



**2014**

**TRIAL HSC  
EXAMINATION**

# Chemistry

## General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Write your Student Number on the Answer sheets on pages 10,11 and the Option booklet
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided.

**Total Marks – 100**

**Section I** Pages 2 – 24

**75 marks**

This section 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 – 55 marks

- Attempt Questions 21 – 33
- Allow about 1 hour and 40 minutes for this part

**Section II** Pages 23 – 24

**25 marks**

- Attempt Question 34
- Allow about 45 minutes for this section

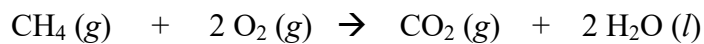


## Multiple Choice

Use the multiple choice Answer sheet for Questions 1 – 20 on page 10

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1. Consider the following reaction:



Which of the alternatives is correct?

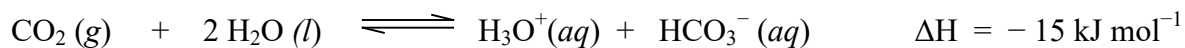
- (A) Carbon was oxidised.
- (B) Hydrogen was reduced.
- (C) Oxygen was oxidised.
- (D) Hydrogen was oxidised.
2. If sufficient amount of element 118 was synthesised, what general characteristic will it have?
- (A) a shiny reactive solid
- (B) a dull unreactive solid
- (C) an unreactive, monatomic gas
- (D) a black corrosive liquid
3. A student was given two solutions labelled *X* and *Y*, which may be acidic, neutral or basic. The student added one drop of each of the indicators and recorded the final colour of the solution.

<i>Indicator</i>	<i>X</i>	<i>Y</i>
methyl orange	red	yellow
bromothymol blue	yellow	yellow
phenolphthalein	colourless	colourless

Which correctly describes each solution?

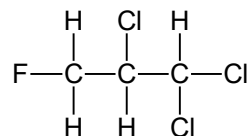
	<i>X</i>	<i>Y</i>
(A)	very acidic	very basic
(B)	very acidic	slightly basic, neutral or slightly acidic
(C)	slightly acidic	neutral or very basic
(D)	very acidic	slightly basic to very basic

4. What volume of carbon dioxide gas measured at 25°C and 100 kPa is released when 50.0 mL of 0.20 mol L<sup>-1</sup> hydrochloric acid is added to 5.0 g of calcium carbonate?
- (A) 0.11 L  
 (B) 0.12 L  
 (C) 0.22 L  
 (D) 0.24 L
5. Which substance will turn red litmus to blue when dissolved in water?
- (A) CO  
 (B) NO  
 (C) Li<sub>2</sub>O  
 (D) Cl<sub>2</sub>O
6. The equation gives the equilibrium reaction between carbon dioxide and water:



What effect will an increase in temperature have on the pH of the solution?

- (A) equilibrium shifts left and the pH increases  
 (B) equilibrium shifts right and the pH decreases  
 (C) equilibrium shifts right and the pH increases  
 (D) equilibrium shifts left and the pH decreases
7. What is the correct systematic name of this compound?



- (A) 3-fluoro-1,1,2-trichloropropane  
 (B) 2,3,3-trichloro-1-fluoropropane  
 (C) 1,1,2-trichloro-3-fluoropropane  
 (D) 1-fluoro-2,3,3-trichloropropane

8. When dilute sulfuric acid was added to an unknown solution, *L*, a white precipitate was formed. The possible ions in the unknown are: sodium, calcium, barium and lead.

What is an additional test that can be done to a fresh sample to determine the exact identity of the ion present?

- (A) add silver nitrate  
(B) do the flame test  
(C) add sodium carbonate  
(D) test the pH
9. Which of the following pair of substances in solution can act as a buffer?  
(A) NaCl and HCl  
(B) NaCH<sub>3</sub>COO and NaOH  
(C) Na<sub>2</sub>HPO<sub>4</sub> and NaH<sub>2</sub>PO<sub>4</sub>  
(D) Na<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>SO<sub>4</sub>

10. Which instrument cannot be used to detect radiation?

- (A) Geiger meter  
(B) photographic plate  
(C) scintillation counter  
(D) spectrophotometer

11. In which of the following reactions is water acting as a Bronsted – Lowry acid?

- (A)  $\text{H}_3\text{O}^+(\text{aq}) + \text{HC}_2\text{O}_4^-(\text{aq}) \rightleftharpoons \text{H}_2\text{O}(\text{l}) + \text{H}_2\text{C}_2\text{O}_4(\text{aq})$   
(B)  $\text{H}_2\text{O}(\text{l}) + \text{H}_2\text{CO}_3(\text{aq}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$   
(C)  $\text{H}_2\text{O}(\text{l}) + \text{CH}_3\text{NH}_2(\text{aq}) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$   
(D)  $\text{H}_3\text{O}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightleftharpoons \text{HS}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$

12. What is an example of a dilute strong acid?

- (A) 2.0 mol L<sup>-1</sup> HCl
- (B) 2.0 mol L<sup>-1</sup> CH<sub>3</sub>COOH
- (C) 0.10 mol L<sup>-1</sup> HNO<sub>3</sub>
- (D) 0.10 mol L<sup>-1</sup> C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>

13. An aqueous sample containing Cl<sup>-</sup>, CO<sub>3</sub><sup>2-</sup> and SO<sub>4</sub><sup>2-</sup> is analysed.

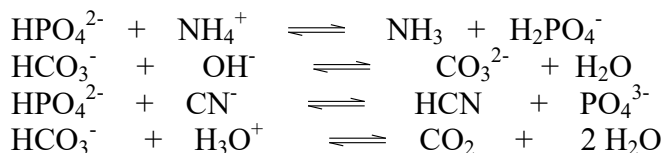
Which order should the reagents be added to determine the amount of chloride in the sample?

	<i>Reagent 1</i>	<i>Reagent 2</i>	<i>Reagent 3</i>
(A)	AgNO <sub>3</sub>	H <sub>2</sub> SO <sub>4</sub>	BaSO <sub>4</sub>
(B)	HCl	Pb(NO <sub>3</sub> ) <sub>2</sub>	AgNO <sub>3</sub>
(C)	Ba(NO <sub>3</sub> ) <sub>2</sub>	AgNO <sub>3</sub>	HCl
(D)	HNO <sub>3</sub>	Ba(NO <sub>3</sub> ) <sub>2</sub>	AgNO <sub>3</sub>

14. What property would be most useful in distinguishing between butan-1-ol and butyl butanoate?

- (A) boiling point
- (B) colour
- (C) conductivity
- (D) pH

15. Consider the reactions represented by the following equations:



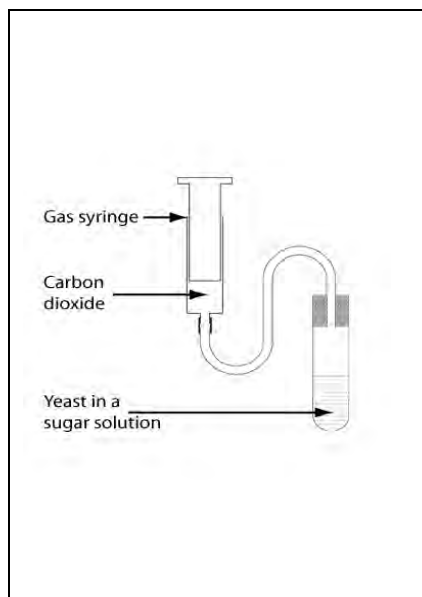
In these reactions which one of the following reacts as an amphoteric species?

- (A) H<sub>2</sub>PO<sub>4</sub><sup>-</sup>
- (B) NH<sub>4</sub><sup>+</sup>
- (C) CO<sub>3</sub><sup>2-</sup>
- (D) HPO<sub>4</sub><sup>2-</sup>

16. What is always produced during the complete combustion of natural gas?

- (A) Carbon monoxide
- (B) Sulfur dioxide
- (C) Carbon (soot)
- (D) Water

17. The diagram shows a set-up used by a group of students to monitor glucose fermentation.



What mass of glucose was fermented if the syringe recorded a volume of 3.0 mL at 25 °C and 100 KPa?

- (A) 0.011 g
- (B) 0.022 g
- (C) 0.044 g
- (D) 0.11 g

18. Which nutrients are the most significant cause of eutrophication?

- (A) phosphorus and nitrates
- (B) potassium and phosphates
- (C) potassium and nitrates
- (D) phosphates and nitrates

19. This image shows a section of a creek at North Parramatta.



What would be the first step needed to treat this water?

- (A) screen filtration
- (B) filtration through sand
- (C) increase the pH of the water and then maintain this by the addition of a buffer
- (D) addition of a chemical to precipitate any heavy metals present thus allowing them to be removed by sand filtration



20. What important role in the oil refining process does this catalytic cracker tower facilitate?



- (A) allows the more usable fractions of the crude oil to rise through the tower to be collected at the top
- (B) allows longer hydrocarbon chains to be broken apart to produce shorter hydrocarbon molecules for which there is a higher demand
- (C) allows very long chain hydrocarbons to sink to the extraction floor of the tower
- (D) allows the collection of the vitally important long chain hydrocarbons

**Section I**  
**Part A**  
**Multiple Choice Answer Sheet**

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Mark ----/20

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

**2014 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION**

**Chemistry**

**Section I (continued)**

Student Number .....

