*1*

Sample Answer:
Molar mass of C4H9OH is 74.12 g mol^{-1}.
n = m/mm = 1/74.12 = 0.0134… mol
0.0134… x -2676 = 36.1 kJ

c) Experimentally, 40% of the heat is lost to the environment. If 100mL of water, initially at 25˚C, was heated by the burning of 1.00g of butan-1-ol, what is the final temperature of the water? **3**

Marking Criteria	*Marks*
• *Correctly calculates final temperature with working*	*3*
• *Shows most steps*	*2*
• *Shows one relevant step*	*1*

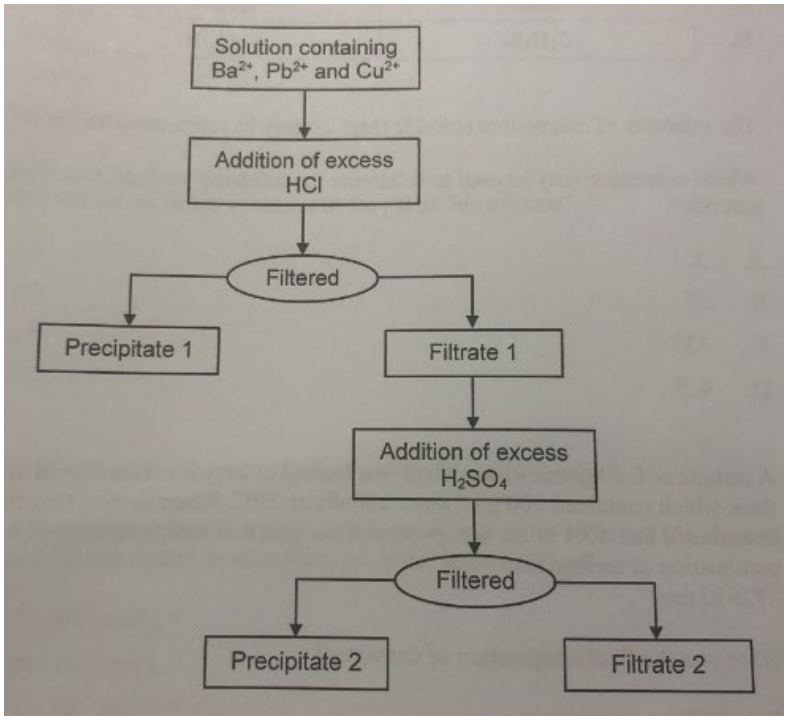
Relevant Steps:
Determines energy for 60% captured
Converts unit from kJ to J
Calculates final temperature of water
Sample Answer:

Marking Criteria	*Marks*
• *Thorough description of conditions required for equilibrium (rates, closed system etc)* • *Links to delta g (identifying exo and explains increase in entropy* • *Gives a reason why combustion is not an equilibrium considering these points.*	*3*
• *Identifies enthalpy change as releasing energy (exothermic) and entropy change as increasing (more chaotic)* • *Identifies what a non – equilibrium system is*	*2*
• *Provides some relevant information*	*1*

Sample Answer:
In non - equilibrium systems the rates of forwards and reverse rxns never become equal, and the reaction goes to completion, rather than reaching equilibrium. The combustion of butan-1-ol is exothermic (Delta H is negative/ heat is released). Exothermic reactions are spontaneous because it is easier for systems to release energy than to absorb it. The entropic change is positive as the system becomes more disordered by breaking down complex butan-1-ol for simpler CO2 and H2O. Reactions will spontaneously favour the direction of reaction in which the system is most disordered.
Both enthalpy and entropy considerations favour the forward reaction, so the combustion of butan-1-ol does not reach an equilibrium state as neither enthalpy nor entropy changes favour the reverse reaction. Delta g will always be negative $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ *" eq "means insufficient description of eq requirements*

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

27. A solution contains three cations – barium, lead and copper. The flow chart below indicates the steps used to confirm the identity of these cations.



a) ...

