



Student Number:

Teacher's Name:

2019

Task 4: Trial Examination

Weighting: 30%

HSC Chemistry

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 data sheet, formulae sheets and Periodic Table are provided at the back of this paper
- For questions in Section II, show all relevant working in questions involving calculations
- This paper **MUST NOT** be removed from the examination room.

Subject Teachers: Ms Disney, Mrs Goddard, Ms Dreesbeimdieke, Mr Weeding, Mr Pimentel

Total marks - 100

Section I - 20 marks (pages 3-15)

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

Section II - 80 marks (pages 16-37)

- Attempt Questions 21-34
- Allow about 2 hours and 25 minutes for this part

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

1. What flame colour is produced by calcium ions in a flame test?

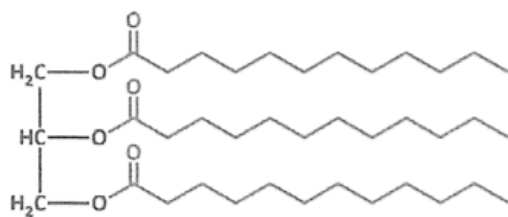
- A. Red
- B. Blue
- C. Green
- D. Purple

2. A, B, C and D are 0.10 mol L^{-1} solutions containing acids of varying pH, with the values of pH for each solution being shown below.

Identify which of the solutions A-D below is a diprotic acid.

- A. 0.69
- B. 1.00
- C. 2.87
- D. 3.45

3. The structure of an organic compound is shown below.



The compound is:

- A. glycerol
 - B. a fatty acid
 - C. a triglyceride
 - D. an alkyl carboxylate
4. Which of the following molecules is most likely to undergo condensation polymerisation with another identical molecule?
- A. $(\text{CH}_3)_3\text{COH}$
 - B. $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$
 - C. $\text{ClOC}(\text{CH}_2)_4\text{COCl}$
 - D. $\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$
5. Excess barium nitrate solution is added to 200 mL of 0.200 mol L^{-1} sodium sulfate.
- What is the mass of the solid formed?
- A. 4.65 g
 - B. 8.69 g
 - C. 9.33 g
 - D. 31.5 g

6. The percentage of sodium chloride in a food sample can be determined as follows:

- Completely dissolve the food sample using an appropriate solvent.
- Add an excess of silver nitrate solution to the dissolved food sample to precipitate all chloride ions.
- Wash and dry the resulting precipitate.

A student carried out this experiment and recorded the following results.

- Mass of original food sample = 22.0 g
- Mass of dried precipitate = 0.396 g

What is the percentage of sodium chloride in the food?

- A. 0.147%
- B. 0.734%
- C. 1.47%
- D. 4.42%

7. Polypropylene is made by the polymerisation of propene, $\text{CH}_3\text{CH}=\text{CH}_2$. One sample of this polymer is found to have a molar mass of approximately $1.05 \times 10^5 \text{ g mol}^{-1}$.

The number of carbon atoms in one molecule of this polymer would be closest to:

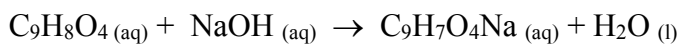
- A. 2500
- B. 2900
- C. 7500
- D. 8750

8. The pH values and concentrations of four acids are given in the table below.

Acids	pH	Concentration
I	2.73	0.20
II	2.06	0.10
III	3.77	1.00
IV	4.78	0.50

Which acid is the weakest?

- A. Acid I
B. Acid II
C. Acid III
D. Acid IV
9. Three flasks were prepared, each containing a mixture of 25 mL of water and 10 mL of ethanol. An aspirin tablet was dissolved in each flask. The aspirin in each solution was titrated with a standardised NaOH solution of concentration $0.1003 \text{ mol L}^{-1}$ according to the following equation:



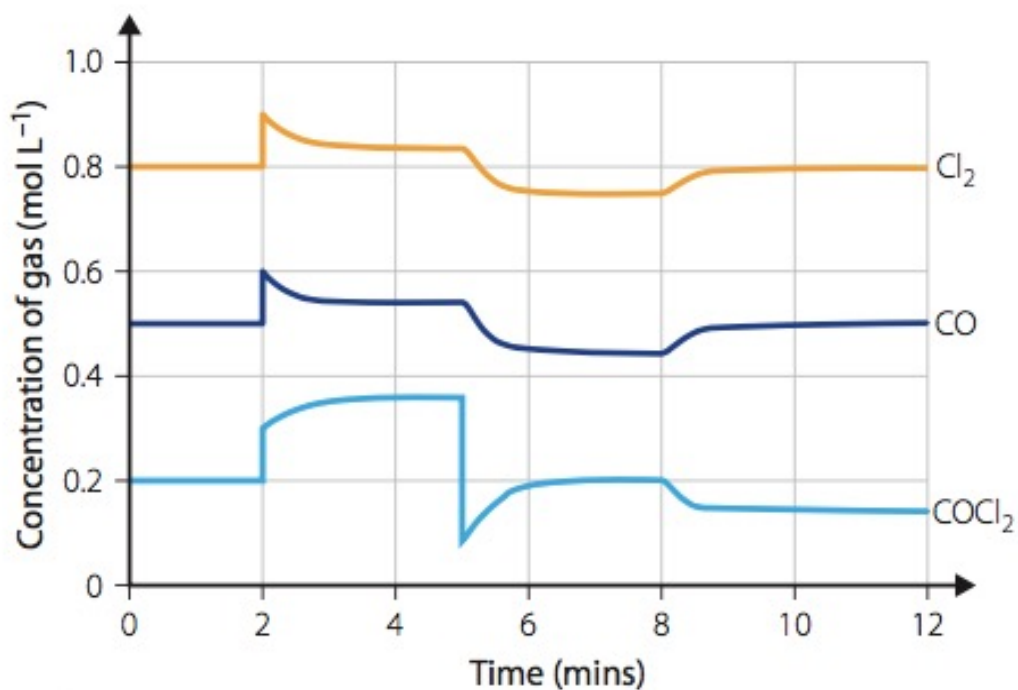
The titration results shown below were obtained.

Tablet	Volume (mL)
1	16.70
2	16.60
3	16.65

The average mass of aspirin per tablet in mg is:

- A. 30.09
B. 89.71
C. 300.9
D. 993.8

10. A closed system consisting of a mixture of the gases CO, Cl₂ and COCl₂ was monitored over time and is shown on the graph below. The decomposition of COCl₂ is an endothermic process.



What changes occurred at 2 minutes, 5 minutes and 8 minutes respectively?

	2 minutes	5 minutes	8 minutes
A.	volume increased	CO removed	temperature decreased
B.	volume increased	CO removed	temperature increased
C.	volume decreased	COCl ₂ removed	temperature decreased
D.	volume decreased	COCl ₂ removed	temperature increased

11. Different indicators change colour over different pH ranges as shown in the table below.

Indicator	Highly acidic	Slightly acidic	Neutral	Slightly alkaline	Highly alkaline
Radish	orange	pink	green	green	green
Blueberries	red	purple	green	green	green
Red Cabbage	red	pink	purple	blue	green
Curry powder	colourless	colourless	colourless	yellow	red

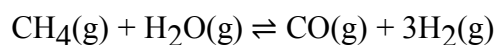
Four different solutions (W, X, Y and Z) were tested with different indicators.