**Part B 55 marks**

**Attempt questions 21 – 33**

**Allow about 1 hour and 40 minutes for this part**

▶ *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*

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**MARKS**

**Question 21 (3 marks)**

Ethanol can be used as a source of ethylene in an industrial process.

Write an equation using structural formulae to illustrate this reaction. Indicate the catalyst used.

**3**

**Question 22 (2 marks)**

Identify TWO factors that affect the concentrations of a range of ions in solution in natural bodies of water such as rivers and oceans.

**2**

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**Question 24** (5 marks)

The reduction potential for half-cell reactions relevant to the dry cell and the lead acid battery are given in the table:

<i>Half reaction</i>	$E^\circ$ (V)
$\text{PbO}_2(s) + 4 \text{H}^+ + \text{SO}_4^{2-} + 2e^- \rightleftharpoons \text{PbSO}_4(s) + 2 \text{H}_2\text{O}$	+ 1.69
$\text{PbSO}_4(s) + 2e^- \rightleftharpoons \text{Pb}(s) + \text{SO}_4^{2-}$	- 0.36
$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}(s)$	- 0.76
$2 \text{MnO}_2(s) + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{Mn}_2\text{O}_3(s) + 2 \text{OH}^-$	+ 0.32

- (a) Use the table to calculate the cell potential of a lead acid battery OR a dry cell. Show calculation.

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- (b) Write the anode half reaction.

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- (c) Discuss the chemistry and the impact on society of ONE other cell you studied. (not the dry cell or the lead acid cell)

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**Question 25 (3 marks)**

Radioisotopes have been extensively used in industry and in medicine

- (a) Identify ONE use of a named radioisotope in medicine and describe a property based on this use.

**2**

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- (b) Discuss ONE problem associated with the use of this radioisotope in medicine.

**1**

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**Question 26** (4 marks)

Oxides of sulfur are continuously being released into the atmosphere. Explain reasons for concern about their release into the environment.

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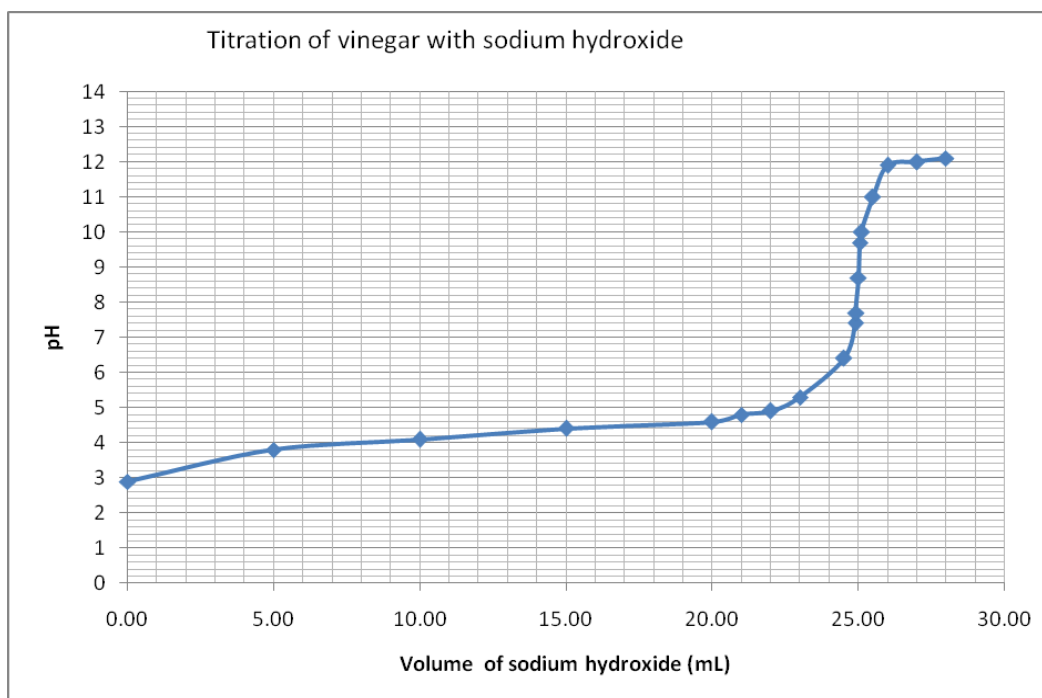
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**Question 27 (7 marks)**

A student needed to determine by titration the acetic acid content of a homemade vinegar that her mother fermented. Her teacher suggested that she use a pH meter and a pH glass electrode instead of an indicator to monitor the progress of the titration with  $0.1034 \text{ mol L}^{-1}$  sodium hydroxide solution.

She recorded the results in a table and plotted her results:

*Titration of 25.00 mL vinegar with sodium hydroxide solution*



- (a) Identify ONE feature of the titration curve that shows the substance being titrated is a weak acid. Briefly justify your answer. 2

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- (b) Use the graph to determine the equivalence volume and the equivalence pH. 2

Equivalence volume = ..... Equivalence pH = .....

- (c) Calculate the concentration of the vinegar solution in  $\text{mol L}^{-1}$ . 1

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*Question 27 continues on the next page...*





**Question 29** (3 marks)

A solution of ammonium chloride in water turns bromothymol blue yellow. Explain this observation. **3**

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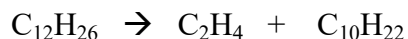
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**Question 30** (5 marks)

Fractional distillation is used to separate crude oil into different fractions. One of the fractions undergoes catalytic cracking as shown.



(a) Identify the products and the homologous series to which they belong. **2**

	$C_2H_4$	$C_{10}H_{22}$
Name		
Name of series		

(b) Describe a chemical test which could be used to distinguish between the two compounds and the result of the test. Include a relevant equation in your answer. **3**

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**Question 31** (4 marks)

Ethylene and glucose are both important monomers which produce useful polymers through different processes.

Compare these polymerisation processes using examples and relevant chemical equations.

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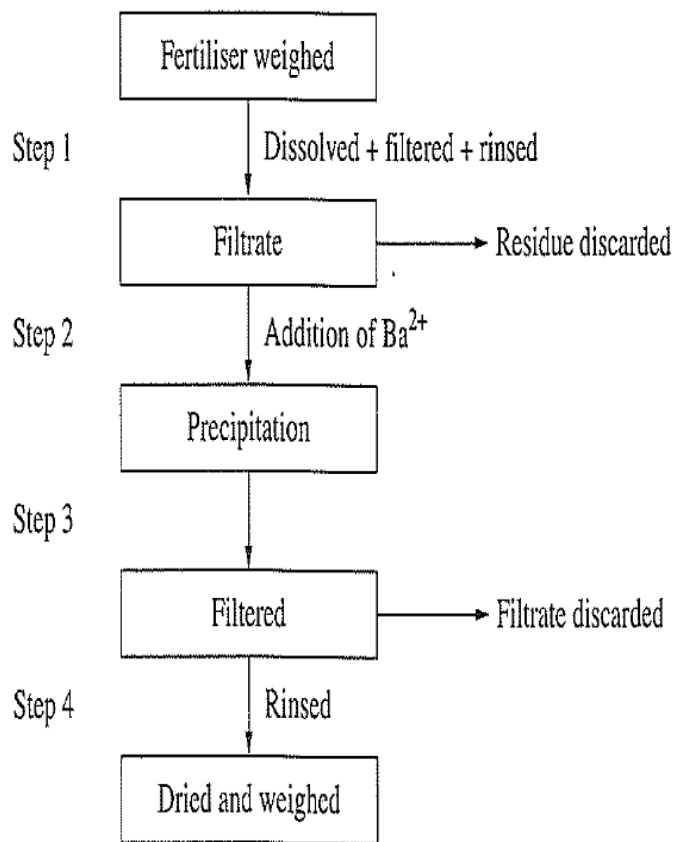
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*Test continues on the next page...*

**Question 32** (4 marks)

The flowchart outlines the process used to determine the amount of sulfate present in a sample of lawn fertilizer.



(a) Write a net ionic equation to show the precipitation reaction. 1

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(b) 4.25 g of the fertilizer had a sulfate content of 35%. Calculate the mass of the dried precipitate in step 4. Show all working. 3

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**Question 33** (5 marks)

An analytical laboratory analysed the amount of magnesium in a certain brand of multivitamin tablet. Four samples of tablets were prepared by dissolving the tablets in separate test tubes with 10% nitric acid and then diluting to 100.00 mL.