Marking Criteria	Marks
• *Identifies precipitate 1 as lead chloride ($PbCl_2$)*	*1*

1

b) Explain why HNO_3 is an inappropriate choice for the first step.

Marking Criteria	Marks
• *Identifies HNO_3 as always soluble* • *Describes HNO_3 as not distinguishing as it won't precipitate/react with suspect ions*	*2*
• *Provides some relevant information*	*1*

2

Marking Criteria	Marks
• *Correct net ionic equation with states as $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4\,(s)}$*	*2*
• *Id ppt*	*1*

1

Marking Criteria	Marks
• *Correct identification of copper complex (copper hexahydrate) as blue*	*1*

1

e) Describe an additional test you could conduct, and the expected results, that would confirm

Marking Criteria	Marks
• *Correct descriptions of test and result eg copper flame test as green, or other appropriate precipitation or complex reaction.*	*2*
• *Describes test OR identifies result*	*1*

2

28. The Gunwinggu people of Arnhem Land eat the roots of a bitter yam plant, which contains toxic salts called oxalates. Using this, or another example, identify at least two steps used in the preparation of these foods and outline how these steps demonstrate chemical principles to make the food safe to eat. **3**

Marking Criteria	***Marks***
• *Identifies 2 step2 and describes 2 chemical principles (must include equilib and open system)*	*3*
• *Identifies 1 step and describes 1 chemical principle*	*2*
• *Provides some relevant information*	*1*

Sample Answer: Solubility - Soaking the food in water allows for the water soluble toxin to be dissolved and leached from the food. Equilibrium – using a running stream as the water source for soaking creates an open system, so the dissolving of the toxin is always pushed to the ion form, and goes to completion. This reduces the toxin in the food as much as possible.

29. Using the data provided on the data sheet, quantitatively and qualitatively compare the solubility of silver chloride in water with its solubility in a 0.10 mol L^{-1} solution of sodium chloride, at 25°C. **4**

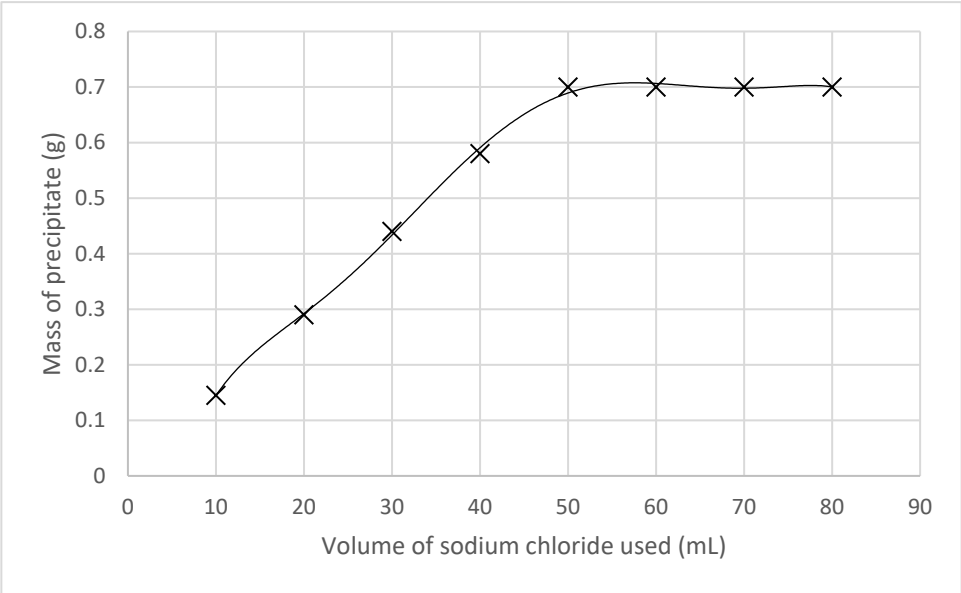
Marking Criteria	***Marks***
• *Calculates solubility of AgCl in water* • *Calculates solubility of AgCl in NaCl* • *Compares values (X>Y, factor etc) must refer to calculated values* • *States AgCl is less soluble in NaCl than in water*	*4*
• *Shows most relevant steps*	*3*
• *Shows some relevant steps (Max 2 if only 1 value calculated)*	*2*
• *Shows one relevant step*	*1*

