

**Student Number**

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## **Exam Choice**

**2006**

### **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
- Approved calculators may be used
- Write your student number in the space provided

**Total marks – 100**

**Section I** Pages 2 - 19

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16-28
- Allow about 1 hour and 45 minutes for this part

**Section II** Pages 20 - 31

25 marks

- Attempt **ONE** Question from Questions 29-33
- Allow about 45 minutes for this section

**Section I**  
**75 marks**

**Part A – 15 marks**

**Attempt Questions 1-15**

**Allow about 30 minutes for this part**

Use the multiple-choice answer sheet.

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

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

A ☐ B ☒ C ☐ D ☐

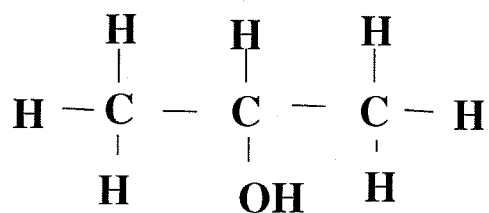
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ☒ B ☒ C ☐ D ☐

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

A ☒ B ☒ C ☐ D ☐  
correct

- 1 Which of the following is the correct IUPAC name for the molecule below.



- (A) 2-propane  
(B) 2-hydroxypropane  
(C) 2-propanol  
(D) 2-hydroxypropanol
- 2 What is the oxidation state of manganese in potassium permanganate,  $\text{KMnO}_4$ .
- (A) -1  
(B) +3  
(C) +7  
(D) +8
- 3 Which of the following nuclei is most likely to undergo nuclear decay?
- (A) carbon-12  
(B) potassium-39  
(C) cobalt-60  
(D) lead-207
- 4 Which of the following are significant industrial sources of sulfur dioxide?
- (A) lightning and bacteria  
(B) bacteria and volcanoes  
(C) internal combustion engine and air conditioning units  
(D) coal burning power stations and metal ore smelting

- 5 Which of the following is the conjugate acid of water?
- (A)  $\text{H}_3\text{O}^+$
  - (B)  $\text{OH}^-$
  - (C)  $\text{H}_2\text{O}_2$
  - (D)  $\text{Cl}^-$
- 6 Which of the following is the common name for 2-hydroxypropane-1,2,3-tricarboxylic acid?
- (A) acetic acid
  - (B) citric acid
  - (C) ascorbic acid
  - (D) sulfuric acid
- 7 Who defined an acid as a substance containing replaceable hydrogen?
- (A) Lavoisier
  - (B) Davy
  - (C) Arrhenius
  - (D) Lowry and Brønsted
- 8 Which of the following equations describes a buffer?
- (A)  $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
  - (B)  $\text{CH}_3\text{COOH}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$
  - (C)  $\text{H}_2\text{SO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HSO}_4^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$
  - (D)  $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
- 9 What is the pH of a  $1.5 \times 10^{-4} \text{ mol L}^{-1}$  solution of sulfuric acid assuming complete ionization?
- (A) 4.0
  - (B) 3.8
  - (C) 3.5
  - (D) 1.5

- 10** Which of the following pairs are isomers?
- (A) graphite and diamond
  - (B) carbon-12 ( $^{12}_6\text{C}$ ) and carbon-14 ( $^{14}_6\text{C}$ )
  - (C) cyclohexane and cyclohexene
  - (D) cyclohexane and 1-hexene
- 11** Which of the following statements about cellulose is correct?
- (A) Cellulose is a condensation biopolymer synthesized from glucose monomers.
  - (B) Cellulose is an addition biopolymer synthesized from glucose monomers.
  - (C) Cellulose is a natural monomer from which many useful products are made.
  - (D) Cellulose is a monomer that contains a carbon chain structure similar to that found in most fuels.
- 12** To which area has Atomic Absorption Spectroscopy contributed the most?
- (A) The analysis of organic water pollutants.
  - (B) The identification and effects of trace elements.
  - (C) The analysis of pollutant gas levels in the atmosphere.
  - (D) The identification of metal ions in water.
- 13** Which of the following is the major origin of *Halons* in the atmosphere?
- (A) Air conditioning units.
  - (B) Dry cleaning processes.
  - (C) Aerosol cans.
  - (D) Fire extinguishers.

- 14 The table below gives the results of some tests performed on water from four different sites.

Test	Site Q	Site R	Site S	Site T
Total dissolved solids (ppm)	550	120	50	635
Phosphate (ppm)	2.2	0.02	0.01	1.1
Dissolved oxygen (ppm)	2.5	5.0	7.0	3.5
Micro-organisms (CFU/100 mL <sup>a</sup> )	190	220	1	2

Which site is most likely to be down stream from a farm?