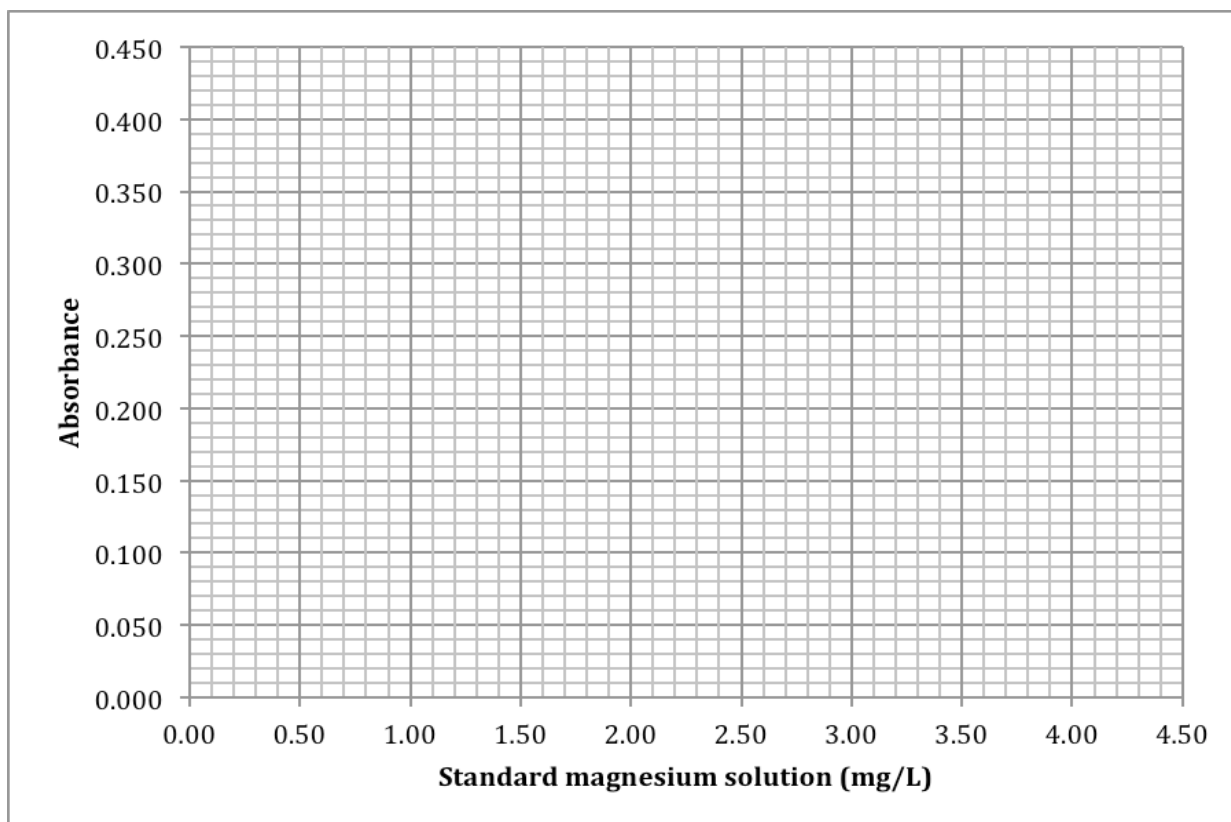
Five standard solutions of magnesium were prepared for construction of a calibration curve.

The standards and sample solutions were determined by AAS. The results are presented in the table below.

<i>Standard magnesium solutions (mg L<sup>-1</sup>)</i>	<i>Absorbance</i>
0.00	0.000
1.00	0.140
2.00	0.260
3.00	0.390
4.00	0.420
Tablet samples: mean absorbance	0.303

(a) Plot a calibration curve for the standard magnesium solutions on the grid below.

2



*Question 33 continues on the next page...*

*Question 33 continues....*

- (b) Calculate the mass of magnesium in mg per tablet using the mean absorbance of the tablet samples.

**3**

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*Turn the page over for question 34...*

# 2014 JRAHS TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

## Chemistry

### Section II

25 marks

Attempt question 34

Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Marks

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#### Question 34 (25 marks)

(a) The equation represents a reaction that can be performed in a school laboratory.



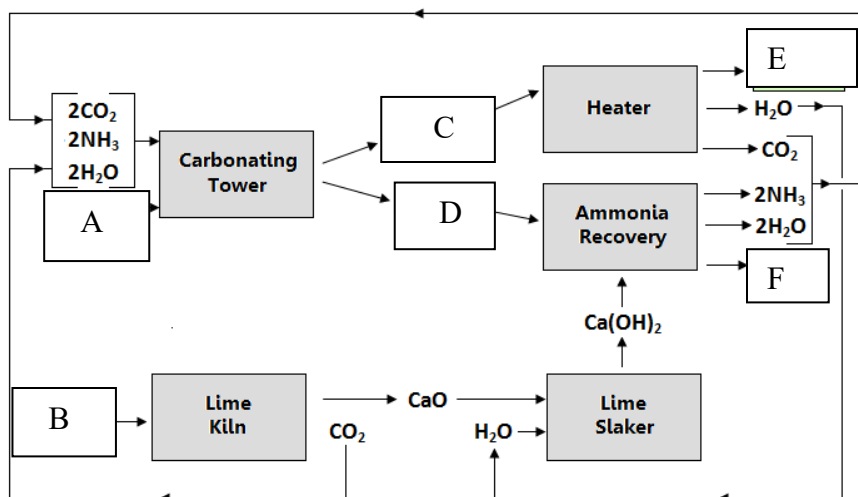
- (i) Identify the product  $X$ . 1
- (ii) The oil used in this reaction is glyceryl tripalmitate. What is the name of the soap produced in this reaction? 1
- (iii) Describe the effectiveness of this soap in hard water. 2
- (b) (i) Describe two safety precautions, besides safety goggles, that must be taken when diluting concentrated sulfuric acid. 2
- (ii) Justify the need for the final step in the production of sulfuric acid by the contact process. 3
- (c) When 1.00 mol hydrogen iodide gas in a sealed 10.00 L flask is maintained at a temperature of 225 °C, it decomposes until 0.182 mol iodine gas is formed.
- Calculate the equilibrium constant for this reaction. 4
- (d) Technological advances have allowed chemicals to be produced with a reduced impact on the environment.
- Justify this statement in reference to the production of sodium hydroxide. 7

Question 34 continues on the next page.....

Question 34 continues...

(e) Below is a flowchart that represents the Solvay Process.

5



(i) Identify the raw materials, **A** and **B**, in this process.

1

(ii) Give an equation for the decomposition of **C** to **E**.

1

(iii) Ammonia is recovered from **D**, also producing water and **F**.  
Why would a small community on the coast be a good option for the location of a Solvay plant at this stage of the process?

3

*End of Trial HSC Examination*





**2014**

**TRIAL HSC  
EXAMINATION**

# **Chemistry      Answers**

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**Total Marks – 100**

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**75 marks**

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**25 marks**

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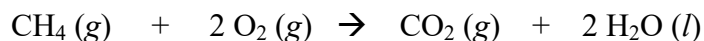


## Multiple Choice

Use the multiple choice Answer sheet for Questions 1 – 20 on page 10

---

1. Consider the following reaction:



Which of the alternatives is correct?

- (A) **Carbon was oxidised.**
- (B) Hydrogen was reduced.
- (C) Oxygen was oxidised.
- (D) Hydrogen was oxidised.
2. If sufficient amount of element 118 was synthesised, what general characteristic will it have?
- (A) a shiny reactive solid
- (B) a dull unreactive solid
- (C) **an unreactive, monatomic gas**
- (D) a black corrosive liquid

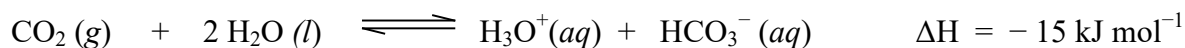
3. A student was given two solutions labelled *X* and *Y*, which may be acidic, neutral or basic. The student added one drop of each of the indicators and recorded the final colour of the solution.

<i>Indicator</i>	<i>X</i>	<i>Y</i>
methyl orange	red	yellow
bromothymol blue	yellow	yellow
phenolphthalein	colourless	colourless

Which correctly describes each solution?

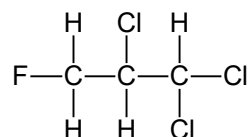
	<i>X</i>	<i>Y</i>
(A)	very acidic	very basic
<b>(B)</b>	<b>very acidic</b>	<b>slightly basic, neutral or slightly acidic</b>
(C)	slightly acidic	neutral or very basic
(D)	very acidic	slightly basic to very basic

4. What volume of carbon dioxide gas measured at 25°C and 100 kPa is released when 50.0 mL of 0.20 mol L<sup>-1</sup> hydrochloric acid is added to 5.0 g of calcium carbonate?
- (A) 0.11 L  
**(B) 0.12 L**  
 (C) 0.22 L  
 (D) 0.24 L
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- (A) CO  
 (B) NO  
**(C) Li<sub>2</sub>O**  
 (D) Cl<sub>2</sub>O
6. The equation gives the equilibrium reaction between carbon dioxide and water:



What effect will an increase in temperature have on the pH of the solution?

- (A) equilibrium shifts left and the pH increases**  
 (B) equilibrium shifts right and the pH decreases  
 (C) equilibrium shifts right and the pH increases  
 (D) equilibrium shifts left and the pH decreases
7. What is the correct systematic name of this compound?



- (A) 3-fluoro-1,1,2-trichloropropane  
 (B) 2,3,3-trichloro-1-fluoropropane  
**(C) 1,1,2-trichloro-3-fluoropropane**  
 (D) 1-fluoro-2,3,3-trichloropropane

8. When dilute sulfuric acid was added to an unknown solution, *L*, a white precipitate was formed. The possible ions in the unknown are: sodium, calcium, barium and lead.

What is an additional test that can be done to a fresh sample to determine the exact identity of the ion present?