- Solution W was colourless in curry powder
- Solution X was red in red cabbage
- Solution Y was green in radish
- Solution Z was purple in blueberries

Which of the solutions could be neutral?

- A. Solutions W and X
- B. Solutions X and Y
- C. Solutions Y and Z
- D. Solutions W and Y

12. A reaction commonly used industrially as a source of hydrogen is:



The equilibrium constant is 0.26 at 1200 K. In a particular reaction mixture, the concentrations were:

$$[\text{CH}_4] = 0.045 \text{ mol L}^{-1}$$

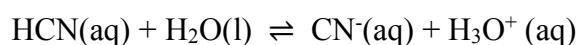
$$[\text{H}_2\text{O}] = 0.24 \text{ mol L}^{-1}$$

$$[\text{H}_2] = 0.50 \text{ mol L}^{-1}$$

$$[\text{CO}] = 0.060 \text{ mol L}^{-1}$$

Which statement regarding this mixture is correct?

- A. The mixture is at equilibrium and no shift will occur.
 - B. The mixture is not at equilibrium and the reaction will shift to the left.
 - C. The mixture is not at equilibrium and the reaction will shift to the right.
 - D. The mixture is at equilibrium and the reaction will shift to both the right and left.
13. Hydrogen cyanide gas is highly toxic. It dissolves in water to form a weak acid. The reaction is:



The acid dissociation constant is 6.3×10^{-10} . The pH of a solution of HCN of concentration $0.00010 \text{ mol L}^{-1}$ is:

- A. 2.51
- B. 3.30
- C. 6.30
- D. 6.60

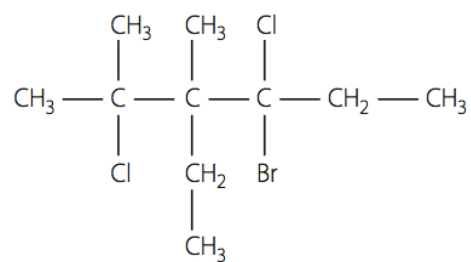
14. Four bottles (W, X, Y, Z) containing colourless liquids were found on the laboratory shelf with no labels. The bottles are known to contain 1-hexene, 1-propanol, ethanoic acid and hexane.

Bottle	Solubility in water	Decolourises bromine water in the absence of UV light	Reacts with sodium hydrogen carbonate to form a gas
W	very low	no	no
X	high	no	no
Y	high	no	yes
Z	very low	yes	no

Which row of the table best identifies the compounds?

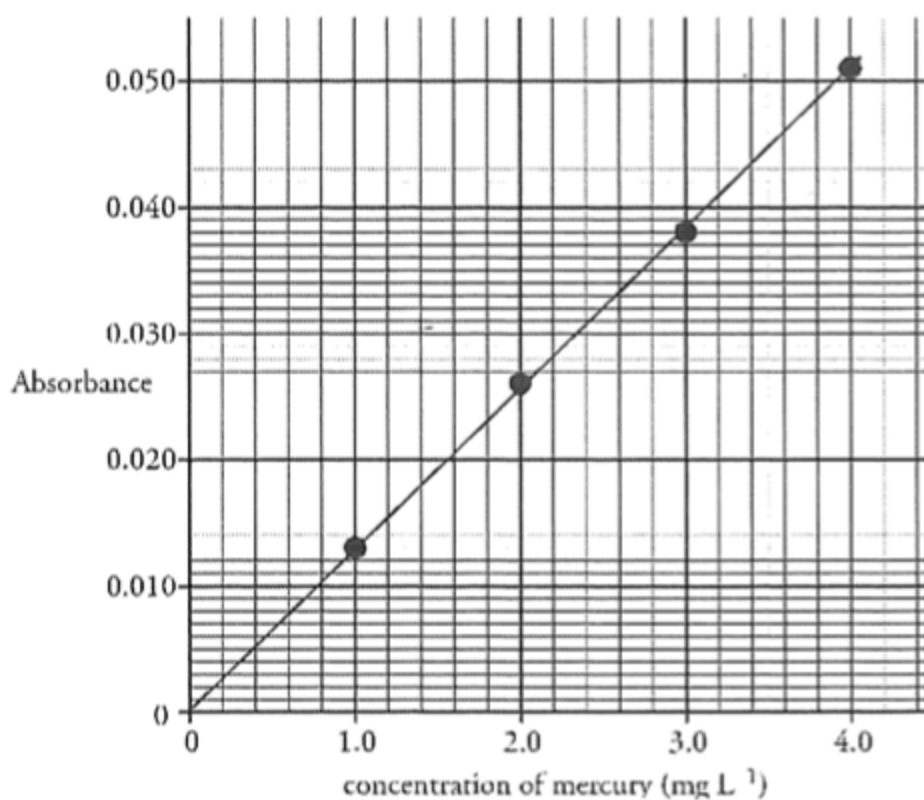
	W	X	Y	Z
A.	1-propanol	hexane	ethanoic acid	hexene
B.	hexene	ethanoic acid	1- propanol	hexane
C.	hexane	1- propanol	ethanoic acid	hexene
D.	hexene	1- propanol	hexane	ethanoic acid

15. The IUPAC systematic name for the compound whose structure is given here is:



- A. 4-bromo-2,4-dichloro-2,3-dimethyl-3ethylhexane
- B. 4-bromo-2,4-dichloro-3-ethyl-2,3-dimethylhexane
- C. 3-bromo-3,5-dichloro-4-ethyl-3,4-dimethylhexane
- D. 3-bromo-1,3-dichloro-2-ethyl-1,1,2-trimethylhexane

16. Atomic absorption spectroscopy has been used to determine the amount of mercury in various types of seafood. Calibration of the apparatus was carried out by spraying samples of standard solutions containing known amounts of mercury into a flame. The results are shown in the graph below.