- (A) Site Q  
(B) Site R  
(C) Site S  
(D) Site T
- 15 A student performed an investigation to measure the sulfate content of ammonium sulfate lawn fertilizer by precipitating the sulfate as barium sulfate ( $\text{BaSO}_4$ ) and weighing the precipitate. His results are tabulated below.

What was weighed	Mass (g)
Ammonium sulfate fertiliser sample	2.00
Clean filter paper	1.05
Filter paper + dry barium sulfate precipitate	1.88

What is the percentage of sulfate, by mass, in the measured ammonium sulfate fertilizer?

- (A) 17.1 %  
(B) 24.4 %  
(C) 41.5 %  
(D) 72.7 %

## Section I (continued)

### Part B – 60 marks

#### Attempt Questions 16 – 28

Allow about 1 hour and 45 minutes for this part.

Answer the questions in the spaces provided.

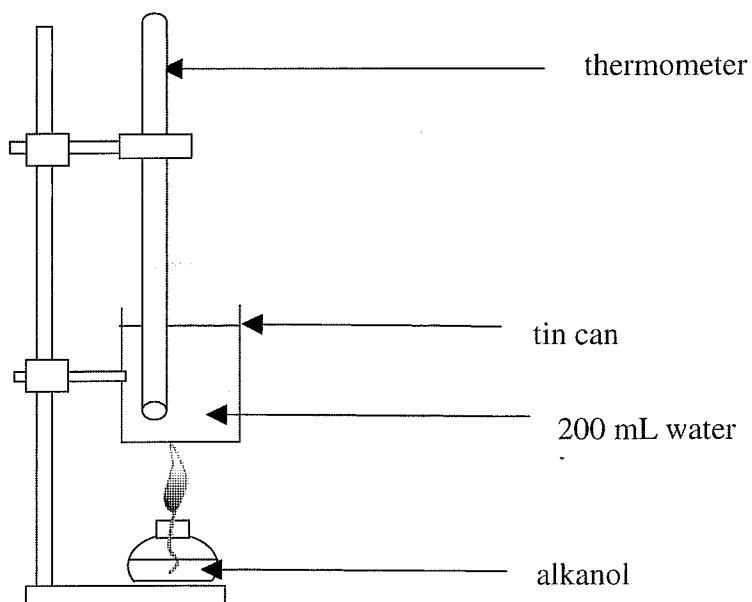
Show all relevant working in questions involving calculations.

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	Marks
<b>Question 16</b> (6 marks)	
Ethanol can be produced by <i>the addition of water to ethylene</i> OR by <i>fermentation of sugars</i> .	
(a) Give the equation for the production of ethanol by the addition of water to ethylene.	1
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(b) Outline how ethanol can be produced by fermentation in the school laboratory.	2
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(c) Discuss ONE advantage and ONE disadvantage of the potential wide-scale use of ethanol as an alternative fuel to petrol in cars.	3
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**Question 17** (8 marks)

A student set up the apparatus below to determine the molar heat of combustion of three liquid alkanols.



Her results are tabulated below.

Alkanol	Water temperature (°C)		Mass of spirit burner containing alkanol (g)		Molar Heat of Combustion (kJmol <sup>-1</sup> )
	Initial	Final	Initial	Final	
Ethanol	20	35	42.6	41.8	x
1-propanol	20	44	42.1	40.9	-1206
1-butanol	20	52	45.4	44.7	-1256



Question 17 (continued)

- (a) There is always some risk involved when using a naked flame in a school investigation.

Assess ONE of the risks involved in conducting this investigation.

2

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- (b) Calculate the molar heat of combustion for ethanol from the student's data provided in the table.

3

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- (c) Explain the trend in heat of combustion for the three alkanols.

1

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- (d) The value obtained by the student for 1-butanol is significantly lower than the theoretical value of  $-2676 \text{ kJ mol}^{-1}$ .

2

Describe and explain ONE way that the student could modify the experiment to obtain a more accurate result.