- (A) add silver nitrate  
(B) **do the flame test**  
(C) add sodium carbonate  
(D) test the pH

9. Which of the following pair of substances in solution can act as a buffer?

- (A) NaCl and HCl  
(B) NaCH<sub>3</sub>COO and NaOH  
(C) **Na<sub>2</sub>HPO<sub>4</sub> and NaH<sub>2</sub>PO<sub>4</sub>**  
(D) Na<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>SO<sub>4</sub>

10. Which instrument cannot be used to detect radiation?

- (A) Geiger meter  
(B) photographic plate  
(C) scintillation counter  
(D) **spectrophotometer**

11. In which of the following reactions is water acting as a Bronsted – Lowry acid?

- (A)  $\text{H}_3\text{O}^+(\text{aq}) + \text{HC}_2\text{O}_4^-(\text{aq}) \rightleftharpoons \text{H}_2\text{O}(\text{l}) + \text{H}_2\text{C}_2\text{O}_4(\text{aq})$   
(B)  $\text{H}_2\text{O}(\text{l}) + \text{H}_2\text{CO}_3(\text{aq}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$   
(C)  **$\text{H}_2\text{O}(\text{l}) + \text{CH}_3\text{NH}_2(\text{aq}) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$**   
(D)  $\text{H}_3\text{O}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightleftharpoons \text{HS}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$

12. What is an example of a dilute strong acid?

- (A) 2.0 mol L<sup>-1</sup> HCl  
(B) 2.0 mol L<sup>-1</sup> CH<sub>3</sub>COOH  
(C) **0.10 mol L<sup>-1</sup> HNO<sub>3</sub>**  
(D) 0.10 mol L<sup>-1</sup> C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>

13. An aqueous sample containing  $\text{Cl}^-$ ,  $\text{CO}_3^{2-}$  and  $\text{SO}_4^{2-}$  is analysed.

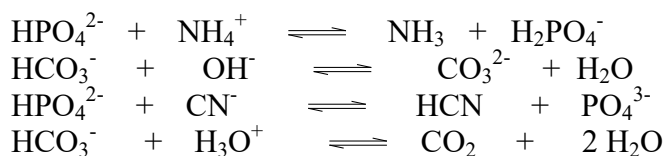
Which order should the reagents be added to determine the amount of chloride in the sample?

	<i>Reagent 1</i>	<i>Reagent 2</i>	<i>Reagent 3</i>
(A)	$\text{AgNO}_3$	$\text{H}_2\text{SO}_4$	$\text{BaSO}_4$
(B)	$\text{HCl}$	$\text{Pb}(\text{NO}_3)_2$	$\text{AgNO}_3$
(C)	$\text{Ba}(\text{NO}_3)_2$	$\text{AgNO}_3$	$\text{HCl}$
(D)	$\text{HNO}_3$	$\text{Ba}(\text{NO}_3)_2$	$\text{AgNO}_3$

14. What property would be most useful in distinguishing between butan-1-ol and butyl butanoate?

- (A) **boiling point**
- (B) colour
- (C) conductivity
- (D) pH

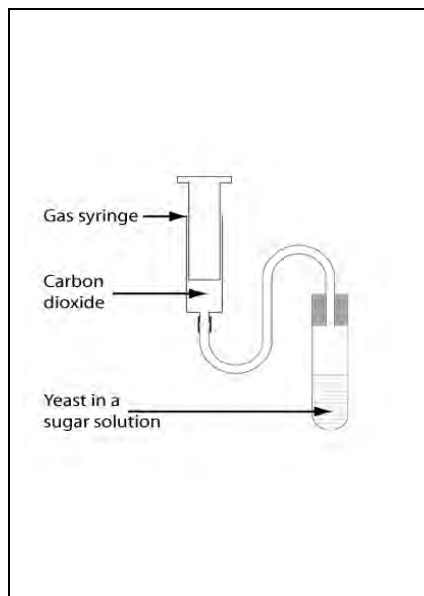
15. Consider the reactions represented by the following equations:



In these reactions which one of the following reacts as an amphoteric species?

- (A)  $\text{H}_2\text{PO}_4^-$
  - (B)  $\text{NH}_4^+$
  - (C)  $\text{CO}_3^{2-}$
  - (D)  **$\text{HPO}_4^{2-}$**
16. What is always produced during the complete combustion of natural gas?
- (A) Carbon monoxide
  - (B) Sulfur dioxide
  - (C) Carbon (soot)
  - (D) **Water**

17. The diagram shows a set-up used by a group of students to monitor glucose fermentation.



What mass of glucose was fermented if the syringe recorded a volume of 3.0 mL at 25 °C and 100 KPa?

- (A) **0.011 g**
- (B) 0.022 g
- (C) 0.044 g
- (D) 0.11 g
18. Which nutrients are the most significant cause of eutrophication?
- (A) phosphorus and nitrates
- (B) potassium and phosphates
- (C) potassium and nitrates
- (D) **phosphates and nitrates**

19. This image shows a section of a creek at North Parramatta.



What would be the first step needed to treat this water?

- (A) **screen filtration**
- (B) filtration through sand
- (C) increase the pH of the water and then maintain this by the addition of a buffer
- (D) addition of a chemical to precipitate any heavy metals present thus allowing them to be removed by sand filtration



20. What important role in the oil refining process does this catalytic cracker tower facilitate?



- (A) allows the more usable fractions of the crude oil to rise through the tower to be collected at the top
- (B) allows longer hydrocarbon chains to be broken apart to produce shorter hydrocarbon molecules for which there is a higher demand**
- (C) allows very long chain hydrocarbons to sink to the extraction floor of the tower
- (D) allows the collection of the vitally important long chain hydrocarbons

**Section I**  
**Part A**  
**Multiple Choice Answer Sheet**

---

Mark ----/20

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

2014 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Section I (continued)

Student Number .....

Part B 55 marks

Attempt questions 21 – 33

Allow about 1 hour and 40 minutes for this part

▶ 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

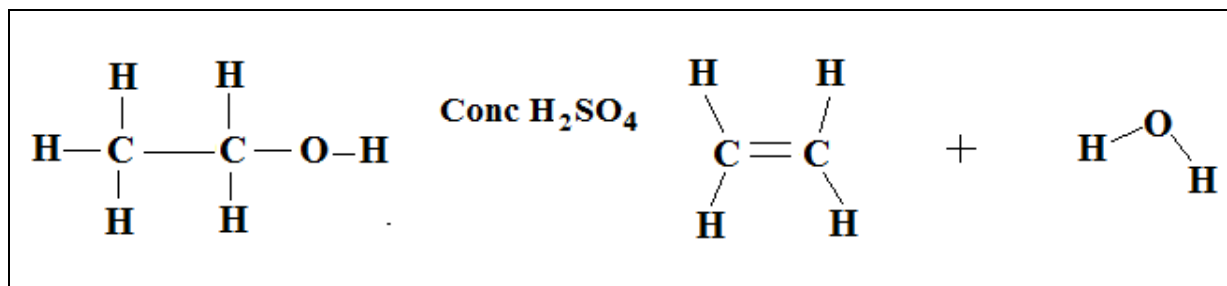
MARKS

Question 21 (3 marks)

Ethanol can be used as a source of ethylene in an industrial process.

Write an equation using structural formulae to illustrate this reaction. Indicate the catalyst used.

3



Answer	Marks Allocated
Equation chemically correct. <b>AND</b> Structural formulae appropriately used. <b>AND</b> Catalyst correctly named.	3 marks
Equation chemically correct. <b>AND</b> Structural formulae appropriately used. <b>BUT</b> Catalyst incorrectly named <b>OR</b> ..... Equation chemically correct. <b>AND</b> Catalyst correctly named.	2 marks

<p><b>BUT</b> Structural formulae incorrectly used</p> <p><b>OR</b> .....</p> <p>Structural formulae appropriately used.</p> <p><b>AND</b> Catalyst correctly named.</p> <p><b>BUT</b> Equation chemically incorrect.</p>	
<p>Equation chemically correct but structural formulae and catalyst incorrect.</p> <p><b>OR</b> Chemical information incorrect, catalyst incorrect but structural formulae appropriately used.</p> <p><b>OR</b> Catalyst correctly named but structural formulae and chemistry incorrect.</p>	1 mark

**Question 22** (5 marks)

Assess the potential of ethanol as an alternative fuel by discussing the advantages and limitations of its use.

5

**Answer**

*Should list at least 2 advantages (2 marks) and 2 disadvantages (2 marks) and clearly identify them as such.*

*Suggestions are listed below. (any other reasonable will be accepted)*

Advantages

*Renewable*

*Cleaner fuel*

Disadvantages

*Infrastructure for fossil fuels: principally petrol, diesel, ethanol and natural gas already established and would have to be replaced. Expense, difficulty, (short term)*

*Amount of land required to grow the sugar cane would be enormous and would require clearing of native vegetation. (long term)*

*Fermentation of sugars produces large amounts of waste materials – disposal a problem. (long term)*

*Requires engine/equipment modifications (short term)*

*Distracts from development of a more appropriate solution (long term)*

**Assessment: Must be clearly an assessment. (1 mark)**

Recognisable by statements such as:

- *by considering these .....it can be seen*
- *because of the above considerations*
- *and therefore by*
- *etc, etc.*

*As long as their assessment is reasonable and is based on the information they provided it will be accepted.*

**Question 23 (2 marks)**

Identify TWO factors that affect the concentrations of a range of ions in solution in natural bodies of water such as rivers and oceans.