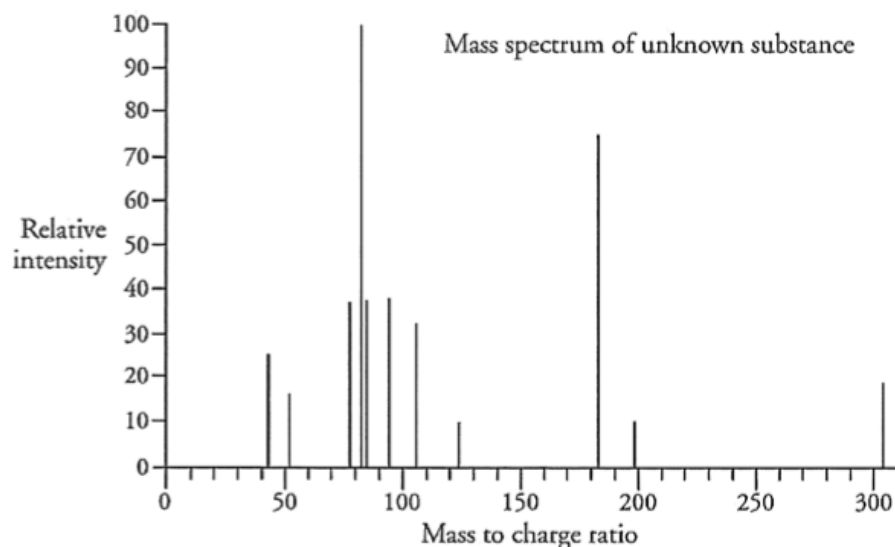


The mercury content of a sample of fish was determined by taking 20.00 g of the fish and heating it with 10 mL of nitric acid in a closed container. The resulting liquid was filtered and sprayed into the flame.

The absorbance reading obtained was 0.034. The concentration of mercury in the fish in ppm is:

- A. 1.3
- B. 2.6
- C. 3.4
- D. 26.0

17. An unknown substance was analysed with mass spectroscopy. The mass spectrum is below.



The table below shows the mass to charge ratio of a selection of fragments in the mass spectrum for four compounds of interest in forensic investigations.

Compound name	Significant fragments (mass to charge ratio)
Caffeine	67 109 194
Cocaine	82 94 182
Paracetamol	43 109 151
Amphetamine	91 119 136

Using the information in the table and the mass spectrum, identify the unknown substance.

- A. Caffeine
- B. Cocaine
- C. Paracetamol
- D. Amphetamine

18. Which one of the anions below will produce a precipitate with each of the solutions I, II and III?

(I) Silver nitrate

(II) Barium nitrate

(III) Copper(II) nitrate

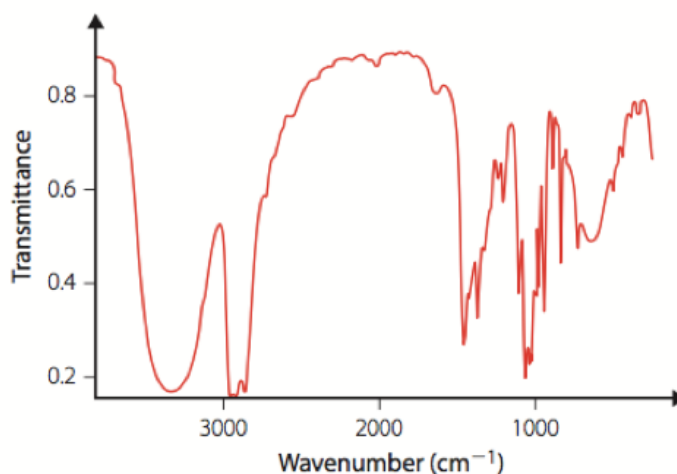
A. Cl^-

B. OH^-

C. SO_4^{2-}

D. CO_3^{2-}

19. The diagram shows the infrared spectrum of a compound.



Identify the compound that would produce a spectrum to match the one shown.

A. Butane

B. Butanal

C. Butanol

D. Butanoic acid

20. Consider the following solubility data for various chromates at 25°C.

Chromate	K_{sp}
Ag_2CrO_4	9.0×10^{-12}
$BaCrO_4$	2.0×10^{-10}
$PbCrO_4$	1.8×10^{-14}
Tl_2CrO_4	9.8×10^{-15}

The chromate that is the most soluble in water at 25°C is:

- A. $PbCrO_4$
- B. $BaCrO_4$
- C. Tl_2CrO_4
- D. Ag_2CrO_4

Section II (80 marks)

Questions: 21 – 34

Marks: 80

Time: Allow approximately 2 hours and 25 minutes for this Part.

Instructions:

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

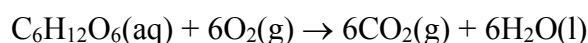
Show all relevant working in questions involving calculations.

Extra writing booklets are available upon request. If you use a booklet, clearly indicate which question you are answering and indicate in this paper that a booklet has been used. Use a new booklet for each question.

Question 21 (2 marks)

The biological process of respiration can be represented by the equation:

2



Given the following data for the reaction, calculate ΔG° and hence determine whether respiration is a spontaneous process at 25°C .

$$\Delta H^\circ = -2803 \text{ kJ mol}^{-1}$$

$$\Delta S^\circ = +212 \text{ J mol}^{-1} \text{ K}^{-1}$$

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Question 22 (4 marks)

Neutralisation is a process used in many every day or industrial situations.

- (a) Calculate the pH and pOH of a 0.600 mol L^{-1} solution of NaOH. **2**

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- (b) With the use of an equation, describe an application of a neutralisation reaction in either everyday life or an industrial process. **2**

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Question 23 (5 marks)

Knowledge of equilibrium has been used by Indigenous peoples for centuries

- (a) Explain how a food item was detoxified by Indigenous Australians. **2**

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- (b) Modern chemists also use equilibrium processes, such as the production of nitric acid. **3**

During one part of the synthesis of nitric acid, dinitrogen tetroxide is in equilibrium with nitrogen dioxide. Initially 0.540 mol of N_2O_4 was placed in a 2.00 L vessel under constant pressure and temperature. When equilibrium was achieved, 0.280 mol of NO_2 was present.

Calculate the value of the equilibrium constant.

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Question 24 (7 marks)

The heat of combustion of ethanol is 1367 kJ mol^{-1} . When students conduct an investigation to measure the heat of combustion, their results are often very inaccurate but often reliable.

- (a) Calculate the mass of ethanol that must be burnt to increase the temperature of 210 g of water by 45°C if exactly half the heat released by this combustion is lost to the surroundings.

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(b) Analyse possible reasons why this investigation is inaccurate but reliable.

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Question 25 (3 marks)

Predict whether a precipitate will form when 0.0010 g of silver carbonate is added to 100 mL of water.

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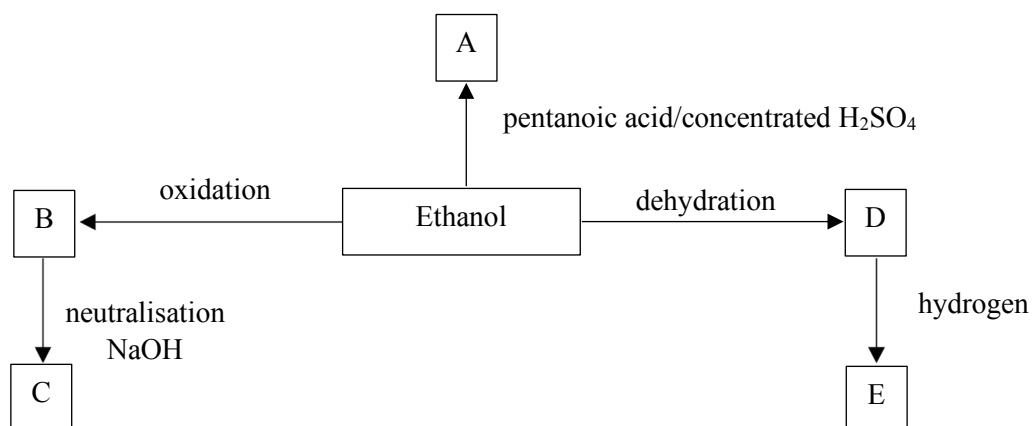
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Question 26 (13 marks)

Consider the following flowchart that shows possible reactions involving ethanol.