Solubility of AgCl in water
K_{sp} *AgCl* $= 1.77 \times 10^{-10} = [Ag^+]\,[Cl^-] = (x)\,(x) = x^2$
$x = \sqrt{(1.77 \times 10^{-10})} = 1.3 \times 10^{-5}$
The solubility of AgCl in water $= 1.3 \times 10^{-5}$ *molL*$^{-1}$

Solubility of AgCl in 0.10 molL^{-1} *solution of sodium chloride*
K_{sp} *AgCl* $= [Ag^+]\,[Cl^-] = (x)\,(0.10 + x) = 1.77 \times 10^{-10}$
Since x is small by comparison with 0.10 is can be assumed as 0
K_{sp} *AgCl* $= [Ag^+]\,[Cl^-] = (x)\,(0.10) = 1.77 \times 10^{-10}$
$x = 1.77 \times 10^{-10} / (0.10) = 1.77 \times 10^{-10} / 1.0 \times 10^{-1} = 1.77 \times 10^{-9}$
The solubility of AgCl in 0.10 M $Cl^- = 1.8 \times 10^{-9}$ *mol*$^{-1}$

Hence AgCl is less soluble (by almost a factor of 10^4*) in a 0.10 mol/L solution of chloride ion than in water.*

30. A chemist was investigating mass and concentration relationships between sodium chloride and silver nitrate. Different volumes of sodium chloride solution were reacted with separate 50mL samples of silver nitrate solution. After each reaction the silver chloride precipitate was filtered, dried and weighed. The relationship between volume of sodium chloride used and the mass of the precipitate formed is shown in the graph below.



Marking Criteria	Marks
• *Identifies the mass stops increasing/mass is constant/no more formed/ max ppt 0.7g* • *Links to reaction completion/excess/ limiting reagent*	*2*
• *Provides some relevant information*	*1*

Sample Answer: The line plateaus between 50 and 80 mL because no more precipitate can be formed. This is because the reaction reached completion and sodium chloride is now being added in excess.

NOTE: Many students incorrectly used saturated – saturation means the solution is at equilibrium and beyond this will then start precipitating. If the ppt is being measured, then the reaction is BEYOND saturation.

2

3

Marking Criteria	Marks
• *Interpolates 0.7g at 50mL* • *Calculates moles of silver chloride* • *Applies mole ratio to determine moles of silver nitrate* • *Calculates concentration of silver nitrate*	*3*
• *Shows one small error. Applies mole ratio to determine moles of silver nitrate requires evidence at this stage.*	*2*
• *Shows one relevant step*	*1*

Sample Answer: The interpolation at 50mL is 0.7g of silver chloride.

n = m/mm = 0.7 / 143.32 = 0.00488418 mol of silver chloride

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$ therefore 1:1 0.00488418 mol of silver nitrate

$c = n/V = 0.00488418/0.05 = 0.097\ molL^{-1}$ 9.7×10^{-2} MM AgNO3 = 169.91

31. Two differently coloured complex ions of cobalt(II), $[Co(H_2O)_6]^{2+}$ (pink) and $[CoCl_4]^{2-}$ (blue), exist in equilibrium in solution when chloride ions are present. The equilibrium is represented by the equation below.

$$[Co(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) \rightleftharpoons [CoCl_4]^{2-}(aq) + 6H_2O(l)$$