2

<i>Answer</i>	<i>Marks Allocated</i>
<i>Any two of the factors below (or any other appropriate) NB Factor below cannot be reworded and used again.</i>	<i>2 marks</i>
<i>Any one of the below (or any other appropriate)</i>	<i>1 mark</i>

*Suggested Answer:*

*Answer should indicate any two of the following factors (NB explanations not required)*

*Factors affecting salinity:*

- \*concentration of dissolved salts in runoff;*
- \*evaporation (increases salinity)*
- \*amount of rainfall, runoff of freshwater, melt water (decreases salinity)*
- \*amount of ice formation (increases salinity as ice is salt free)*
- \*or any other valid*

**Question 24** (5 marks)

The reduction potential for half-cell reactions relevant to the dry cell and the lead acid battery are given in the table:

Half reaction	$E^{\circ}$ (V)
$\text{PbO}_2(s) + 4 \text{H}^+ + \text{SO}_4^{2-} + 2e^- \rightleftharpoons \text{PbSO}_4(s) + 2 \text{H}_2\text{O}$	+ 1.69
$\text{PbSO}_4(s) + 2e^- \rightleftharpoons \text{Pb}(s) + \text{SO}_4^{2-}$	- 0.36
$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}(s)$	- 0.76
$2 \text{MnO}_2(s) + \text{H}_2\text{O} + 2e^- \rightleftharpoons \text{Mn}_2\text{O}_3(s) + 2 \text{OH}^-$	+ 0.32

- (a) Use the table to calculate the cell potential of a lead acid battery OR a dry cell. Show calculation.

1

*sample answer:*

*lead acid battery:*  $-(-0.36) + 1.69 = 2.05 \text{ V}$  (1 mark)

*Dry cell:*  $-(-0.76) + 0.32 = 1.08 \text{ V}$

- (b) Write the anode half reaction.

1

*Anode half reactions: dry cell:*  $\text{Zn}(s) \rightleftharpoons \text{Zn}^{2+} + 2e^-$

*lead acid:*  $\text{Pb}(s) + \text{SO}_4^{2-} \rightleftharpoons \text{PbSO}_4(s) + 2e^-$  (1 mark)

- (c) Discuss the chemistry and the impact on society of ONE other cell you studied. (not the dry cell or the lead acid cell)

3

**Outcome(s):H1,H7,H4,H13**

*Sample answer:*

*Button cell: Chemistry*

*anode:*  $\text{Zn}(s) + 2 \text{OH}^- \rightarrow \text{ZnO}(s) + \text{H}_2\text{O}(l) + 2e^-$

*cathode:*  $\text{Ag}_2\text{O}(s) + \text{H}_2\text{O}(l) + 2e^- \rightarrow 2 \text{Ag}(s) + 2 \text{OH}^-$

**Impact on society:**

*The button cell because of its small size has allowed the miniaturization of many equipment such bionic ear for the hearing impaired, pacemaker for the heart. These application has improved the lives of humans able to afford it.*

*Marking Guidelines:*

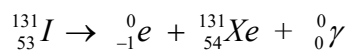
Criteria	Marks
<i>Chemistry – balanced chemical equation for both anode and cathode reactions</i>	1
<i>Impact on society - A clear statement on the impact on society with details on the physical or chemical aspect of the battery that provides for the mentioned impact.</i>	2
<i>Impact on society discussed with less details on the physical or chemical aspect of the battery that allows for the greater impact.</i>	1

**Question 25** (3 marks)

Radioisotopes have been extensively used in industry and in medicine

- (a) Identify ONE use of a named radioisotope in medicine and describe a property based on this use. **2**

*Sample answer: Iodine-131 can be administered by injection or drunk in solution form as sodium iodide. The iodine -131 concentrates in the thyroid gland (a property of iodine) where its presence can be monitored and imaged via gamma radiation or where its beta and gamma emission can destroy the diseased cells in the thyroid gland.*



Criteria	Marks
<i>Details of how it is used</i>	<i>1</i>
<i>Its action or property that allows it to work</i>	<i>1</i>

- (b) Discuss ONE problem associated with the use of this radioisotope in medicine. **1**

*Sample answer:*

*One problem is the non-specificity of the radioactive emission. Hence, nearby cells which may be healthy are also destroyed. In common with other radioisotope, health workers and family members also need protection from the radiation while the patient is undergoing treatment.*

Criteria	Marks
<i>A thorough discussion of one problem associated with the use of the radioisotope</i>	<i>1</i>

**Question 26** (4 marks)

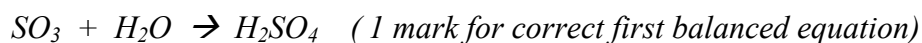
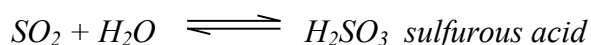
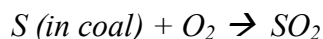
Oxides of sulfur are continuously being released into the atmosphere. Explain reasons for concern about their release into the environment.

4

**Outcome(s):**H4, H16*Sample answer:*

*Sulfur dioxide is an acidic oxide released by power plants and internal combustion engines such as those in cars. When released, they can create respiratory problems to susceptible individuals such as asthma sufferers. (1 mark)*

*They also combine with rain water to form acid rain, rainwater with pH substantially below pH 6: (1 or 2 marks depending on the thoroughness of the answer)*



*The production of acid rain can have a variety of damaging effects:*

*Acid rain destroys marine life, releases ions from soil depleting the soil of nutrients and also increasing the salinity of the water around the soil.*

*Acid rain destroys structural materials especially those ones made with calcium carbonate by chemically weathering the structure and replacing  $CaCO_3$  with the chalky  $CaSO_4$ . (1 mark)*

*Marking Guidelines*

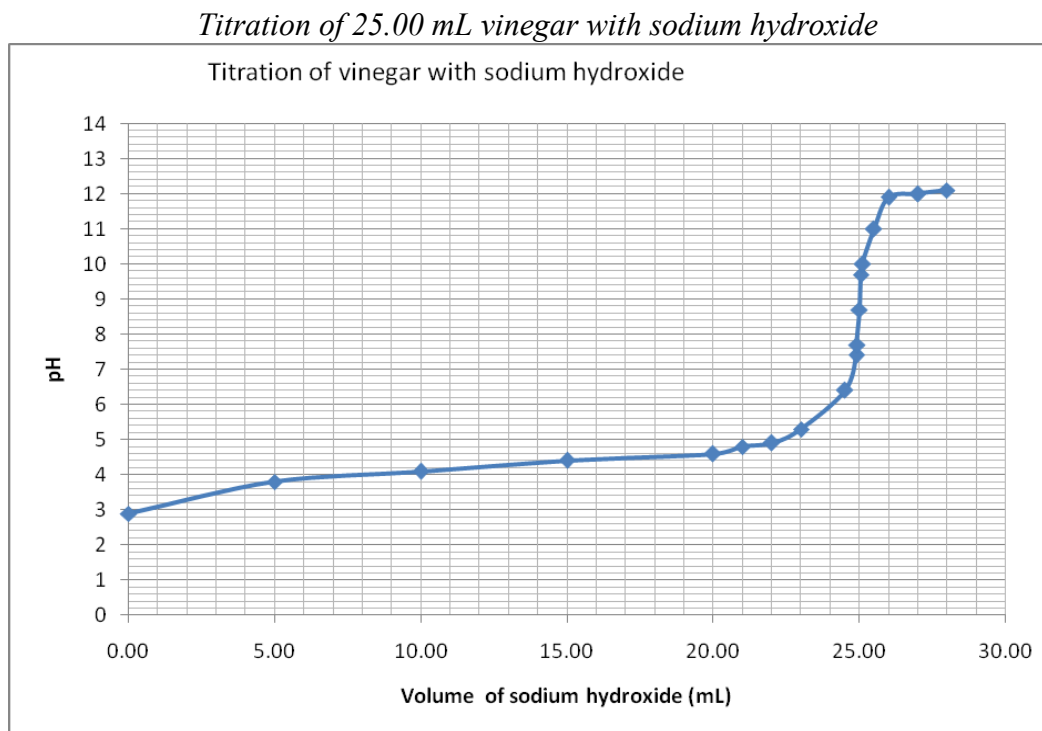
<i>Criteria</i>	<i>Marks</i>
<i>A thorough discussion of at least two reasons for concern supported by one equation. The reason must deal with two different aspects such as the health effects of the emission and the environmental effects of the production of acid rain</i>	<i>4</i>
<i>A thorough discussion of at least one reason for concern with one supporting equation</i>	<i>3</i>
<i>A thorough discussion of at least two reasons for concern with no equation given</i>	<i>3</i>
<i>A thorough discussion of one reason for concern supported by an equation or equations</i>	<i>3</i>
<i>A thorough discussion of two reasons for concern with no supporting equation</i>	<i>3</i>
<i>A thorough discussion of one reason for concern with no supporting equation</i>	<i>2</i>
<i>A superficial discussion of one reason for concern with no supporting equation</i>	<i>1</i>



**Question 27 (7 marks)**

A student needed to determine by titration the acetic acid content of a homemade vinegar that her mother fermented. Her teacher suggested that she use a pH meter and a pH glass electrode instead of an indicator to monitor the progress of the titration with  $0.1034 \text{ mol L}^{-1}$  sodium hydroxide solution.