- (a) Draw the structural formula of B and C and justify your choice.

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- (b) Explain, with the use of an equation, the formation of E from ethanol. 3

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- (c)(i) Write an equation, using structural formula, for the formation of A. 2

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- (ii) Outline a method that could be used to prepare chemical A. 5

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Question 27 (4 marks)

The pH range for human blood is 7.35-7.45.

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Explain the role of the conjugate acid/base pair $\text{H}_2\text{CO}_3/\text{HCO}_3^-$ in maintaining the pH in blood.

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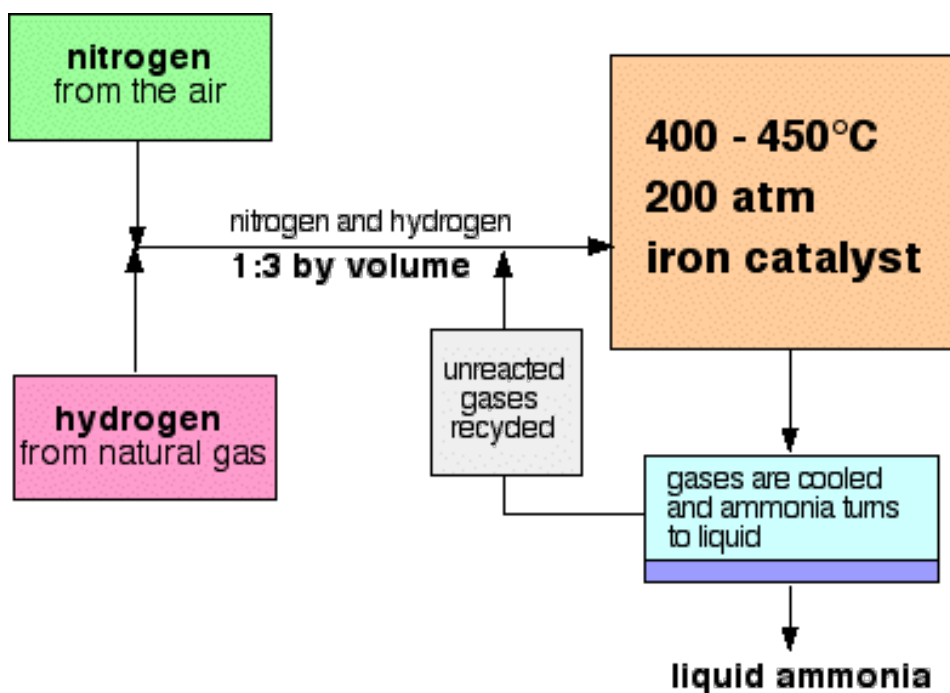
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Question 28 (6 marks)

The flowchart below shows the simplified version of the formation of ammonia by the Haber Process.



- (a) Given the formation of ammonia is an equilibrium reaction, write a balanced equation for the formation of ammonia.

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- (b) The formation of ammonia is exothermic. Assess the use of a moderate temperature in this process. 4

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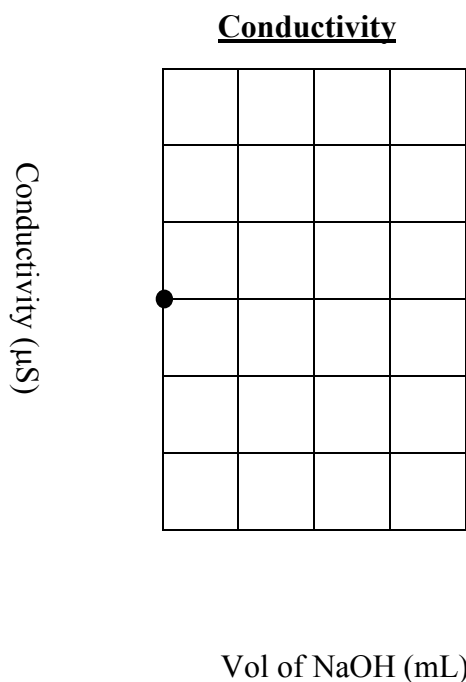
Question 29 (5 marks)

To determine the concentration of a sodium hydroxide solution, a student determined through titration that 25.0 mL of 0.200 mol L⁻¹ hydrochloric acid reacted with 10.0 mL of the sodium hydroxide solution.

- (a) Identify a piece of equipment that could be used to accurately measure pH changes. **1**

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- (b) Use the information provided to sketch the conductivity and pH curves on the following grids. In answering this: **4**
- Put appropriate values for the volume of sodium hydroxide on both the conductivity and pH graphs.
 - Put appropriate pH values on the pH graph.
 - Start the conductivity graph at the point indicated.



pH

pH

Vol of NaOH (mL)

Question 30 (7 marks)

Inter and intra electrostatic forces play an important role in determining the properties of chemical substances.

7

Analyse the impact of electrostatic attractions on the following:

- Solubility of ions in a water body in determining the water hardness
- Flexibility of LDPE polyethylene compared with polyvinyl chloride
- Completeness of combustion of ethanol compared to 1-pentanol

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Question 31 (5 marks)

With the aid of a diagram, explain the differences in boiling points between the three compounds in the table below.

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	Molecular mass (g mol ⁻¹)	Boiling Point (°C)
1-propanamine	59.11	47.8
Butane	58.1	-1.0
Ethanoic Acid	60.052	118.1

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Question 32 (6 marks)

A 100.0 mL solution is known to contain iodide ions. To determine the concentration of iodide ions in the solution, the following investigation was conducted by a student.

Step 1: 50.0 mL of 0.05619 mol L⁻¹ silver nitrate solution was added so that all the iodide ions formed a precipitate. This precipitate was filtered and separated from the final solution.

Step 2: The excess silver ions in the final solution were titrated against 0.05322 mol L⁻¹ potassium thiocyanate (KSCN) using iron(III) ions as the indicator. 35.14 mL of potassium thiocyanate was required to reach the endpoint.

- (a) During the investigation, the burette was filled with thiocyanate solution. Identify what the burette was rinsed with prior to filling. **1**

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- (b) Determine the concentration of the iodide ions in the original solution. **3**

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(c) Explain why a deep red colour forms at the endpoint.