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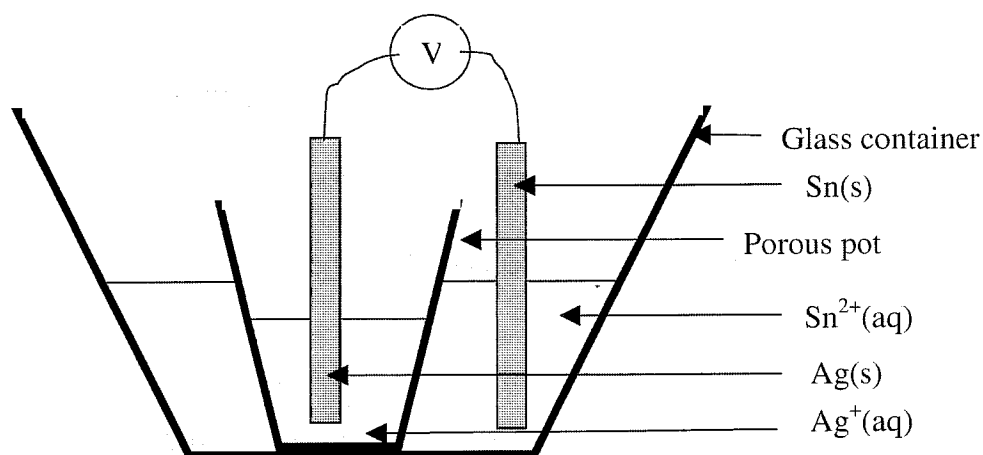
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**Question 18** (4 marks)

A Galvanic cell may be constructed by placing one half-cell in a porous pot inside another half-cell as shown below.



- (a) Identify the *anode*.

1

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- (b) Use the standard potentials supplied to calculate the theoretical voltage of this cell.

1

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- (c) Explain the function of the *porous pot*.

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**Question 19** (3 marks)

Elements discovered in the past 50 years could be described as being *recently* discovered.

3

Describe how one named element has been produced or discovered in recent times.

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**Question 20** (4 marks)

During this course you will have studied the use of catalysts in a number of different reactions and processes.

(a) Identify one chemical reaction or process that uses a catalyst.

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(b) Name the catalyst used.

1

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(c) Explain how the catalyst functions in this process.

2

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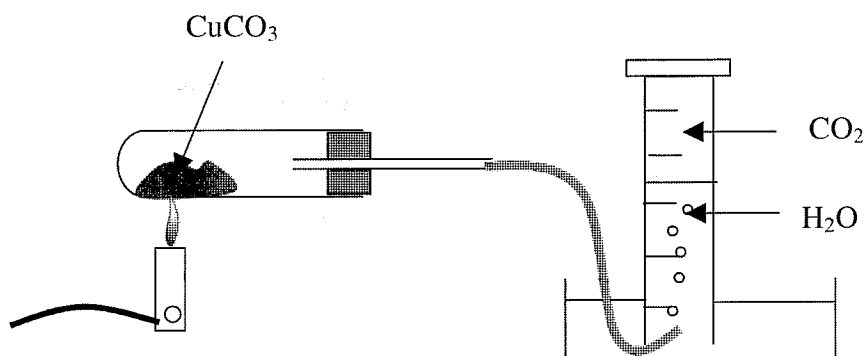
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**Question 21** (7 marks)

Copper carbonate ( $\text{CuCO}_3$ ) is decomposed to carbon dioxide and copper (II) oxide when heated.

The volume of carbon dioxide produced can be measured by displacing water.



The results of an investigation into the decomposition of copper(II) carbonate are tabulated below.

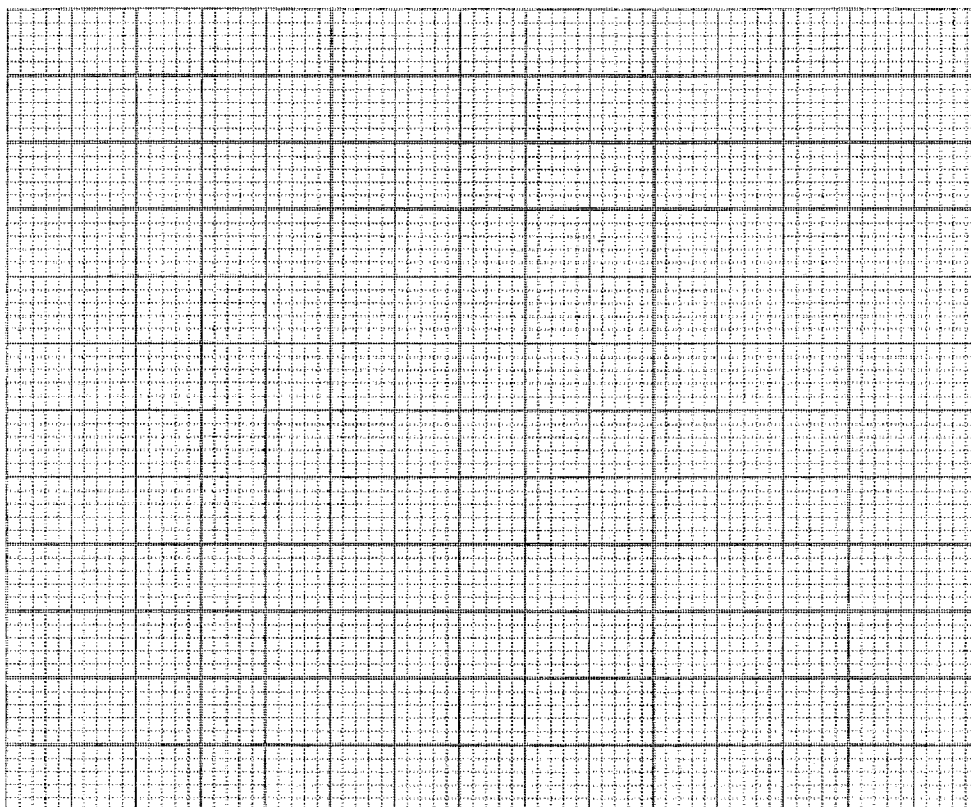
Time (sec)	Gas Volume at 25°C and 100 kPa (mL)
10	20
30	66
50	84
70	90
100	92
130	92