She recorded the results in a table and plotted her results:



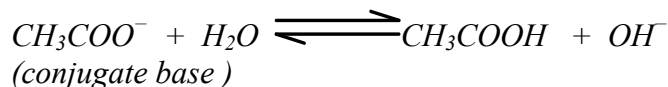
- (a) Identify ONE feature of the titration curve that shows the substance being titrated is a weak acid. Briefly justify your answer.

2

*Sample answers:*

*The starting pH before any sodium hydroxide is added is higher (pH 3), indicating less ionisation of the acid, hence a weak acid. A strong acid would have a pH close to 1.0*

*The equivalence point is a basic pH (8.5) indicating the hydrolysis of the conjugate base of the weak acid resulting in a basic pH.*



*Marking Guidelines*

Criteria	Marks
<i>One observation on the titration curve with a correct justification</i>	2
<i>One observation on the titration curve with superficial justification</i>	1

- (b) Use the graph to determine the equivalence volume and the equivalence pH. 2

Equivalence volume = 25.00 mL (1 mark)      Equivalence pH = pH 8.50 (1 mark)

- (c) Calculate the concentration of the vinegar solution in mol L<sup>-1</sup>. 1

$$\text{Sample answer: } \text{Conc}_{\text{acid}} = C_{\text{NaOH}} \times V_{\text{NaOH}} / V_{\text{vinegar}} = \frac{0.1034 \times 0.02500}{0.02500} = 0.1034 \text{ mol L}^{-1}$$

- (d) Calculate the concentration of the vinegar solution in % w/v. 1

$$\text{Conc of vinegar} = 0.1034 \text{ mol L}^{-1}$$

$$\% \text{ w/v} = \frac{0.1034 \times (2 \times 12.01 + 4 \times 1.008 + 2 \times 16.00) \times 100 \text{ mL}}{1000 \text{ mL} / \text{L}} = 0.6209\% \text{ (4 sig fig)}$$

**Outcome(s): H10, H11, H13**

**Question 28** (5 marks)

Outline the significance of the ideas of Lavoisier, Davy, Arrhenius and Bronsted – Lowry in the development of our understanding of acids and acid – base reactions. 5

*Sample answer:*

*The unique characteristics of acids have led scientists to relate these characteristics to their chemistry.*

***Lavoisier** was the first scientist to attribute acidity to an element, according to Lavoisier, all acids contain oxygen. No idea given about acid-base reaction*

***Davy**, however, found that certain substances such as HCl are acidic but contain no oxygen and rather some oxygen-containing substances are basic such as oxides. Davy was the first scientist to attribute acidity to the presence of hydrogen in the compound, the hydrogen is replaceable by a metal.*

***Arrhenius** in his conductivity studies put forward the idea that acids dissociate in water to form hydrogen ion and the anion of the acid. The stronger the acid, the more dissociated it is. An acid base reaction is a reaction between a hydrogen ion and a hydroxide ion. Hydroxide is the ion produced in solution by bases.*

***Bronsted- Lowry** were the first scientists to include the solvent in the ionisation of an acid in solution. according to them, an acid-base reaction is not limited to a reaction between a hydroxide ion and a hydrogen ion, but rather is a proton transfer reaction from a proton donor (the acid) to a proton acceptor (the base). Acids and bases unlike the Arrhenius' concept can be an ion or a molecule.*

**Outcome(s):H1,H2***Marking Guidelines*

<i>Criteria</i>	<i>Marks</i>
<i>Correct ground breaking ideas of 4 scientists on the nature of acidity and that of acid –base reaction The discussion includes an explicit recognition (in a statement or statements) of the contribution of each scientist to our understanding of acid-base reaction</i>	<i>5</i>
<i>Correct ideas of 4 scientists on the nature of acidity only but no recognition of their actual contribution to our understanding of acidity and acid-base reactions</i>	<i>4</i>
<i>Correct ideas of 3 scientists on the nature of acidity only but no recognition of their actual contribution to our understanding of acidity and acid-base reactions</i>	<i>3</i>
<i>Correct ideas of 2 scientists on the nature of acidity only but no recognition of their actual contribution to our understanding of acidity and acid-base reactions</i>	<i>2</i>
<i>Correct ideas of a scientist on the nature of acidity only with or without the recognition of his actual contribution to our understanding of acidity and acid-base reactions</i>	<i>1</i>

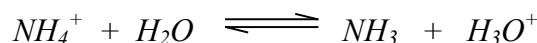
**Question 29** (3 marks)

A solution of ammonium chloride in water turns bromothymol blue yellow. Explain this observation.

**3**

*Sample answer:*

*Bromothymol blue is greenish in neutral medium, blue in a basic solution and yellow in an acidic solution. Ammonium chloride is acidic because of the reaction of the ammonium ion with water producing hydronium ion. The ammonium ion is the conjugate acid of a weaker base and hence is a stronger acid than water. It will, thus, donate a proton to water, water acting as a base.*



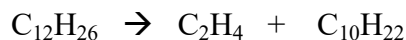
*The increase in the concentration of the hydronium ion causes the bromothymol blue to change to its acid colour (yellow)*

*Marking Guidelines*

<i>Criteria</i>	<i>Marks</i>
<i>Statement on the acidic nature of ammonium because it is the conjugate acid of a weak base</i>	<i>1</i>
<i>Ammonium is more acidic than water and hence would behave as an acid (water will act as the base) and will donate proton to water forming hydronium ion</i>	<i>1</i>
<i>The acid – base reaction between water and ammonium results in an increase in the hydronium ion concentration and a change in colour of the bromothymol blue or the use of an equation to show the increase in the hydronium ion concentration and the change in colour of bromothymol blue.</i>	<i>1</i>

**Question 30** (5 marks)

Fractional distillation is used to separate crude oil into different fractions. One of the fractions undergoes catalytic cracking as shown.



(a) Identify the products and the homologous series to which they belong.

2

*Sample Answer:*

	$\text{C}_2\text{H}_4$	$\text{C}_{10}\text{H}_{22}$
Name of compound	Ethane	decane
Name of series	Alkene	Alkane

*Marking criteria*

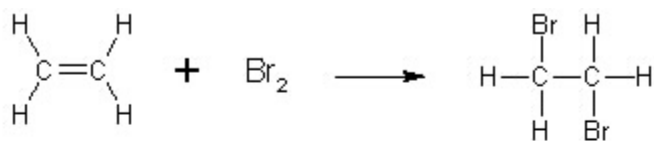
Criteria	Mark
Correct name and series for both	2
Correct name and series for one	1

(b) Describe a chemical test which could be used to distinguish between the two compounds and the result of the test. Include a relevant equation in your answer.

3

*Sample Answer :*

*Add bromine water to a small sample of each hydrocarbon in separate test tubes. The alkene will decolourise the bromine water and the alkane will not.*



*ethylene, dibromoethane and 2-bromoethanol are all colourless substances*

*Marking Criteria*

Criteria	Marks
Correct reagent, results and equation	3
One of the above missing	2
Two of the above missing	1

**Question 31** (4 marks)

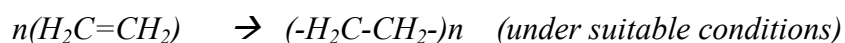
Ethylene and glucose are both important monomers which produce useful polymers through different processes.

Compare these polymerisation processes using examples and relevant chemical equations.

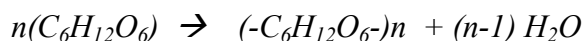
**4****Outcome(s): H7**

*Sample Answer :*

*Ethylene undergoes addition polymerization where its double bond is opened up to form a long chain polymer, polyethylene.*



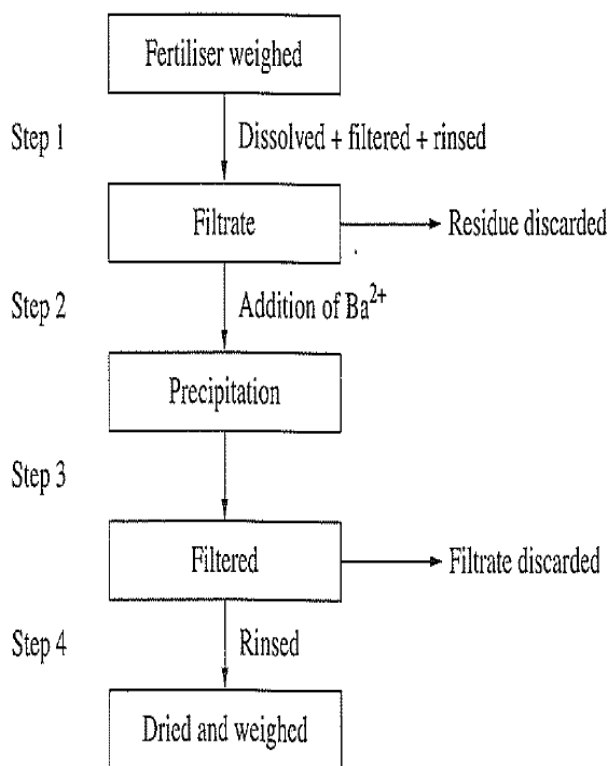
*Glucose undergoes condensation polymerization in which water is eliminated as each bond forms and polymers such as starch and cellulose is formed.*

*Marking Criteria*

<i>Criteria</i>	<i>Mark</i>
<i>Thorough comparison with correct equations</i>	<i>4</i>
<i>Description with one equation</i>	<i>3</i>
<i>Outline with no equation</i>	<i>2</i>
<i>Identification of one type of process</i>	<i>1</i>

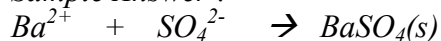
**Question 32** (4 marks)

The flowchart outlines the process used to determine the amount of sulfate present in a sample of lawn fertilizer.