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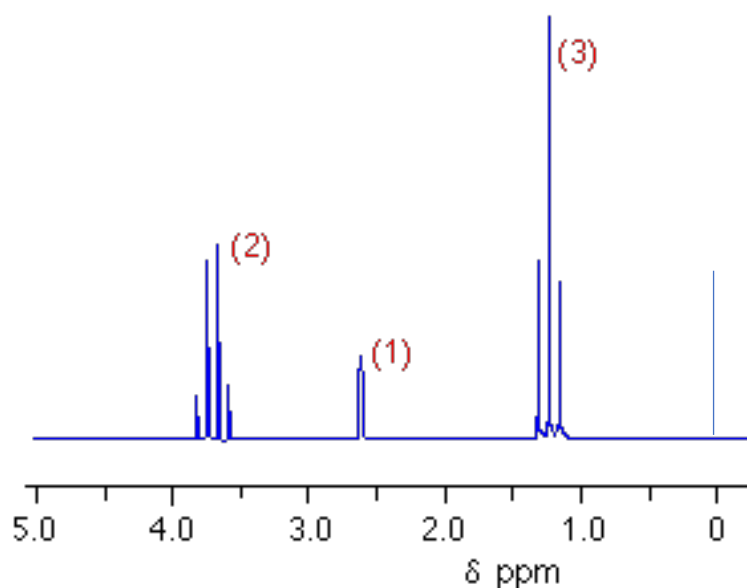
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Question 33 (4 marks)

The following diagram shows a high resolution proton NMR spectrum for ethanol.



TYPE OF PROTON	CHEMICAL SHIFT (ppm)	TYPE OF PROTON	CHEMICAL SHIFT (ppm)
Alkane CH_3	0.9	$\text{R}-\text{NH}_2$ $\text{RCH}=\text{CH}_2$	Variable, about 1.5–4 4.6–6.0
$\text{R}-\text{CH}_2-\text{R}$	1.3	$\text{R}-\text{O}-\text{CH}_3$ or ROCH_2R	3.3
$\text{R}-\text{C}=\text{OCH}_3$	2.1	$\text{R}-\text{OH}$	Variable, about 1–6
$\text{R}-\text{CH}_2-\text{X}$ ($\text{X} = \text{F}, \text{Cl}, \text{Br}$ or I)	3–4	$\text{Ar}-\text{OH}$	Variable, about 4–7
CH_3-COOR	2.0	$\text{R}-\text{COOH}$	9–13
RCH_2OH $\text{RCH}=\text{CH}-\text{CH}_3$	3.3–4.5 1.6–1.9	$\text{R}-\text{C}(\text{O})\text{H}$	9–10

Explain how the features of the NMR spectrum represent the different parts of the ethanol molecule.

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Question 34 (9 marks)

The use of carbon based chemicals can lead to significant negative environmental effects.

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Analyse the impact of carbon based chemicals upon the environment by examining THREE different negative effects.

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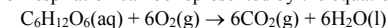
Mcq Answers are as follows:

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

Yr 12 Trial 2019 – Marking Guidelines

Question 21 (2 marks)

The biological process of respiration can be represented by the equation:



Given the following data for the reaction, calculate ΔG° and hence determine whether respiration is a spontaneous process at 25°C.

$$\Delta H^\circ = -2803 \text{ kJ mol}^{-1}$$

$$\Delta S^\circ = +212 \text{ J mol}^{-1} \text{ K}^{-1}$$

2

Criteria (Band 2-4)	Marks
Provides the correct steps in the calculation ΔG° and determines that respiration is spontaneous at 25°C since $\Delta G^\circ < 0$.	2
Provides a correct step in the calculation of ΔG°	1

COMMENTS: Generally well done by most students. Take care to convert temperature values to Kelvin and convert ΔS° into kilojoules when calculating Gibbs Free Energy and clearly link your judgement as to whether a reaction is spontaneous or non spontaneous based on whether the value for ΔG° is positive or negative....don't assume the marker knows this.

Question 22 (4 marks)

Neutralisation is a process used in many everyday or industrial situations.

- (a) Calculate the pH and pOH of a 0.600 mol L⁻¹ solution of NaOH.

2

Criteria (Band 2-4)	Marks
Provides the correct steps in the calculation of pH and pOH	2
Provides a correct step in the calculation of pH and /or pOH	1

COMMENTS: Remember to give values of pH and pOH to correct number of decimal places (in the same way as sig figs are calculated). Marks were not deducted in this instance but may in your HSC.

Many students calculated the pH using the value of hydroxide concentration. Be careful here.

- (b) With the use of an equation, describe an application of a neutralisation reaction in either everyday life or an industrial process.

2

Criteria (Band 2-6)	Marks
With a correct equation, describes an application of a specific neutralisation reaction in either everyday life or an industrial process	2
Identifies an application of a neutralisation reaction in everyday life or an industrial process	1

COMMENT: Many students should read pg 131-134 from their text again and make notes (refer to your chem manual for module 6). Many 'hopeful' answers here. Learn some applications of neutralisation reactions in case you are asked 3 or 4 marks for this type of question.

Question 23 (5 marks)

Knowledge of equilibrium has been used by Indigenous peoples for centuries.

- (a) Explain how a food item was detoxified by Indigenous Australians.

2

Criteria (Band 2-4)	Marks
With a specific example, explains the detoxification of a food by Indigenous peoples and makes reference to an equilibrium process.	3
Describes an example of detoxification of food by Indigenous peoples	2
Provides one relevant piece of information regarding detoxification of food by Indigenous peoples	1

COMMENT: Read pg91-93 textbook and make notes. Obvious that this part of the syllabus has not been well studied.

Students needed to address that static equilibrium (or no dynamic equilibrium) was established in this situation of leaching toxins by using a running stream of water.

- (b) Modern chemists also use equilibrium processes, such as the production of nitric acid. During one part of the synthesis of nitric acid, dinitrogen tetroxide is in equilibrium with nitrogen dioxide. Initially 0.540 mol of N_2O_4 was placed in a 2.00 L vessel. When equilibrium was achieved, 0.280 mol of NO_2 was present. Calculate the value of the equilibrium constant at this temperature. 3

Criteria (Band 2-6)	Marks
With an equation, provides the correct steps to calculate the equilibrium concentration	3
Provides some correct steps to calculate the equilibrium concentration	2
Provides a correct steps to calculate the equilibrium concentration	1

COMMENT: Some very well structured answers here but we could do with more of the cohort planning their answers as recommended in the textbook (I.C.E). Make it easier for the marker to follow your calculation process by using units in the various stages and don't just introduce a number without stating what it is or where it came from. Stating the K_{eq} expression is vital here.

Question 24 (7 marks)

The heat of combustion of ethanol is 1367 kJ mol^{-1} . When students conduct an investigation to measure the heat of combustion, their results are often very inaccurate but often reliable.

- (a) Calculate the mass of ethanol that must be burnt to increase the temperature of 210 g of water by 45°C if exactly half the heat released by this combustion is lost to the surroundings. 4

Criteria (Band 2-6)	Marks
Provides correct steps in the calculation of the mass of ethanol All working shown Correct sig fig	4
Provides mostly correct steps in the calculation of the mass of ethanol All working shown	3
Provides some correct steps in the calculation of the mass of ethanol Some working is shown	2
1 step of the calculation correct	1

Markers Comment:

- This question was done well by the cohort – including ALL working shown.
- A few students forgot to incorporate into their calculation the fact that half of the heat released by the combustion was lost to surroundings.