Question 21 (continued)

- (a) Write the equation for the decomposition of copper carbonate. 1

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- (b) Graph the results from this experiment. 3



- (c) Calculate the initial mass of copper carbonate heated. 2

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- (d) Assess the validity of the procedure for collecting the gas. 1

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**Marks**

**Question 22** (4 marks)

Assess the use of sodium hydrogen carbonate,  $\text{NaHCO}_3$ , in neutralizing acid and base chemical spills.

**4**

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**Question 23** (3 marks)

Special techniques are used to ensure accuracy when preparing a standard solution and conducting a titration.

**3**

Describe TWO such techniques for the preparation of the standard solution OR TWO such techniques for conducting the titration.

Explain how each assists in obtaining a precise result.

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**Question 24 (4 marks)**

**Marks**

Explain why it is crucial to monitor the temperature and pressure in the reaction vessel used in the Haber Process.

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**Question 25** (4 marks)

**Marks**

Ions such as lead, phosphate and copper can move from farms and industry into the environment where they can cause problems.

**4**

Describe and explain evidence for the need to monitor levels of ONE named ion used by society.

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**Question 26** (3 marks)

Hydronium,  $\text{H}_3\text{O}^+$ , ammonium,  $\text{NH}_4^+$ , and ozone,  $\text{O}_3$ , each have a *coordinate covalent bond*.

(a) Define *coordinate covalent bond*.

**1**

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(b) Draw a Lewis electron dot structure of one of these molecules/ions and identify the position of the *coordinate covalent bond*.

**2**



**Question 27 (6 marks)**

Ozone is being gradually removed from the stratosphere by our use of CFC's.

- (a) Identify ONE CFC molecule that has caused problems. **1**

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- (b) Give equations to demonstrate the removal of ozone from the atmosphere by this CFC. **2**

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- (c) Evaluate the effectiveness of replacement chemicals for CFC's. **3**

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**Question 28** (4 marks)

(a) Describe how water from your local catchment is sanitized.

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(b) Assess the effectiveness of this method.

**2**

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## Section II

**25 marks**

**Attempt ONE question from Questions 29 to 33**

**Allow about 45 minutes for this section.**

Answer in a writing booklet. Extra booklets are available.

Show all relevant working in questions involving calculations.

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	Pages
Question 29    Industrial Chemistry .....	20 - 23
Question 30    Shipwrecks, Corrosion and Conservation .....	24 - 25
Question 31    Biochemistry of Movement .....	26 - 28
Question 32    The Chemistry of Art .....	29
Question 33    Forensic Chemistry .....	30 - 31

**Question 29 – Industrial Chemistry (25 marks)**

- |         |   |   |
|---------|---|---|
| (a) (i) | Identify a natural product, (not a fossil fuel), that is a shrinking world resource.                      | 1 |
| (ii)    | Discuss the issues associated with the increasing need for this resource.                                 | 3 |
| (iii)   | Identify a possible replacement for this resource or outline current research into finding a replacement. | 1 |

- (b) Dinitrogen tetroxide ( $\text{N}_2\text{O}_4$ ) is a colourless gas. It exists in equilibrium with nitrogen dioxide ( $\text{NO}_2$ ), a brown gas.



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|------|---|---|
| (i)  | Write the expression for the equilibrium constant for this reaction.  | 1 |
| (ii) | Some pure $\text{NO}_2$ is placed in a gas syringe at $25^\circ\text{C}$ and allowed to reach equilibrium. Keeping the volume constant, the temperature is then raised to $35^\circ\text{C}$ . The brown colour becomes more intense. | 2 |

Explain whether the forward reaction is endothermic or exothermic.