- (a) Write a net ionic equation to show the precipitation reaction. 1

*Sample Answer :*



- (b) 4.25 g of the fertilizer had a sulfate content of 35%. Calculate the mass of the dried precipitate in step 4. Show all working. 3

$$\text{Molar mass of } \text{SO}_4^{2-} = 32.07 + (4 \times 16.00) = 96.07 \text{ g}$$

$$\text{Molar mass of } \text{BaSO}_4 = 137.3 + 32.07 + (4 \times 16.00) = 233.37 \text{ g}$$

$$\text{Mass of sulfate} = 35\% \text{ of } 4.25 \text{ g} = 0.35 \times 4.25$$

$$\text{Mass of dried } \text{BaSO}_4 = 0.35 \times 4.25 \text{ g} \times 233.37 / 96.07 = 3.61 \text{ g}$$

*Marking criteria*

Criteria	Mark
Correct net ionic equation	1

*Marking criteria*

Criteria	Mark
Correct calculation with all working	3
One error in calculation	2
Two errors in calculation	1

**Question 33** (5 marks)

An analytical laboratory analysed the amount of magnesium in a certain brand of multivitamin tablet. Four samples of tablets were prepared by dissolving the tablets in separate test tubes with 10% nitric acid and then diluting to 100.00 mL.

Five standard solutions of magnesium were prepared for construction of a calibration curve.

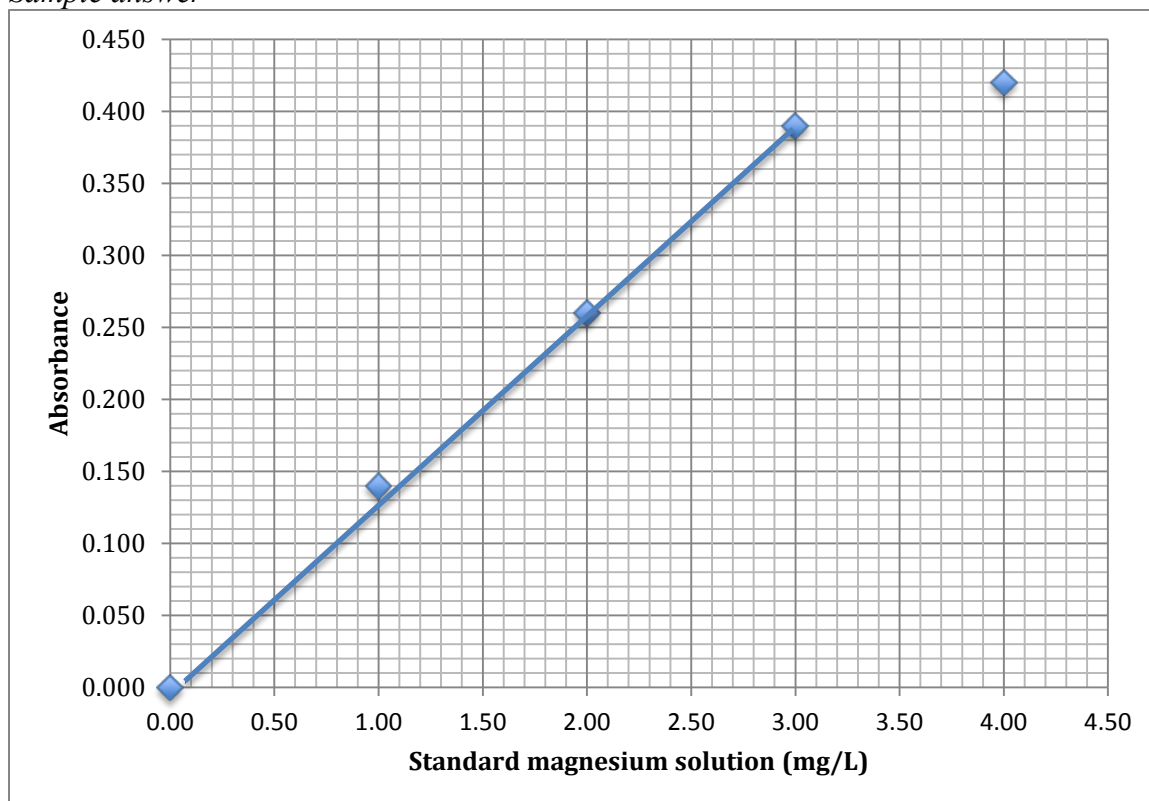
The standards and sample solutions were determined by AAS. The results are presented in the table below.

<i>Standard magnesium solutions (mg L<sup>-1</sup>)</i>	<i>Absorbance</i>
0.00	0.000
1.00	0.140
2.00	0.260
3.00	0.390
4.00	0.420
Tablet samples: mean absorbance	0.303

(a) Plot a calibration curve for the standard magnesium solutions on the grid below.

2

*Sample answer*



- (b) Calculate the mass of magnesium in mg per tablet using the mean absorbance of the tablet samples.

3

**Outcome(s): H3,H13**

*Correctly plotted and line of best fit*

*Mean Absorbance = 0.303*

*From graph [Mg] = 2.30 mg L<sup>-1</sup>*

*Thus concentration Mg in tablet sample = 2.30 mg L<sup>-1</sup>*

*Each tablet was made up to 100 mL solution so*

*Amount of Mg was 0.230 mg per 100 mL*

*Thus amount Mg per tablet = 0.230 mg*

a) Marking Criteria

Criteria	Mark
Correct plotting and line of best fit	2
Any one missing	2

b Marking criteria

Criteria	Marks
Correct calculation with all working	3
One error in calculation	2
Two errors in calculation	1



2014 JRAHS TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Section II

25 marks

Attempt question 34

Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Marks

Question 34 (25 marks)

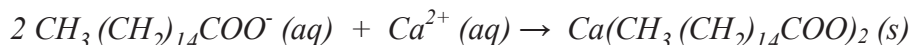
- (a) The equation represents a reaction that can be performed in a school laboratory.



- (i) Identify the product X. (1 mark)  
 (ii) The oil used in this reaction is glyceryl tripalmitate. What is the name of the soap produced in this reaction? (1 mark)  
 (iii) Describe the effectiveness of this soap in hard water. (2 marks)

Sample Answer

- (i) X is glycerol (1,2,3- propantriol) (1 mark)  
 (ii) sodium palmitate (1 mark)  
 (iii) Sodium palmitate is ineffective in hard water as the cleaning anion forms a precipitate with  $\text{Ca}^{2+}$  or  $\text{Mg}^{2+}$  ions, leaving a grey scum on washing or sinks.



Criteria	Marks
<ul style="list-style-type: none"> <li>Correctly describes the ineffectiveness in hard water because of precipitation of the cleaning anion with <math>\text{Ca}^{2+}</math> or <math>\text{Mg}^{2+}</math> ions</li> </ul>	2
<ul style="list-style-type: none"> <li>Correct equation OR</li> <li>Identifies hard water by <math>\text{Ca}^{2+}</math> or <math>\text{Mg}^{2+}</math> ions OR</li> <li>Outlines the reaction between this soap and hard water</li> </ul>	1

Outcomes : H4, H9, H10

- (b) (i) Describe two safety precautions, besides safety goggles, that must be taken when diluting concentrated sulfuric acid. (2 marks)

Sample answer

As sulfuric acid is corrosive protective clothing and gloves should be worn when diluting sulfuric acid.

When diluting, always add acid to water as the ionisation of the acid is strongly exothermic.

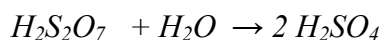
Criteria	Marks
<ul style="list-style-type: none"> <li>Two safety precautions relevant to the dilution of sulfuric acid, one of which must be adding the acid to water.</li> </ul>	2
<ul style="list-style-type: none"> <li>One safety precaution relevant to the dilution of sulfuric acid</li> </ul>	1

(ii) Discuss the final step in the production of sulfuric acid in industry. (3 marks)

*Sample answer*

*Although it would be simple to bubble sulfur trioxide through water to produce sulfuric acid, the reaction is strongly exothermic and would release a lot of heat and cause water to boil and create a toxic acid mist.*

*To avoid this, the sulfur trioxide is bubbled through sulfuric acid making an interim product, oleum ( $H_2S_2O_7$ ), a reaction which is not strongly exothermic. This is then combined with water to make sulfuric acid.*