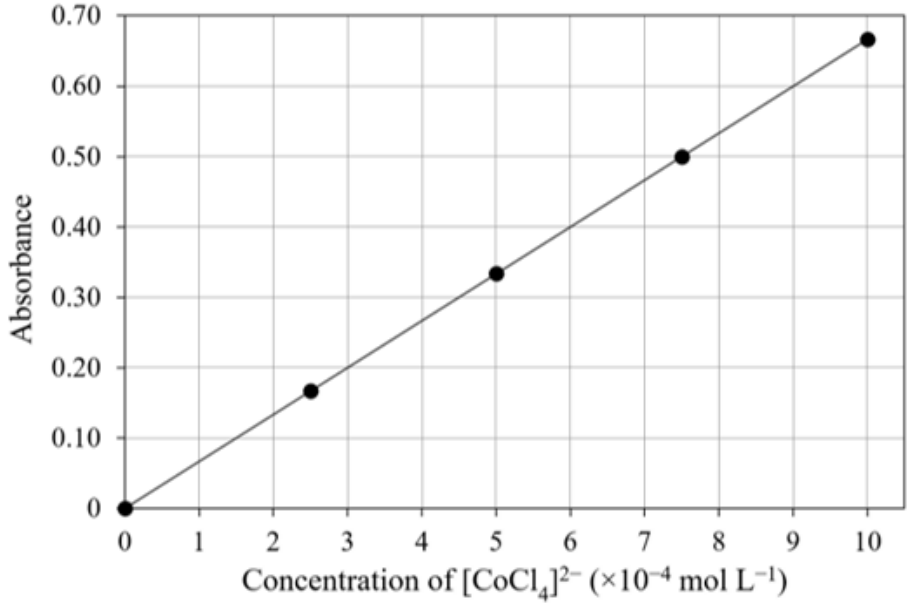
Marking Criteria	***Marks***
• *Describes an appropriate method (paper, or temperature, or addition of water/chloride ions)* • *Includes required detail of reversible colour change (pink to blue, blue to pink)*	*2*
• *Provides any relevant information*	*1*

Sample Answer:

Paper dipped in the complex solution was allowed to dry over a flame – this turned the paper blue. When a drop of water was added, the paper turned pink. Drying again returned it to blue.

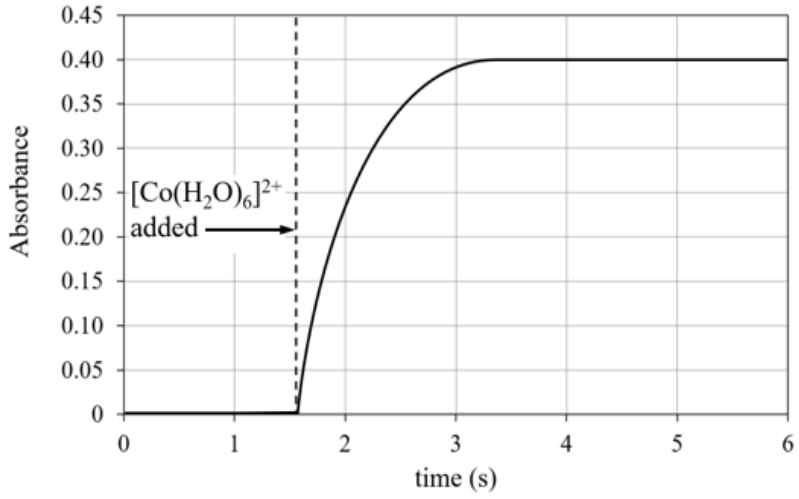
2

blue wavelength recorded the following calibration graph.



An identical cuvette was filled with an aqueous 0.9900 mol L^{-1} sodium chloride solution and placed in the UV-Vis spectrometer. Note: Sodium ions play no part in this equilibrium. The spectrometer continuously recorded the absorbance at the same blue wavelength. The temperature was held constant.