- Don't round off values early in the calculations. Leave rounding off in the final answer when significant figures are also assessed.

- (b) Analyse possible reasons why this investigation is inaccurate but reliable. 3

Criteria (Band 2-6)	Marks
Thoroughly analyses reasons why the investigation is inaccurate but reliable	3
Soundly explains why this investigation is inaccurate but reliable OR Thoroughly analyses why the investigation is either inaccurate or reliable	2
Identifies why this investigation is inaccurate or reliable	1

Analyse = Identify components and the relationship among them; draw out and relate implications; Accuracy = how close to the theoretical value; Reliability = how close the results are to each other

Marker Comments:

Students should include the following in their response:

- identify the two significant reasons for the inaccuracy obtained in this investigation namely heat loss to surroundings and incomplete combustion and explain how these affect the accuracy of the result.
- Explain why the same inaccuracies (i.e. heat loss) will occur for all repeats and relate this to the reliability of results.

Question 25 (3 marks)

Predict whether a precipitate will form when 0.0010 g of silver carbonate is added to 100 mL of water. 3

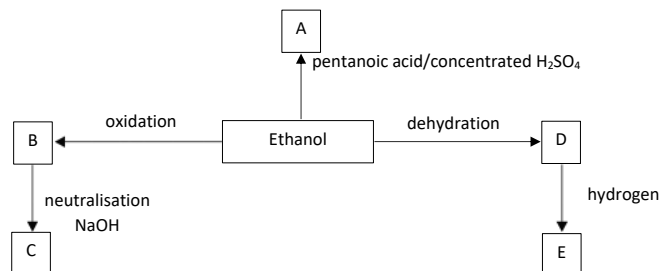
Criteria (Band 2-6)	Marks
Shows all relevant steps in the calculations to show that no precipitate will form when 0.0010g of silver carbonate is added to 100 mL of water.	3
Uses K_{sp} and/or data provided to show substantial steps to calculate conditions to predict whether a precipitate forms.	2
Provides some relevant calculation steps	1

Marker Comments:

- Note that there are at least 3 methods/ways to determine the answer to this question.
- A few students need a reminder to use their NESA data sheet – i.e. K_{sp} values!
- Substantiate your prediction of whether a ppt forms or not by making a clear statement at the end.

Question 26 (13 marks)

Consider the following flowchart that shows possible reactions involving ethanol.



- (a) Justify the name and structure of B and C.

3

Criteria (Band 2-6)	Marks
Correctly names B and C and draws structural formula for each Justifies formation of B and C	3
Correctly names B and C and draws structural formula Gives a reason for the name or structure of B and C Or Gives a reason for the name and structure of B or C	2
Correctly names B or C	1

Marker's comments

Structural formula includes ALL bonds. "OH" was a common area where the bond was not drawn.

I would have liked to see a full justification of ethanoic acid given that the oxidation of ethanol goes first through alkanal then alkanic acid. Using both oxidation and neutralisation would have been the best justification for B.

- (b) Explain, with the use of an equation, the formation of E from ethanol.

3

Criteria (Band 2-6)	Marks
Correctly identifies the formation of E Uses equation/s to show the formation of ethene and then ethane Includes correct catalyst for both reactions	3
Correctly identifies the formation of ethene with correct equation OR Correctly identifies the formation of D and E with an error in an equation	2
Either D or E correctly identified	1

Marker's comments:

Catalysts!

- (c)(i) Write an equation for the formation of A

2

Criteria (Band 2-6)	Marks
Correct equation for the formation of A	2
Correct reactants and products in equation for formation of A Or correct equation, missing water	1

Markers comments:

very few students did the structural formula of H₂O! Therefore, banding of question changed to 2-4 (Also no bond in O-H not penalised - tested in previous qu and lower band)

Also – equilibrium arrow OR catalyst was not penalised – lower band!!

Very few people did a 100% correct equation.

- (ii) Outline a method that could be used to prepare chemical A.

5

Criteria (Band 2-6)	Marks
Provides an extensive outline of the production of an ester including all required chemicals and conditions and an assessment of risk	5
Provides a thorough outline of the production of an ester including all chemicals and conditions and an assessment of risk - but with minor errors	4
Provides a valid outline of the production of an ester but missing some key chemicals and/or conditions and/or a risk assessment	3
Provides some valid steps in the production of an ester with some reference to required chemicals	2
Provides some valid steps in the production of an ester	1

Markers Comments:

The risk assessment was not well done.

MUST address conc sulfuric and volatile and flammable organics

Careful with "do not use in presence of flame" – then how do you safely heat it – state use a heating mantle

Check quantities – equipment, including water cooled condenser and time of reflux (3 drops, 10ml ethanol and 12mL pentanoic acid) .

Turn your water tap on before you start heating the mixture

Good words to use in a method "transfer", "dropwise"

Note, purifying the ester was not required for this question though several people did this well. Note: NaOH is not used to neutralise the acid – it is sodium carbonate!

Question 27 (4 marks)

The pH range for human blood is 7.35-7.45.

Explain the role of the conjugate acid/base pair $\text{H}_2\text{CO}_3/\text{HCO}_3^-$ in maintaining the pH in blood.

4

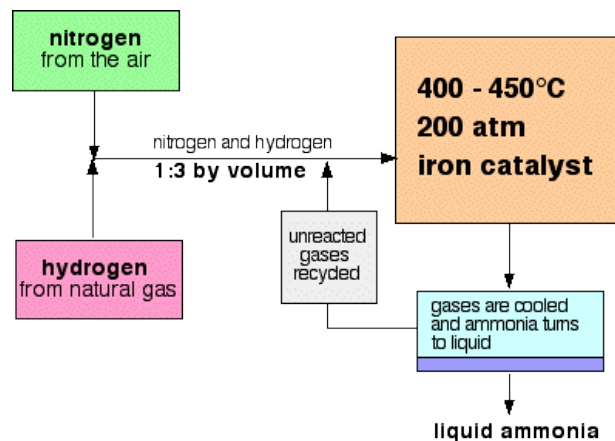
Criteria (Band 2-6)	Marks
Demonstrates a thorough understanding of a buffer by using an appropriate chemical equilibrium equation of the conjugate acid/base pair $\text{H}_2\text{CO}_3/\text{HCO}_3^-$ to show the effect when blood acid AND base levels change.	4
Demonstrates a thorough understanding of a buffer by using an appropriate chemical equilibrium equation of the conjugate acid/base pair $\text{H}_2\text{CO}_3/\text{HCO}_3^-$ to show the effect when blood acid OR base levels change.	3
Demonstrates a thorough understanding of a buffer to describe the role of the $\text{H}_2\text{CO}_3/\text{HCO}_3^-$ in maintaining the pH in blood	2
Provides some relevant information in relation to a change in blood pH	1

Markers Comments:

- Generally well done
- Students who answered this well-established what a buffer is and used a BL equation to demonstrate buffering capacity in the blood when the pH is both raised and lowered.

