Student Number	
Mark / 100	

2010

TRIAL HIGHER SCHOOL CERTIFICATE 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 at the top of this page and on the response sheets on pages 10,11,13,15,17,19, and 21
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper. This may be removed for your convenience.

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Total Marks – 100

Section I   Pages 2 – 21

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– 32
•Allow about 1 hour and 35 minutes for this part

Section II   Pages 22 – 23

25 marks

•Attempt Question 33
•Allow about 45 minutes for this section

Section I
75 marks

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

Use the multiple choice answer sheet on page 10

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

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

A ○   B ●   C ○   D ○

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

A ●   B ✖   C ○   D ○

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

correct

A ✖   B ✖   C ○   D ○

1. What type of chemists are employed in research and development laboratories to produce synthetic fibres, adhesives, colloids and surface coatings?

   (A) environmental

   (B) polymer

   (C) biochemist

   (D) metallurgical

2. What is the IUPAC name of an isomer of the following compound?
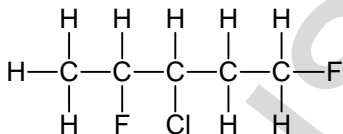
   (A) 3-chloro-1,4-difluoropentane

   (B) 3-chloro-2,3-difluoropentane

   (C) 3-chloro-2,5-dichloropentane

   (D) 2,5-difluro-3-chloropentane

3. The sulfate solution of an unknown cation did not form any precipitate with the chloride ion. Which ion is definitely absent from the solution?

   (A) copper (II) ion

   (B) iron (II) ion

   (C) lead (II) ion

   (D) iron (III) ion

4. Which of the following reactions is definitely exothermic?

(A) $CH_3COOH\ (aq) + NaOH\ (aq) \rightarrow NaCH_3COO\ (aq)\ +\ H_2O\ (l)$

(B) $Ca^{2+}(aq)\ + CO_3^{2-}\ (aq) \rightarrow CaCO_3(s)$

(C) $NH_4Cl\ (s) \xrightarrow{\ water\ } NH_4^+\ (aq)\ +\ Cl^-\ (aq)$

(D) $Na^+\ (aq)\ + e^- \rightarrow Na(s)$

5. Which of the following is a conjugate acid-base pair?
(A) $CO_2 - HCO_3^-$

(B) $O^{2-}\ -\ H_2O$

(C) $PO_4^{3--}\ -\ H_2PO_4^-$

(D) $NH_3\ -\ NH_2^-$

6. A hydrochloric acid solution and a citric acid solution were found to have the same pH. Which statement is correct concerning the citric acid solution?

(A) Both solutions contain the same number of intact acid molecules.

(B) Both solutions contain the same number of ions.

(C) The hydrochloric acid solution has a higher concentration of hydrogen ions.

(D) The citric acid has a higher concentration of intact acid molecules than hydrochloric acid.

7. Ozone reacts with nitric oxide according to the equation:

$$NO(g) + O_3\ (g) \rightarrow NO_2(g) + O_2(g)$$

0.33 g NO(g) was mixed with 0.36 g $O_3(g)$.

What is the maximum volume of $O_2\ (g)$ produced at 0°C and 100 kPa?

(A) 0.17 L

(B) 0.19 L

(C) 0.25 L

(D) 0.27 L

8. A student prepares an ester from butanoic acid and methanol. When she distils the mixture she obtains three fractions with the boiling points: 64.7 ºC, 102.3 ºC and163.3 ºC.
 What is the most likely identity of each fraction?

	Boiling Points		
	64.7ºC	102.3ºC	163.3ºC
(A)	methanol	methyl butanoate	butanoic acid
(B)	methanol	butyl methanoate	butanoic acid
(C)	butanoic acid	methanol	butyl methanoate
(D)	butanoic acid	methyl butanoate	methanol

9. A 382.3 g bottle of soda water was decarbonated by adding 17.7 g of salt to it. Salt does not react with the contents but assists with the decarbonation. The final mass of the bottle of soda water after decarbonation was 395 g. What volume of gas was formed at 25ºC and 100 kPa?

(A)   2.6 L

(B)   2.8 L

(C)   17.1 L

(D)   124 L

10. A red cabbage indicator chart is shown below

Colour	Red	Violet	Purple	Blue	Green	Yellow
pH	1 – 2	3 – 4	5 – 7	8 – 9	10 – 11	12 – 14

What colour would the red cabbage indicator be in a 0.005 molL^{-1} solution of H_2SO_4?