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|-------|--|---|
| (iii) | $2 \times 10^{-3}$ moles of $\text{N}_2\text{O}_4$ was placed in a 100 mL syringe at $25^\circ\text{C}$ and given time to come to equilibrium with $\text{NO}_2$ . Two minutes later $6 \times 10^{-4}$ moles of $\text{NO}_2$ were measured in the container. | 2 |
|-------|--|---|

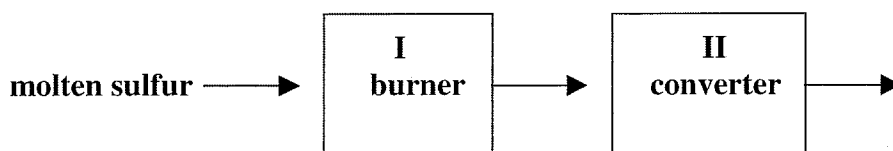
Calculate whether the system had reached equilibrium.

**Question 29 continues**

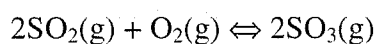
## Question 29 (continued)

- (c) Sulfuric acid can be produced from mined sulfur via the Contact Process.

The first two stages in the industrial production of sulfuric acid by this process are represented below.



- (i) Give a reason why, in stage I, the molten sulfur is sprayed into the burner rather than being allowed to flow through it. 1
- (ii) A conflict is involved in choosing the best temperature to be used in stage II, where the reaction is: 2



Describe the nature of the conflict and explain how the conflict is resolved.

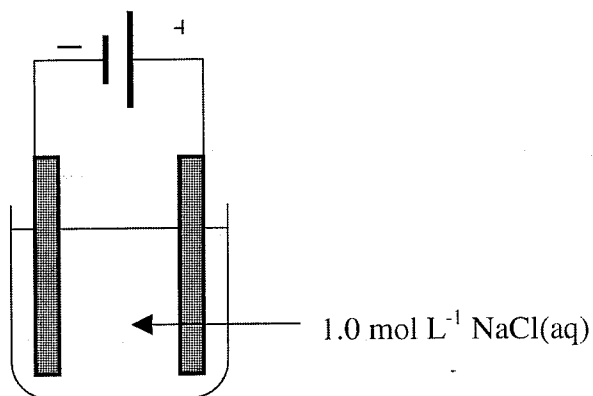
- (iii) Describe by using an equation/s a specific example of sulfuric acid acting as an oxidizing agent. 1
- (d) Anionic detergents are effective in cleaning greasy glass plates. 3
- Give details of the structure of an anionic detergent molecule and explain exactly how the detergent works to lift and remove grease.

**Question 29 continues**

## Question 29 (continued)

- (e) A student carries out the electrolysis of a  $1.0 \text{ mol L}^{-1}$  solution of sodium chloride using inert graphite electrodes.

The setup for this experiment is shown below.



- (i) Write a half-equation for the reaction that would occur at the cathode. 1

- (ii) Two different gases are produced at the anode. 1

Write a half-equation for a reaction that results in the production of one of these gases.