After about 1.6 seconds, $[Co(H_2O)_6]^{2+}$ was added so that the initial concentration in the cuvette was 0.3600 mol L^{-1}. The results are shown on the graph below.



b) Account for the use of sodium chloride solution in the cuvette **2**

Marking Criteria	***Marks***
• *Identifies sodium chloride as a source of chlorine ions* • *Describes chlorine ions pushes equilibrium to the blue/$CoCl_4$ side*	*2*
• *Provides any relevant information*	*1*

c) Calculate K_{eq} for the cobalt (II) complex equilibrium reaction. **4**

Marking Criteria	***Marks***
• *Calculates Keq with working*	***4***
• *Shows most relevant steps*	***3***
• *Shows some relevant steps*	***2***
• *Shows one relevant step*	***1***

Relevant steps:

- *Extracts 0.4 absorbance from graph 2, and uses graph 1 to interpolate concentration of* $[CoCl_4]^{2-}$ *at equilibrium as 6 x 10^{-4}.*
- *Leaves water off because its concentration doesn't change.*
- *Applies mole ratio to determine equilibrium conc of other species*
- *States equilibrium expression*
- *Correctly calculates Keq*

Sample Answer:

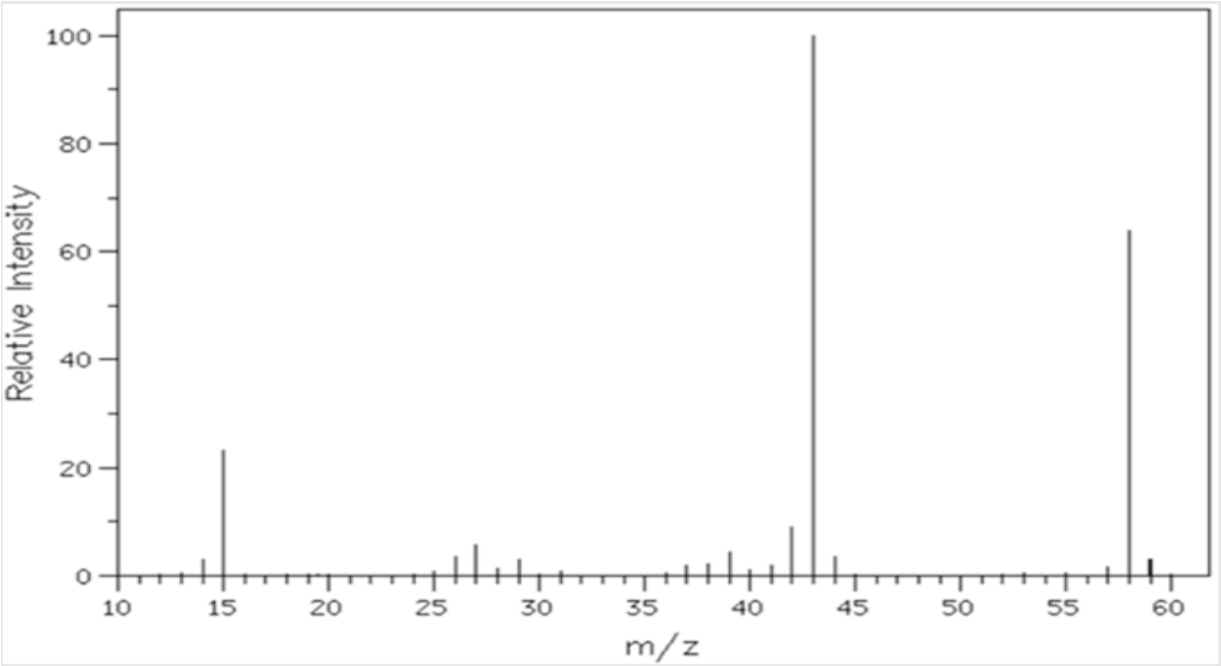
	$[Co(H_2O)_6]^{2+}$	Cl^-	$[CoCl_4]^{2-}$
I	*0.3600*	*0.99*	*0*
C	*- 6 x 10^{-4}.*	*- 4x (6 x 10^{-4})*	*+ 6 x 10^{-4}.*
E	*0.3594*	*0.9876*	*6 x 10^{-4}*

32.