(A)   Purple

(B)   Red

(C)   Blue

(D)   Yellow

11. The diagram represents a cell in which two metal electrodes have been placed in solutions containing their respective metallic ions. The metals are connected to a voltmeter.
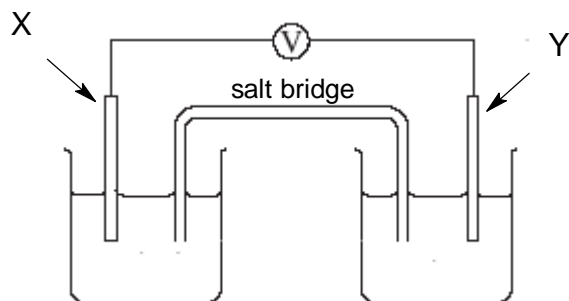
Which of the following combination of metals would produce the highest reading on the voltmeter?

	Metal X	Metal Y
(A)	tin	zinc
(B)	copper	zinc
(C)	copper	silver
(D)	magnesium	lead

12. In a galvanic cell, what is the pathway of anion flow?

	Direction	Medium
(A)	Anode to cathode	Salt bridge
(B)	Anode to cathode	External wire
(C)	Cathode to anode	Salt bridge
(D)	Cathode to anode	External wire

13. Glucose, $C_6H_{12}O_6$, is a monomer that can form naturally occurring polymers.

The approximate atomic weights for the elements which make up glucose are shown in the table

Element	Approximate atomic weight
Carbon	12
Hydrogen	1
Oxygen	16

Using data from the table, what would be the approximate molecular weight of a polymer made from 5 glucose monomers?

(A)   810

(B)   828

(C)   882

(D)   900

14. A student diluted a solution of an acid by mixing 10 ml with 90 ml of water.
If the original acid solution had a pH of 3.1, what is the final pH of the acid solution after dilution?

(A)   1.1

(B)   2.1

(C)   4.1

(D)   5.1

15. What is the major industrial source of ethylene ?

   (A)   the fermentation of sugars

   (B)   the ripening of fruits

   (C)   the cracking of long hydrocarbons

   (D)   the hydration of ethanol

16. Given the following equation for the combustion of 1– propanol:

$$2\ CH_3CH_2CH_2OH(l)\ +\ 9\ O_2\ (g) \rightarrow\ 6\ CO_2\ (g)\ +\ 8\ H_2O(l)\ + 4042\ kJ$$
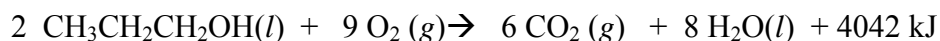
Which of the expressions gives the correct molar heat of combustion of 1–propanol?

   (A) $\Delta H = -\ 4042$ kJ

   (B) $\Delta H = -\ 2021$ kJ

   (C) $\Delta H = +\ 4042$ kJ

   (D) $\Delta H = +\ 2021$ kJ

17. Which of the conditions is responsible for producing the given radioactive nucleus?

	Nucleus	Condition
(A)	$^{3}_{2}He$	neutron to proton ratio is too high
(B)	$^{24}_{11}Na$	neutron to proton ratio is too low
(C)	$^{37}_{17}Cl$	neutron to proton ratio is too high
(D)	$^{131}_{53}I$	neutron to proton ratio too low

18. The first passenger–carrying balloons were made in the 18th century using hydrogen from the reaction of iron with sulfuric acid.
What mass of iron would be required to produce 25 kL of hydrogen required to fill a balloon at 25ºC and 100 kPa?

   (A)   28 kg

   (B)   56 kg

   (C)   61 kg

   (D)   113 kg

Questions 19 and 20 refer to the figure below
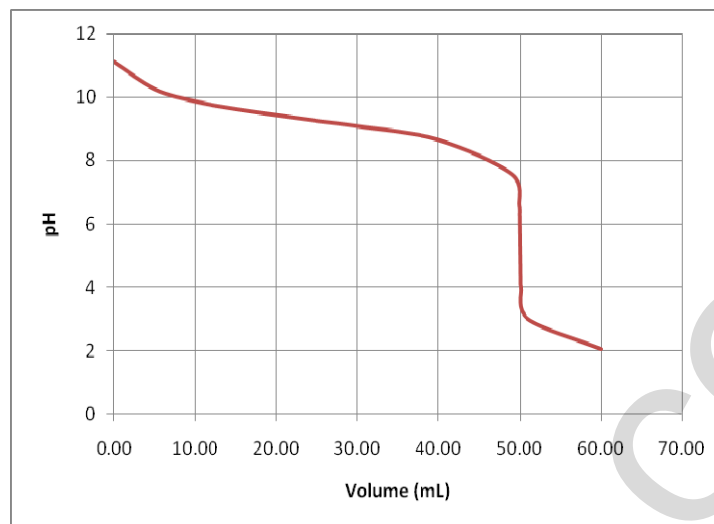
19. Which titration set-up produced the titration curve drawn?