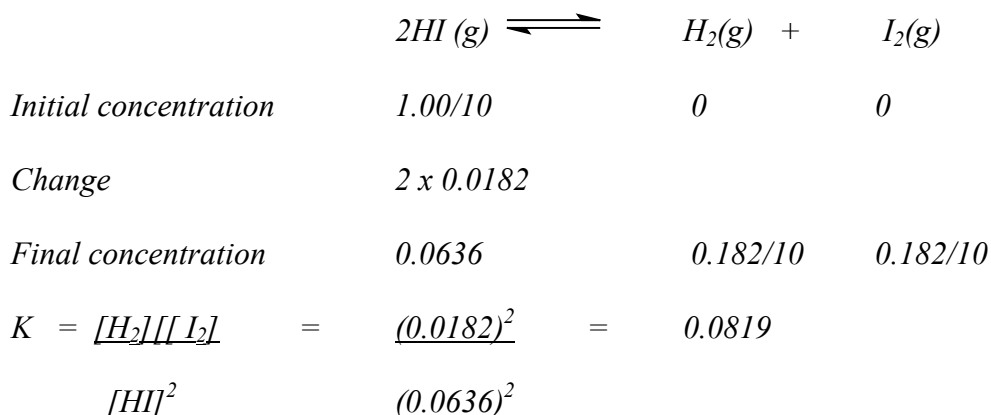
Criteria	Marks
<ul style="list-style-type: none"> <li>Discusses the disadvantage of bubbling <math>SO_3</math> through water (exothermic) and the advantage of the production of oleum as an intermediate product.</li> </ul>	3
<ul style="list-style-type: none"> <li>Outlines the final step in the production of sulfuric acid.</li> </ul>	2
<ul style="list-style-type: none"> <li>Identifies oleum as a product in this step. OR</li> <li>Gives a relevant equation</li> </ul>	1

**Outcomes : H3, H4, H16**

(c) When 1.00 mol hydrogen iodide gas in a sealed 10.00 L flask is maintained at a temperature of 225 °C, it decomposes until 0.182 mol iodine gas is formed.

Calculate the equilibrium constant for this reaction. (4 marks)

*Sample answer*



Criteria	Marks
<ul style="list-style-type: none"> <li>Changes mol to concentration</li> <li>Calculates equilibrium concentrations</li> <li>Gives the K expression</li> <li>Completes the calculation</li> </ul>	4
<ul style="list-style-type: none"> <li>Most relevant working given</li> </ul>	3
<ul style="list-style-type: none"> <li>Some relevant working given</li> </ul>	2
<ul style="list-style-type: none"> <li>Gives the equation OR</li> <li>Gives the K expression OR</li> <li>Calculates one concentration</li> </ul>	1

**Outcomes : H8, H10**

- (d) Technological advances have allowed chemicals to be produced with a reduced impact on the environment.

Justify this statement in reference to the production of sodium hydroxide. (7 marks)

*Sample answer*

*This statement can be supported by the evidence of change in production methods of sodium hydroxide over time to improve production and reduce environmental impacts.*

*In all these processes brine, the raw material, is electrolysed. Chloride ions are oxidised at the anode to produce chlorine gas and water is reduced at some stage to produce hydroxide ions which combine with sodium ions to make sodium hydroxide.*

*Though the mercury process has the ability to produce a high quality product, the process uses large amounts of energy and is in two stages. The production of this energy creates greenhouse gases which contribute to climate change. A reduction in energy consumption will have a positive impact on the environment. Moreover, some toxic mercury is released to the environment causing contamination of the food chain. The liquid cathode itself will need to be disposed of carefully to avoid further contamination of the environment. Because of these concerns, mercury cells are being phased out of construction.*

*The diaphragm cell an alternate method of production to the mercury cell, has an asbestos diaphragm and is conducted in a single stage. The diaphragm allows the migration of sodium ions from the anode half cell to cancel out the build up of electrical charge in the cathode half cell. Though improvements have been made in the form of the diaphragm, the diaphragm itself is made of asbestos which can cause lung diseases in organisms in the environment of the process. The diaphragm may also allow the movement of hydroxide and chloride ions and hypochlorite ions may be produced. These ions are strong oxidants and can cause serious damage to cells. The one stage process requires less energy than the mercury process which has a flow on positive effect on the environment in the reduction of energy consumption.*

*Advances in polymer chemistry have resulted in the production of the membrane cell. It has a polymer membrane instead of an asbestos membrane. Negatively charged molecules line the pores of the membrane, repelling anions but allowing for the migration of sodium ions to the cathode. This produces an uncontaminated product so removes the need to fractionally crystallize the cathode contents, removing an energy consuming step from the process. This process requires less energy to run than both the other two which reduces greenhouse gas emissions from energy production, which is better for the environment.*

Criteria	Marks
<ul style="list-style-type: none"><li>• <i>Demonstrates a thorough knowledge of the technological changes to the processes over time and the reduction in environmental impacts via products, materials and/or energy consumption.</i></li><li>• <i>Uses correct and relevant chemistry</i></li><li>• <i>Justifies the statement through examples</i></li><li>• <i>Articulates a concise, coherent and logical progression and includes correct use of scientific principles.</i></li></ul>	6-7
<ul style="list-style-type: none"><li>• <i>Demonstrates a sound knowledge of the technological changes to the processes over time and the reduction in environmental impacts via products, materials an/or energy consumption.</i></li><li>• <i>Uses some correct and relevant chemistry</i></li><li>• <i>Communicates some scientific principles and ideas in a clear manner</i></li></ul>	4-5
<ul style="list-style-type: none"><li>• <i>Demonstrates a basic knowledge of the technological changes to the processes over time.</i></li><li>• <i>Identifies some environmental impacts.</i></li><li>• <i>Communicates ideas in a basic form using general scientific</i></li></ul>	2-3

<i>terms.</i>	
<ul style="list-style-type: none"> <li>• <i>Demonstrates a limited knowledge of the processes</i></li> <li>• <i>Communicates simple ideas</i></li> </ul>	<i>1</i>

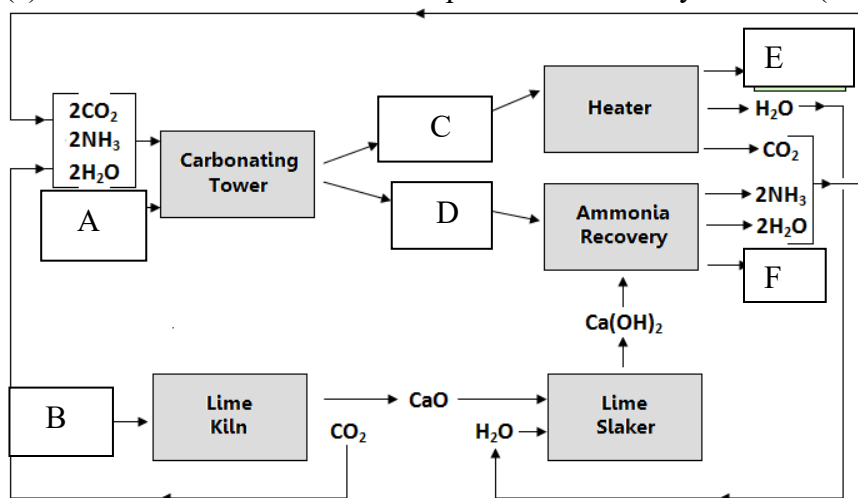
**Outcomes : H1, H3, H4, H8, H16**

- Ev Environmental concern  
 Tt Thorough technological advances addressed  
 Ts Sound technological advances addressed  
 Ct Thorough knowledge of the chemistry  
 Cs Sound knowledge of the chemistry

**Marking examples**

Ev	Ev	Ev	Tt	Ct	7
Ev	Ev		Tt	Ct	6
Ev	Ev	Ev	Tt	Cs	6
Ev	Ev		Tt	Cs	5
Ev	Ev		Ts	Cs	5
Ev	Ev		Ts	Ct	5
Ev	Ev		T (Ts, Tt)	C	4

(e) Below is a flowchart that represents the Solvay Process. (5 marks)



- (i) Identify the raw materials, A and B, in this process. (1 mark)  
 (ii) Give an equation for the decomposition of C to E. (1 mark)  
 (iii) Ammonia is recovered from D, also producing water and F. Why would a small community on the coast be a good option for the location of a Solvay plant at this stage of the process? (3 marks)

*Sample answer*

- (i) *A is brine and B is limestone (must link A to brine and B to limestone)*  
 (ii)  $2\text{NaHCO}_3(s) \rightarrow \text{Na}_2\text{CO}_3(s) + \text{CO}_2(g) + \text{H}_2\text{O}(l)$  (1 mark)  
 (iii) *Ammonia is recovered from ammonium chloride, also forming water and calcium chloride. The calcium chloride is a waste product of this process. If the plant is on the coast, the calcium chloride can be discharged back into the ocean without creating a significant imbalance in the concentration of dissolved ions already present. Ammonia is a toxic gas. The risk of an ammonia leak is low, however, should such a leak occur, the community is small and being on the coast, the gas would disperse quickly.*

Criteria	Marks
<ul style="list-style-type: none"> <li>• Outlines the advantage of a coastal location for two environmental risks and links <math>\text{NH}_3</math> threat to small community</li> </ul>	3
<ul style="list-style-type: none"> <li>• Outlines the advantage of a coastal location for one environmental risk</li> </ul>	2
<ul style="list-style-type: none"> <li>• Identifies one environmental risk OR</li> <li>• Identifies F as calcium chloride OR</li> <li>• Identifies D as ammonium chloride</li> </ul>	1

\*Buffers in the ocean and pH

$\text{CaCl}_2$  is neither acidic or basic so mention of buffers in the ocean or changing pH is incorrect if there is no mention of the buffers working on any leftover slaked lime ( $\text{Ca}(\text{OH})_2$ ) in the discharged solution.

Outcomes : H4, H10, H16