Question 28 (6 marks)

The flowchart below shows the simplified version of the formation of ammonia by the Haber Process.



6

- (a) Given the formation of ammonia is an equilibrium reaction, write a balanced equation for the formation of ammonia. 2

Criteria (Band 2-4)	Marks
Correct balanced equation demonstrating states and using an equilibrium arrow	2
Partially correct equation	1

Comments: iron catalyst could/should have been added as well if you used the stimulus!) – not penalised.

- (b) The formation of ammonia is exothermic. Assess the use of a moderate temperature in this process. 4

Criteria (Band 2-6)	Marks
Extensive discussion of temperature in terms of equilibrium (yield) and reaction rates. Answer includes clear "Assess" structure including a judgement	4
Thorough discussion of temperature in terms of equilibrium (yield) and reaction rates. Answer includes "Assess" structure including a judgement	3
Sound discussion of temperature in terms of equilibrium (yield) and reaction rates.	2
Some relevant point made about either	1

Marker's comments:

Common error: "Moderate temperature will increase reaction rate" Does that make sense?? Compared to what??

Generally well done – most deductions were for not fully explaining effect of temperature change on equilibrium.

Please structure your answer to match verb!! (A marker shouldn't have to look very hard to find your for, against and a judgement.

Most people had a judgement which was pleasing to see.

Question 29 (5 marks)

To determine the concentration of a sodium hydroxide solution, a student determined through titration that 25.0 mL of 0.200 mol L⁻¹ hydrochloric acid reacted with 10.0 mL of the sodium hydroxide solution.

- (a) Identify a piece of equipment that could be used to accurately measure pH changes. 1

Criteria (Band 2-4)	Marks
Correctly identifies a piece of equipment that could be used to measure pH changes	1

Comments

Very well answered

- (b) Use the information provided to sketch the conductivity and pH curves on the following grids. In answering this: 4
- Put appropriate values for the volume of sodium hydroxide on both the conductivity and pH graphs.

7

- Put appropriate pH values on the pH graph.
- Start the conductivity graph at the point indicated.

Criteria (Band 2-6)	Marks
• Correctly sketches both pH and conductivity curves and uses appropriate values for volume of NaOH	4
• Correctly sketches pH OR conductivity curves and uses appropriate values for volume of NaOH • The other graph is mostly correct	3
• Correctly sketches pH OR conductivity curves and uses appropriate values for volume of NaOH OR • Sketches both pH and conductivity curves partially correct	2
• Either graph is sketched with some correct information	1

Comments

Students who answered this well were able to incorporate values into their graph by using the data provided in the question to do appropriate calculations and draw the graph with the correct shape..

Question 30 (7 marks)

Inter and intra electrostatic forces play an important role in determining the properties of chemical substances.

Analyse the impact of electrostatic attractions on the following:

- Solubility of ions in a water body in determining the water hardness
- Flexibility of LDPE polyethylene compared with polyvinyl chloride
- Completeness of combustion of ethanol compared to 1-pentanol

Criteria (Band 2-6)	Marks
• Clearly demonstrates an extensive knowledge and understanding of the relevant intra or inter molecular forces with all three examples • Provides correct relevant equations and structures	7
• Clearly demonstrates an extensive knowledge and understanding of the relevant intra or inter molecular forces with two examples • Demonstrates thorough knowledge and understanding of the relevant intra or inter molecular forces with one example • Provides relevant equations and structures	6
• Clearly demonstrates an extensive knowledge and understanding of the relevant intra or inter molecular forces with one example • Demonstrates a thorough knowledge and understanding of the relevant intra or inter molecular forces with two examples • Provides a relevant equation and/or structure	5
• Demonstrates a thorough knowledge and understanding of the relevant intra or inter molecular forces with two examples OR • Demonstrates a thorough (or extensive) knowledge and understanding of the relevant intra or inter molecular force with one example AND a sound knowledge and understanding of the relevant intra or inter molecular force with two example	4
• Demonstrates a thorough (or extensive) knowledge and understanding of the relevant intra or inter molecular force with one example OR • Demonstrates a sound knowledge and understanding of the relevant intra or inter molecular forces with at least two examples	3
• Demonstrates a basic knowledge and understanding of the relevant intra or inter molecular forces with one (or more) of the examples	2
• Provides some relevant information with one of the examples	1

Marker comments:

- The students who understood this question were able to draw on their knowledge across a large part of the syllabus. In revising for the HSC students must practise making links across all areas of the syllabus in preparation for a possible long response question(s).
- Students are encouraged to plan an answer carefully and provide examples. In this question students are expected to remember the theory of structure and bonding eg

intermolecular forces (dispersion and dipole-dipole), ion dipoles and ionic bonding and covalent bonding.

Question 31 (5 marks)

With the aid of a diagram, explain the differences in boiling points between the three compounds in the table below.

	Molecular mass (g mol ⁻¹)	Boiling Point (°C)
1-propanamine	59.11	47.8
Butane	58.1	-1.0
Ethanoic Acid	60.052	118.1

5

Criteria (Band 2-6)	Marks
Thoroughly explains the differences in boiling points between the three compounds (links structure to IMF, to heat energy, to boiling point) and identifies that the dispersion forces would be similar between the three compounds Draws labelled diagrams to indicate intermolecular bonds	5
Soundly explains the differences in boiling points between the three compounds Draws at least one labelled diagram to indicate intermolecular bonds	4
Explains the differences in boiling points between at least two of the compounds Draws at least one relevant diagram	3
Demonstrates a limited understanding of the difference in boiling points of at least 2 of the compounds	2
One relevant point made	1

Marker Comments:

- A lot of students failed to show the intermolecular forces (IMF) on their diagrams. Diagrams need labels indicating the IMF and the polarity of the molecule.
- A lot of students ignored the information of the MM provided. I.e. similar MM indicate that dispersion forces between each of the compounds are similar; thus, functional groups of molecules need to be considered to explain the difference in BP.
- Ensure that your response (and diagrams) indicate that IMF exist BETWEEN molecules.
- Link the strength of IMF to the heat energy needed to overcome IMF and link this to BP.

Question 32 (6 marks)

A 100.0 mL solution is known to contain iodide ions. To determine the concentration of iodide ions in the solution, the following investigation was conducted by a student.

Step 1: 50.0 mL of 0.05619 mol L⁻¹ silver nitrate solution was added so that all the iodide ions formed a precipitate. This precipitate was filtered and separated from the final solution.

Step 2: The excess silver ions in the final solution were titrated against 0.05322 mol L⁻¹ potassium thiocyanate (KSCN) using iron(III) ions as the indicator. 35.14 mL of potassium thiocyanate was required to reach the endpoint.