	Solution in the conical flask	Solution in the burette
(A)	HCl	NH_3
(B)	NH_3	HCl
(C)	CH_3COOH	NaOH
(D)	NaOH	CH_3COOH

20. What will be a suitable indicator for this titration?

(A) bromothymol blue

(B) phenolphthalein

(C) methyl orange

(D) litmus

Section I   **Mark   -----/20**
Part A
Multiple Choice Answer Sheet

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 ○

Section I (continued)   **Student Number …………………………….**

Part B. 55 marks

Attempt questions 21-32
Allow about 1 hour and 45 minutes for this part

▸ *Answer the questions in the spaces provided*
▸ *Show all relevant working in questions involving calculations*

Marks

Question 21 (2 marks)

Write a balanced equation to show the dehydration of ethanol to ethylene including the
catalyst used.   **2**

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Question 22 (4 marks)

(a)   Draw the structural formula for the monomer vinyl chloride.   **1**

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(b)   Identify the systematic name for the monomer of vinyl chloride.   **1**

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(c)   Describe two uses of polyvinylchloride in terms of its properties.   **2**

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Question 23 (6 marks)

Evaluate the potential use of a named biopolymer relating it to its properties.
Include the name of the specific enzyme or organism used in the production of the biopolymer.   **6**

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Question 24 (4 marks)

Explain the use of ONE named radioisotope in industry OR medicine in terms of its properties.   **4**

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Question 25 (4 marks)

(a)   Write a balanced chemical equation showing ONE metallic oxide acting as as a base..   **1**

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(b)   Outline the relationship between position of elements in the Periodic Table and
acidity / basicity of oxides. Include specific examples of elements in your answer.   **3**

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Question 26 (4 marks)

One acidic oxide found in the atmosphere is $SO_2(g)$

(a)   Identify one natural and one industrial source of $SO_2(g)$ **2**

	Source of SO_2(g)
Natural	
Industrial	

(b)   Write an equation to demonstrate the acidic nature of $SO_2(g)$ **1**

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(c)   At 25º C and 100 kPa, what volume of $SO_2(g)$ would be needed to produce 1.50 L of 1.50 mol L^{-1} acid   **2**

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Qustion 27 (5 marks)

(a)   Draw the structural formula of 1-hexanol and methanoic acid.
        Circle and name the functional groups in these molecules.   **2**

1- hexanol	methanoic acid

(b)   Draw a fully labelled diagram of the apparatus and reagents needed for the esterification
        reaction between 1-hexanol and methanoic acid.   **3**

Test continues next page

Question 28 (6 marks)

Amphiprotic substances have the ability to work as buffers in natural systems.

Explain why natural systems require buffers and using a specific example of an amphiprotic substance show how this can behave as a buffer. Include equations in your answer.

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Test continues next page

Marks

Question 29 (5 marks)

A 0.2845 g sample of impure sodium carbonate required 24.65 mL of an HCl solution for titration.   A 0.2204 g sample of pure sodium carbonate required 20.06 mL of the HCl solution of the same concentration.
What is the percentage of sodium carbonate in the sample?   **5**

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Question 30 (4 marks)

What would you use to clean an acid spill in the laboratory? Justify your choice. If you were an assistant in Arrhenius' laboratory in 1884, would Arrhenius have advised you to use this same substance to clean the acid spill? Give reasons for your answer.

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Test continues next page

Marks

Question 31 (6 marks)

A typical Australian ammonia plant using the Haber process employs a temperature range of $450 – 550^{o}C$, a pressure range of 15-18 Mpa, (~250 atm) and magnetite as catalyst. Justify the use of these conditions in the manufacture of ammonia. Write a relevant equation including the energy term.

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Question 32 (5 marks)

A bottle of *Cool JR Springs*® water was analysed for mercury using AAS. The analysis consisted
of accurately measuring 250.00 mL of *Cool JR Springs*® water sample, evaporating it to about
50 mL and then diluting it with demineralised water, accurately to 100.00 mL. Standard
mercury solutions and the treated *Cool JR Springs*® water sample were then passed through the AAS.