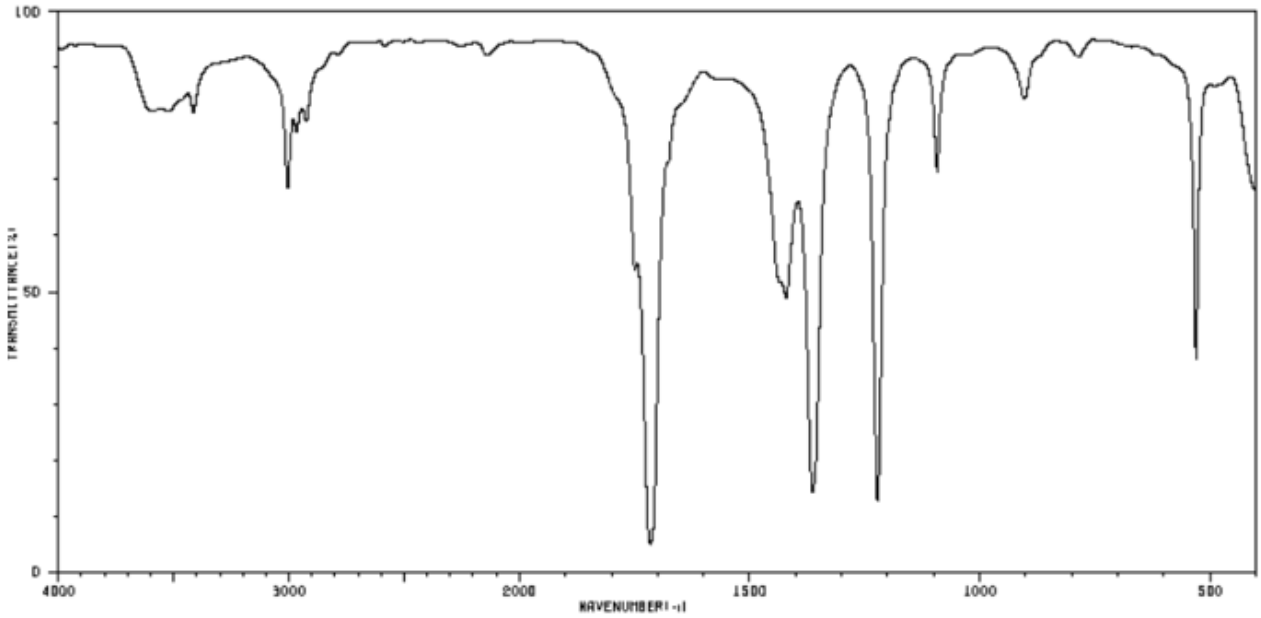
$$K_{eq} = \frac{[CoCl_4{}^{2-}]}{[Co(H_2O)_6{}^{2+}] \times [Cl^-]^4} = \frac{6 \times 10^{-4}}{0.3594 \times (0.9876)^4} = 1.75 \times 10^{-3}$$