- (a) During the investigation, the burette was filled with thiocyanate solution. Identify what the burette was rinsed with prior to filling. 1

Criteria (Band 2-4)	Marks
correct identification	1

Markers Comment:

- nearly all students got this right
- note that identify does not require an extended explanation

- (b) Determine the concentration of the iodide ions in the original solution. 3

Criteria (Band 2-6)	Marks
Correct calculations shown with full working and final units	3
Mostly correct calculations shown with minor errors	2
At least one correct step shown	1

Markers Comments:

- Done well overall, most students able to access full marks
- Several students used the wrong volume at the end to calculate the concentration - consider how you extract data from the stimulus to ensure you are using the correct values.
- The majority of mistakes came from writing the incorrect formula for substances and thus using the wrong mole ratio during calculations.
- PLEASE include units at each step, not just at the end!

- (c) Explain why a deep red colour forms at the endpoint. 2

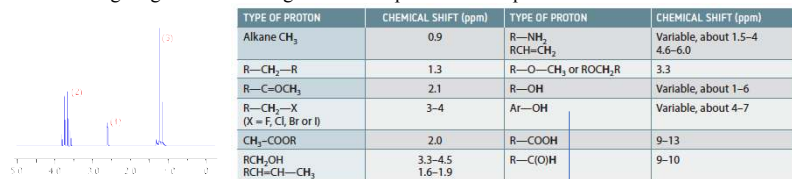
Criteria (Band 2-6)	Marks
Equation used to explain formation of iron thiocyanate - linked to endpoint of titration	2
Formation of iron thiocyanate explained without link to endpoint	1

Markers Comments:

- The majority of students gained full marks.
- Comment mistake 1 - not referring to the SCN⁻ ions being in excess at the endpoint, just giving the overall reaction and colour - this does not link back to the idea of what is occurring at the endpoint
- Common mistake 2 - discussing the iron thiocyanate equilibrium and how the extra SCN ions would adjust by LCP - prior to the colour change there were no SCN ions (all used by silver) so there cannot be an equilibrium to change.

Question 33 (4 marks)

The following diagram shows a high resolution proton NMR spectrum for ethanol.



Explain how the features of the NMR spectrum represent the different parts of the ethanol molecule.

4

Criteria (Band 2-6)	Marks
Extensively explains how each of the three peak clusters represents the different parts of the ethanol molecule using multiple pieces of evidence from the spectrum and table	4
Explains how the peak clusters represent some different parts of the ethanol molecule using pieces of evidence from the spectrum and table	3
Explains how the peak clusters represent at least one part of the ethanol molecule using pieces of evidence from the spectrum and table OR Identifies multiple peaks as specific parts of the ethanol molecule with minimal supporting evidence OR Gives general overview of how multiple spectral features can be used to identify organic molecules	2
Provides some relevant information	1

Markers Comments:

- Very well done by the majority of students.
- To gain full marks you had to explain EACH peak using multiple pieces of evidence (chemical shift, peak height and peak clusters) clearly linked to the peak you were discussing.
- Some students gave a more generic overview of spectral features without linking to the ethanol molecule. When specific molecules are given in the stimulus - USE THEM!
- Better responses annotated the stimulus (drew arrows from spectral peaks to the relevant parts of the table)
- Better responses used a labelled diagram that showed the hydrogen environments of ethanol, labelled them then referred to this diagram in their answer.

Question 34 (9 marks)

The use of carbon based chemicals can lead to significant negative environmental effects. Analyse the impact of carbon based chemicals upon the environment by examining THREE different negative effects.

9

Criteria (Band 2-6)	Marks
• Extensive analysis of three different negative environmental effects from carbon compounds. • Extensive chemical description of the cause of three problems. • Extensive description of three environmental problems caused - related to chemistry of the carbon compound • At least two relevant equations included.	8-9
• Thorough analysis of at least two different negative environmental effects from carbon compounds. • Thorough chemical description of the cause of at least two problems. • Thorough description of at least two environmental problems caused - with some links to chemistry of the carbon compound • At least one relevant equation included.	6-7
• Sound analysis of at least two different negative environmental effects from carbon compounds. • Sound chemical description of the cause of at least two problems. • Sound description of at least two environmental problems caused - with attempts to link to chemistry of the carbon compound	4-5
• Limited analysis of at least two problems	3
• Identification of at least two problems	2
• Identification of at least one problem	1

Markers comments:

- The majority of students were able to identify three good impacts, and give a pretty high level discussion of the cause of the issue, using a lot of good chemistry.
- The majority of students used an equation! Many students used multiple equations! Just make sure they are correct and balanced though...
- Major issue in this question was not reading the question: "impact of carbon based chemicals upon the environment"
 - The majority of students spent a page discussing the chemical problem and 1-2 sentences on the environmental impact
 - A large number of students discussed the impact of sulfur, sulfur dioxide, nitrogen, nitrogen based fertilisers, phosphates on the environment. *Unsure if I need to point out none of these are carbon.*
- Several features of the **OLD SYLLABUS** were raised including exceptionally detailed answers on acid rain from sulfur dioxide emissions (discussed minorly in this course), the ozone layer (not in this course). However, the current syllabus provided multiple, easy carbon based impacts/issues that could have been discussed without going to the "this is sort of linked to carbon in the most minor way so I will make a whole answer out of it" answer. Possible points included:
 - Enhanced greenhouse effect (please discuss the ENHANCED effect or you are just discussing the natural one)
 - Acidification of oceans from release of carbon dioxide
 - Polymer pollution
 - Products of incomplete combustion (carbon monoxide/soot)
 - Mining/transport of fossil fuels leading to environmental degradation and oil spills

- Release of organic wastes from industrial processes into waterways
- Release of ionic detergents into the environment that cause foam/lather to form in waterways, also non-biodegradable nature of some soap/detergent molecules
- Weaker points (that gained none-some marks)
 - release of random chemicals including methane, platinum, palladium, benzene from unspecified industrial processes with no specific reasoning other than "they are used in industrial processes"
 - acid rain from carbon dioxide - this is a natural process and not an issue. Acid rain issues are exclusively from nitrogen/sulfur compound emissions
 - acid rain from sulfur/nitrogen compounds - not carbon based. To mention coal once then basically ignore carbon entirely when so many better options were available....
 - phosphates in detergents - its a stretch, did get some marks as the carbon based detergents are released to the environment
 - ozone issues - NO - **STOP LINKING CARBON DIOXIDE TO OZONE**. Better still! **DO NOT DISCUSS OZONE IN THIS COURSE**.
- The major issue is the discussion of the environmental points:
 - Very few students did anything other than a list potential problems (listicles from Buzzfeed are not acceptable HSC answers for anything...). This got you into the 4-5 range.
 - Students who attempted to link problems, show some detail and description - in the 6-7 range.
 - Students who were able to layer their responses (extensive....) and show how the initial pollution builds into major problems over time, also linking environmental issues to potential issues with economics, tourism and incorporating large scale problems - in the 8-9 range
 - LISTS ARE NOT AN ANSWER TO ANYTHING OTHER THAN AN IDENTIFY QUESTION