The results are tabulated below:

Concentration of mercury standard solution ($\mu g\ L^{-1}$)	Absorbance
0.00	0.002
0.30	0.090
0.60	0.175
1.00	0.268

Treated *Cool JR Springs*® sample recorded an absorbance of 0.140

$1\ \mu g\ = 10^{-6}\ g$

Question 32 continues next page

Student Number …………………

Marks

(a)   Use the grid to plot a calibration curve. Label your graph.   **2**
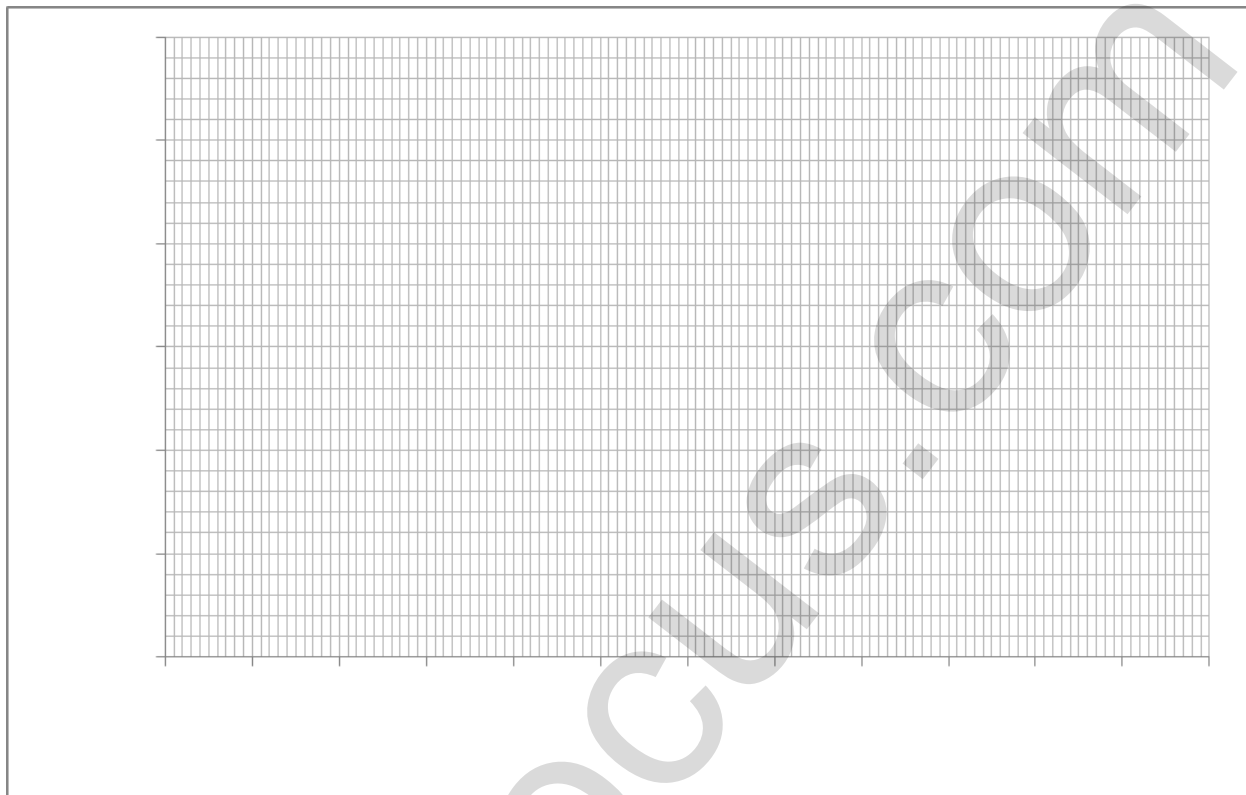
(b)   The US Environmental Protection Agency, (EPA) has estimated a safe daily intake limit
of mercury of 0.1 µg /kg of body mass.
What volume in litres of the untreated *Cool JR Springs*®bottled water can a 50 kg person
safely drink daily without the adverse effect of mercury poisoning?   **3**

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End of question 32

Please turn the page over for Question 33 (Industrial Chemistry option)

Chemistry

Section II

25 marks
Attempt question 33
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.

Question 33

Marks

(a)   During your practical work you performed first hand investigations to observe
        reactions of sulfuric acid.

    (i)   Identify a risk associated with your procedures and outline a safety   **2**
                precaution taken to minimise the risk.

    (ii)   Describe how sulfuric acid is diluted in the laboratory safely and explain why   **2**
                this procedure is necessary.

(b)   Dinitrogen tetroxide, N_2O_4 (*g*), dissociates to form nitrogen dioxide (*g*), according
        to the equation:

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

0.45 mol of N_2O_4 gas is placed in an empty 1.00 L vessel at 100^oC. When the system
reaches equilibrium, 0.36 mol of NO_2 gas is present in the vessel.