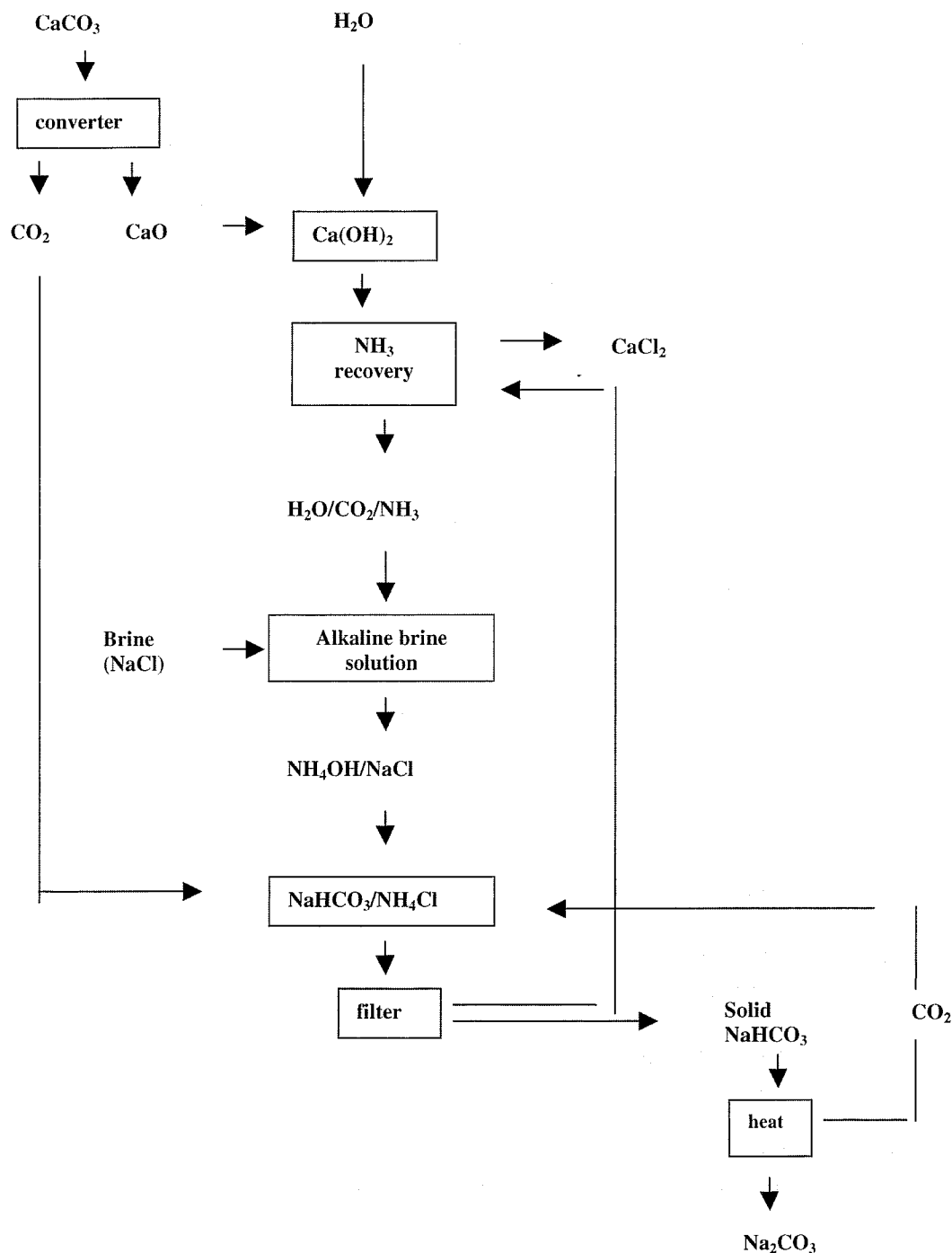
- (iii) Using the same current and electrodes, the student carries out a second electrolysis, this time of molten sodium chloride instead of a solution. What difference, if any, would you expect in the products formed at the anode and cathode? 2

Give equations for any different relevant oxidation and/or reduction reactions occurring.

**Question 29 continues**

## Question 29 (continued)

- (f) The flow chart below summarises the steps in the Solvay Process, the production of sodium carbonate.



Discuss TWO environmental issues associated with the Solvay Process and explain how these issues are addressed.

4

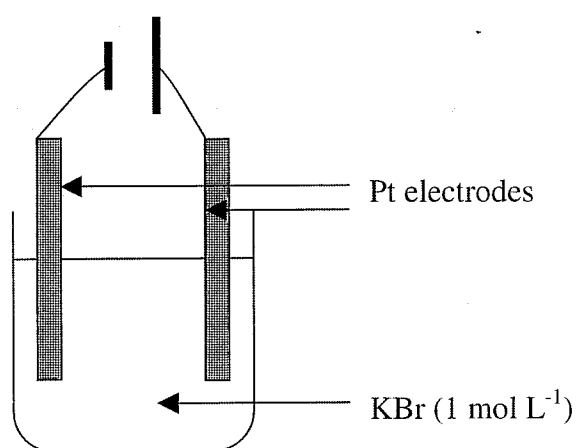
**Question 30 – Shipwrecks, Conservation and Corrosion (25 marks)**

- (a) In 1780 Luigi Galvani generated an electric current by taking two wires made of different metals, at one end joining them together and at the other end placing them on a dissected frog's leg muscle. 3

The muscle contracted, prompting Galvani to coin the term *animal electricity*.

Outline how a more recent chemist, Alessandro Volta, interpreted Galvani's results and describe how he built on Galvani's work.

- (b) The experiment below was set up to investigate the factors that affect the rate of electrolysis.



- (i) Give the half-equation for the reaction occurring at the cathode. 1
- (ii) Calculate the voltage required for the reaction to proceed. 1
- (iii) In some investigations, reaction rate can be measured by recording the change in temperature. 1
- Describe what the investigator could have recorded as a measure of reaction rate in this investigation.
- (iv) Identify one other factor that the investigator may have varied and give the likely result of varying this factor on reaction rate. 2
- (c) Describe how the process of *cathodic protection* minimizes rusting of iron in marine environments in terms of oxidation and reduction. 4

**Question 30 continues**



**Question 30 (continued)**

- (d) In the year 1770 Captain Cook tossed 10 cannons overboard when his ship, the Endeavour, hit a coral reef.