Sodium carbonate added to sample	

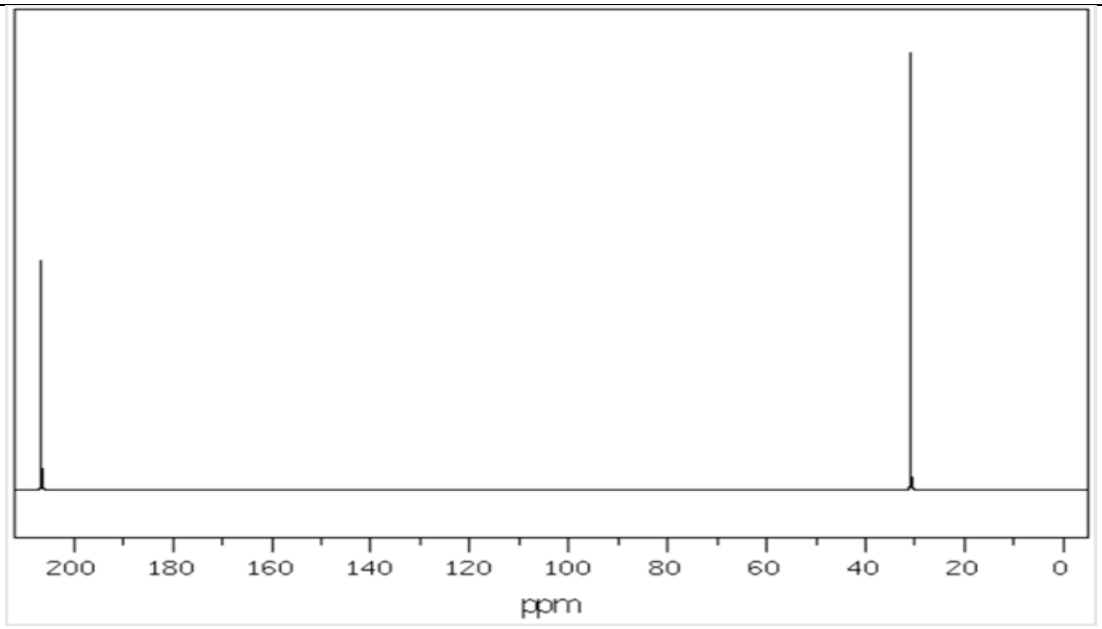
Graph 1 – Mass Spectrum



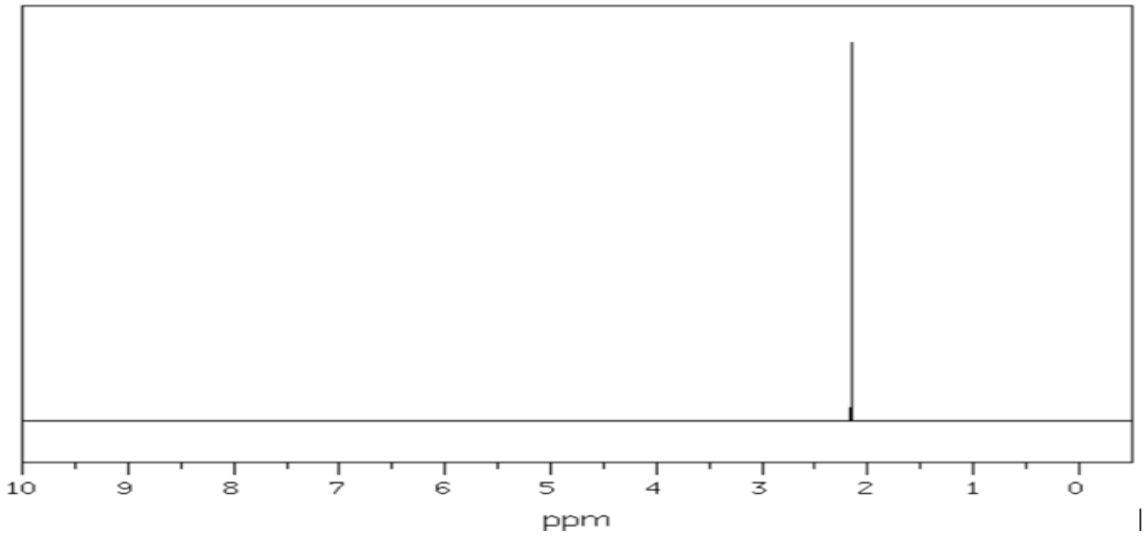
Graph 2 – Infrared Spectrum



Graph 3 – Carbon -13 NMR



Graph 4 – Proton NMR



1

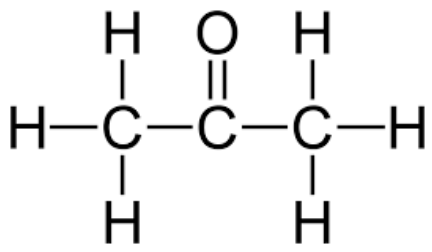
2

6

Marking Criteria	***Marks***
• *Identifies the compound as propanone*	*1*

b) Draw the structural formula that represents this compound.