    (i)   Calculate the equilibrium constant, *K*, for this reaction at 100^oC.   **3**

    (ii)   At 25^oC, the equilibrium constant in this reaction is 0.144. Is this reaction
                endothermic or exothermic? Give an explanation for your answer.   **2**

(c)   Sodium hydroxide can be made industrially by the electrolysis of sodium chloride.

Explain the different products of electrolysis of aqueous and molten sodium chloride.   **4**
Use equations to demonstrate your answer.

Question 33 continues next page

Marks

(d)   Distinguish between soaps and synthetic detergents in terms of their chemical
       composition and their behaviour in hard water.   **4**

(e)   The diagram shows a flowchart of the reactions involved in the Solvay process.
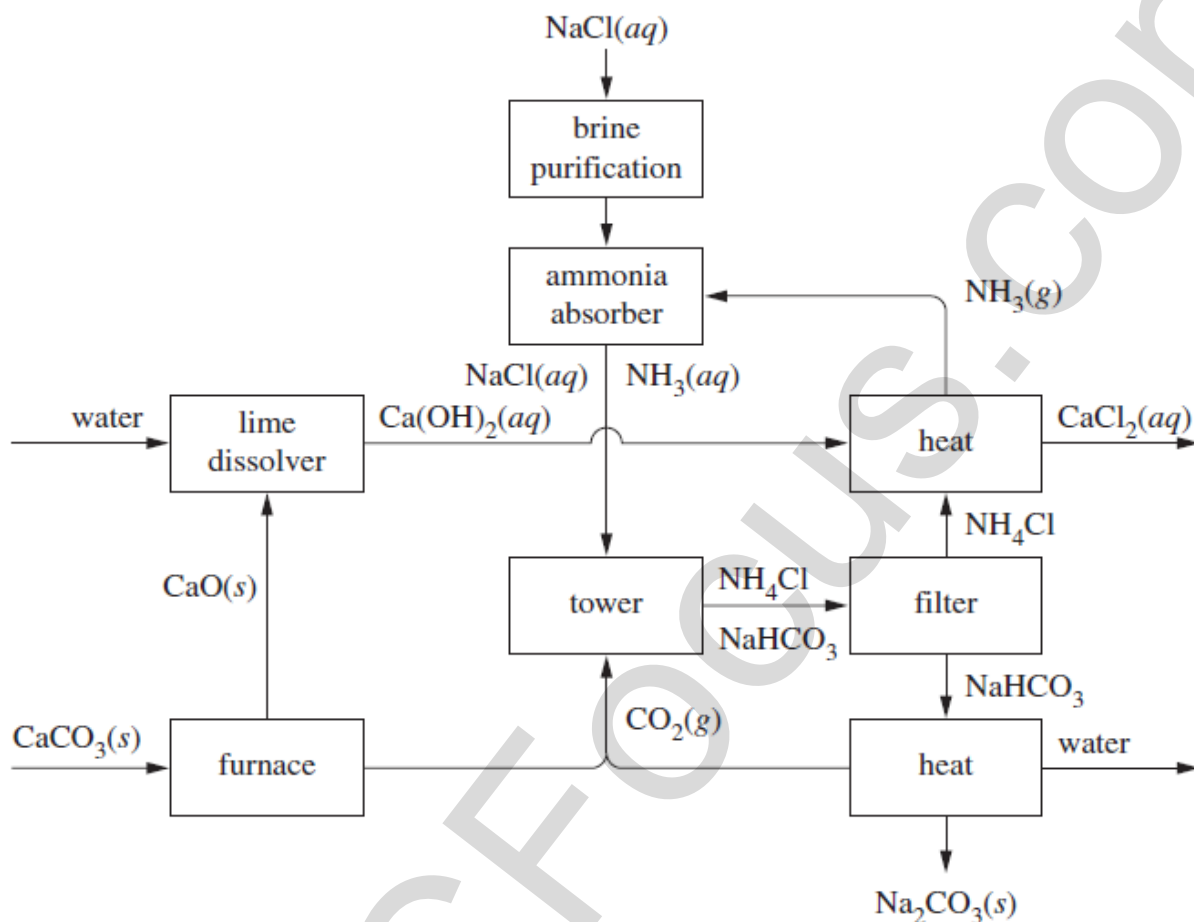
(i)   Identify the major product of the Solvay process and describe one of its uses.   **2**

(ii)   Describe the chemistry involved in the recovery of ammonia during the process.   **2**

(iii) Discuss two environmental issues associated with the process and explain how
       these issues are addressed.   **4**

End of Test ☺