These were discovered 200 years later but they were in poor condition. They were covered in coral ( $\text{CaCO}_3$ ) and extensively pitted and corroded.

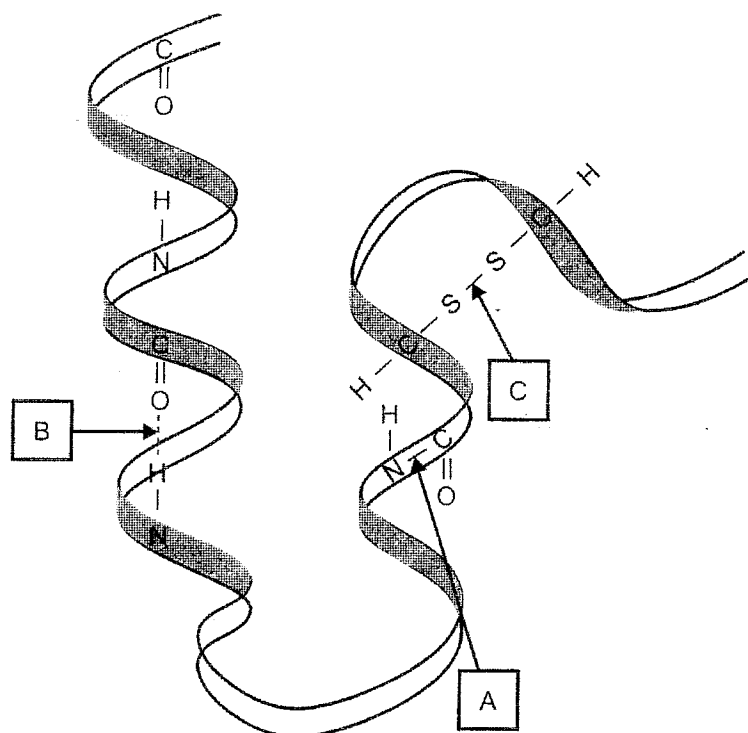
They were recovered and firstly kept in a basic sodium hydroxide solution.

- |  |          |
|--|----------|
| (i) Explain why the cannons would be kept in a basic solution before work began on them.                               | <b>1</b> |
| (ii) Describe how the coral may have been removed.   | <b>1</b> |
| (iii) Describe and explain how the corrosion may have been halted and reversed.  | <b>3</b> |
| (iv) Describe and explain how the cannons may be treated to protect them from further corrosion as they are displayed. | <b>2</b> |
| (e) Identify and discuss factors that influence the rate of corrosion of a steel shipwreck in deep ocean waters.       | <b>6</b> |

**Question 31 – The Biochemistry of Movement (25 marks)**

- (a) Enzymes, which are composed mostly of proteins, catalyse many chemical reactions.

The structure of a portion of an enzyme, with some of its constituent atoms shown, is represented below.

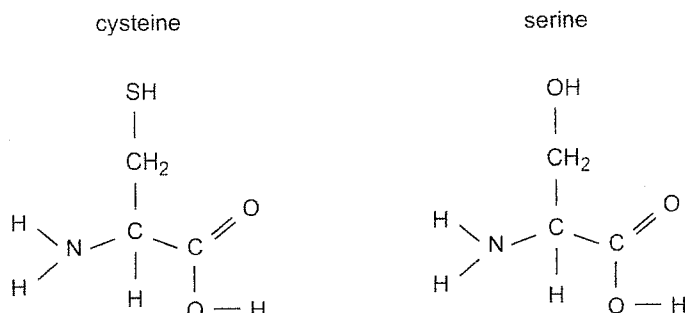


- |  |          |
|--|----------|
| (i) Name the type of chemical bond present in the parts labelled A, B and C.   | <b>2</b> |
| (ii) If the tertiary structure of an enzyme is disrupted, the enzyme is no longer active. Explain why.   | <b>2</b> |
| (iii) When a solution of the enzyme amylase is boiled at 100°C for several minutes, the enzyme loses its tertiary structure yet its primary structure remains intact. Explain why. | <b>1</b> |

**Question 31 continues**

Question 31 (continued)

- (b) Two common amino acids are cysteine and serine. Their structural formulas are given below.