Marking Criteria	***Marks***
• *Draws identified compound from part a following drawing conventions.*	*1*



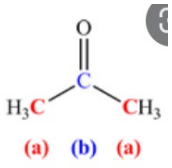
Marking Criteria	*Marks*
• *Justifies the correct structure showing an extensive understanding of the interpretation of all spectroscopic AND reactivity data* • *Refers explicitly to all spectroscopic and reactivity data stimuli including reference values for spectra.*	*5- 6*
• *Shows a sound understanding of the interpretation of spectroscopic AND reactivity data* • *Uses some relevant information presented in the question to justify the structure of the chemical*	*4*
• *Shows a sound understanding of the interpretation of some spectroscopic OR reactivity data* • *Uses some relevant information presented in the question to justify the structure of the chemical*	*2-3*
• *Provides any relevant correct information*	*1*

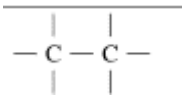
Sample Answer:

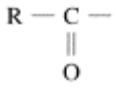
Qualitative Reactivity Tests - Acidified potassium dichromate remains orange means it is not a primary or secondary alcohol (could still be tertiary) or an aldehyde. Bromine water remains orange/brown means molecule is saturated (no double or triple CC bonds). Sodium carbonate unreacted means it is not acidic/absence of COOH. Propanone is not an alcohol, is saturated and is not an aldehyde/carboxylic acid.

Mass Spectrum shows a molecular ion at 58 m/z. Small peak at 59 is the result of an isotope. This means the molecular mass of the compound is close to 58gmol^{-1}. mm of Propanone = C3H6O = (3 x 12.01) + (1.008 x 6) + (16) = 58.078gmol^{-}**Infrared spectrum** shows strong narrow absorption band at around 1700cm. This indicates the carbonyl functional group (C=O) which propanone carries on carbon #2. There is weak absorption band at around 3000cm which is consistent with C-H bonds which propanone carries on carbon #1 and #3. The absence of any other significant absorption bands from 2500cm+ excludes other functional groups and confirms the reactivity tests (absence of OH and COOH).

Carbon-13 NMR shows two unique carbon environments. This means the molecule must have at least 2 or more carbons. If there are more than 2 carbons, the additional carbons must share a similar arrangement/symmetry. In propanone, the terminating carbons are the same, and the centre carbon is different (as illustrated).



The peak at 30ppm is consistent with  *(5-40) which represents the carbon chain.*



The peak at 200+ is consistent with *(190-220) which represents aldehyde/ketone functional groups according to the data sheet.*

***Proton NMR** shows a single hydrogen environment. This means that the molecule shows symmetry. Because the peak is a singlet, using n-1 rule, it means the neighbouring carbon doesn't contain any hydrogen (1-1 = 0) – as evidenced by the central carbonyl group with no hydrogens in propanone. Combined with the reactivity tests, this confirms that the substance is a ketone, and not an aldehyde.*

A ketone, with 2 carbon environments, with a mass of 58 justifies propanone.

NOTE: Students are reminded that the bromine test looks for double AND triple CC bond.

NOTE: Better responses used diagrams, subheadings, and spectra values as evidence.

NOTE: Justify verb means give reasons why. It's not enough to just describe the spectra you must interpret and then connect the dots! Really spell it out.

NOTE: Many students didn't properly use C-13NMR values/data sheet or explain the significance of splitting H-NMR.

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