- |  |   |
|--|---|
| (i) What chemical feature must a substance have to be classified as an amino acid?                                 | 1 |
| (ii) Give the general formula for an amino acid.   | 1 |
| (iii) Using either cysteine or serine or both, describe the chemistry involved in the formation of a peptide bond. | 2 |
- (c) Glycolysis, which occurs in the cytoplasm of all cells, is a metabolic pathway which consists of a series of enzyme mediated reactions, organized so that the end product of one reaction is the substrate for the next.
- |  |   |
|--|---|
| (i) State the main purpose of glycolysis.  | 1 |
| (ii) Explain the role of ATP in glycolysis.  | 1 |
| (iii) Explain the role of $\text{NAD}^+$ in glycolysis.  | 1 |
| (iv) Pyruvic acid, the final product formed in glycolysis can be used in two further metabolic pathways. | 2 |
- Outline the two possible fates of this molecule in muscle cells.
- |   |   |
|---|---|
| (d) Analyse the structure of the glycerol molecule and predict BOTH its viscosity and solubility in water, giving reasons for your predictions. | 4 |
|---|---|

Question 31 continues

**Question 31 (continued)**

- (e) The muscles used for movement are called skeletal muscles.

Muscles cause movement by contracting along their length and are found as two types.

- |  |          |
|--|----------|
| (i) Compare and contrast the appearance and function of Type I and Type II muscle cells.   | <b>4</b> |
| (ii) Identify the cause of muscle cell contraction and briefly explain why ATP is consumed in the process of muscle contraction. | <b>3</b> |

## Question 32 – The Chemistry of Art (25 marks)

- (a) Minerals have been used as pigments by ancient people and Australian aboriginal people.
- (i) Identify ONE mineral by name that has been used as a pigment by either of these groups of people. 1
  - (ii) Give the chemical composition of the mineral named in (i). 1
  - (iii) Assess the potential health risk of ONE named cosmetic used by ancient people. 3
- (b) (i) Explain why when hydrogen atoms are excited they emit certain frequencies of radiation which we call the *hydrogen spectrum*. 2
- (ii) Describe how the Danish scientist, Neils Bohr, developed a model of the atom based on research into the hydrogen spectrum. 3
  - (iii) Discuss ONE merit and ONE limitation of the Bohr Model of the atom. 3
- (c) Outline the use of *infra-red spectroscopy* in detecting the presence of pigments in a sample. 3
- (d) (i) Give the electron configuration, using s, p, d notation, of an iron atom in its ground state. 1
- Transition metals have many similarities in their chemical properties.
- (ii) Explain, in terms of current atomic theory, why iron is classified as a transition metal. 1
  - (iii) Explain, in terms of ionization energy, why Group I elements typically exhibit a +1 oxidation state in their compounds and not the +2 and or +3 often found in transition metals. 2
- (e) (i) Define “*ligand*”. 1
- (ii) Identify an example of a *chelated ligand*. 1
  - (iii) Discuss the importance of models in developing an understanding of the nature of ligands using specific examples. 3

	Marks
<b>Question 33 – Forensic Chemistry (25 marks)</b>	
(a) (i) Identify an example of two different alkanols that each belong to different classes.	1
(ii) Outline a distinguishing test that can be used to identify the two.	1
(b) (i) Identify two properties of soil that can be used in forensic evidence.	1
(ii) Explain how these properties could be used in evidence.	2
(c) (i) Describe the difference between reducing and non-reducing sugars giving an example of each.	2
(ii) Describe a test that can be used in the school laboratory to identify whether a sugar is reducing or non-reducing.	2
(d) Chromatography and electrophoresis are both powerful tools for a forensic chemist when trying to identify an unknown.	6
Compare and contrast these processes and identify the properties of mixtures that allow them to be separated by these processes.	

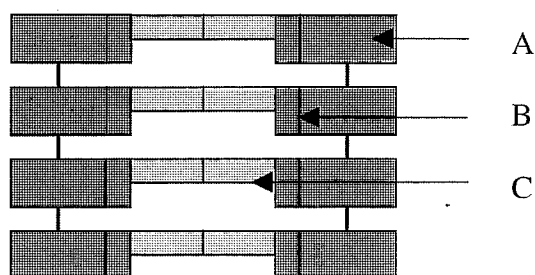
**Question 33 continues**

Question 33 (continued)

- (e) DNA is the universal inheritance molecule and is now being used in forensic studies to identify persons who produced biological samples at crime scenes, identifying fathers in paternity cases and identifying bodies in natural and terrorist incidents.

- (i) Identify the individual components, A, B and C in a DNA molecule.

1



- (ii) What is a DNA data bank?

1

- (iii) Discuss one ethical issue associated with the keeping of DNA data banks.

2

- (f) Outline how a mass spectrometer operates and assess its usefulness to a forensic scientist.

3

- (g) When an element is energized by heating to high temperatures or bombarding with electrons, light is emitted. This light can be split into a distinctive spectrum.

- (i) Account for the emission of a line spectrum from an element.

1

- (ii) Name the instrument used to observe the line spectrum in the school laboratory.

1

- (iii) Account for the line spectrum of each element being *unique* to each element.

1

End of Paper