

Student Number

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Exam Choice

2008

**TRIAL HIGHER SCHOOL
CERTIFICATE
EXAMINATION**

Chemistry

Total marks – 100

Section I Pages 2 - 18

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 16-25
- Allow about 1 hour and 45 minutes for this part

Section II Pages 19 - 28

25 marks

- Attempt **ONE** Question from Questions 26-30
- Allow about 45 minutes for this section

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

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. A polymer has the following properties and uses:

- low melting point
- transparent
- oil and water resistant
- uses include food packaging

Which one of the following polymers is consistent with the above description?

- (A) high density polyethene
- (B) low density polyethene
- (C) polychloroethene
- (D) polyphenylethylene

2. Which one of the following pairs of chemicals react to give products which depend on the reaction conditions?

- (A) ethene + water
- (B) bromine + ethene
- (C) methane + oxygen
- (D) ethanol + ethanoic acid

3. A student was shown a demonstration in which a sample of an element was heated strongly in air, and the powder produced by the reaction was added to water. When tested with a pH probe connected to a data logger, the resulting solution had a pH of 9.

Which one of the following elements could have been used?

- (A) S
- (B) C
- (C) Si
- (D) Ca

4. Which one of the following molecules is least likely to have a negative effect on the concentration of ozone in the stratosphere?

- (A) halon
- (B) HFC (hydrofluorocarbon)
- (C) CFC (chlorofluorocarbon)
- (D) HCFC (hydrochlorofluorocarbon)

5. A few drops of bromine water are added to an unknown colourless hydrocarbon. No change was observed after allowing the mixture to stand for 5 minutes under ordinary laboratory lighting.

Which one of the following is the most appropriate conclusion?

- (A) The hydrocarbon must be unsaturated.
 - (B) The hydrocarbon contains single bonds only.
 - (C) The hydrocarbon must contain a double bond.
 - (D) The hydrocarbon must contain a triple bond.
6. A student diluted a solution of an acid by mixing 10 mL with 90 mL of water. If the original solution had a pH of 2.1, what will the final pH of the solution be?
- (A) 1.1
 - (B) 2.1
 - (C) 3.1
 - (D) 4.1
7. Consider the equilibrium reaction:

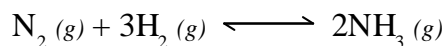


Which one of the following would decrease the $\text{C}_6\text{H}_5\text{COO}^-$ ion concentration in solution?

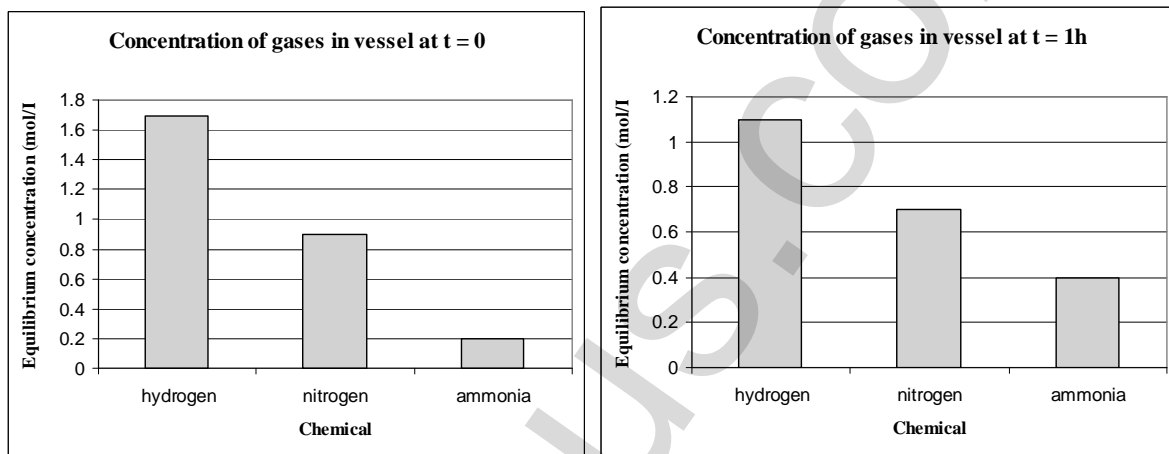
- (A) adding H_2
 - (B) adding HCl
 - (C) adding NaOH
 - (D) adding $\text{C}_6\text{H}_5\text{COOH}$
8. Which one of the following is an acid/base conjugate pair?
- (A) HCl/NaOH
 - (B) $\text{H}_2\text{SO}_4/\text{SO}_4^{2-}$
 - (C) $\text{H}_3\text{O}^+/\text{H}_2\text{O}$
 - (D) $\text{NH}_2^-/\text{NH}_3$

9. Graph 1 below shows the initial concentration of hydrogen, nitrogen and ammonia in a reaction vessel at a Haber plant at $t = 0$.

The reaction that occurs in the vessel is as follows:



After some time a change was made to the reaction conditions. An hour after this change was imposed, the concentration of the gases had changed, as shown in Graph 2.



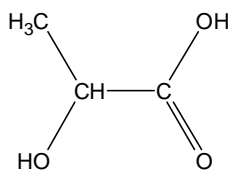
Which one of the following changes could have brought about the changes shown in the graphs?

- (A) The pressure on the gases was decreased.
 - (B) Ammonia was added to the vessel.
 - (C) The temperature of the vessel was decreased.
 - (D) A catalyst was added to the vessel.
10. A piece of zinc is placed into copper(II) nitrate solution in a test tube.

Which one of the following changes would occur?

- (A) The concentration of nitrate ions would decrease.
- (B) The colour of the solution would darken.
- (C) The concentration of nitrate ions would increase.
- (D) The colour of the solution would fade.

11. The following monomer undergoes condensation polymerisation.



What is the small molecule eliminated in this reaction?

- (A) H_2O
(B) CH_4
(C) H_2O_2
(D) CH_3OH
12. An unknown solid was analysed by a number of tests, the results of which are described below.
- The solid did not react when HNO_3 (aq) was added to a sample.
 - When $\text{Ba}(\text{NO}_3)_2$ (aq) was added to a solution of the solid, no observable change occurred.
 - When AgNO_3 (aq) was added to a solution of the solid, a cream precipitate formed. The precipitate dissolved in excess nitric acid.
 - When a small sample of the solid was placed into a Bunsen flame, a flash of red colour was observed.

Which one of the following chemicals would behave in a similar way when analysed with the same set of tests?

- (A) barium chloride
(B) barium phosphate
(C) calcium chloride
(D) calcium phosphate
13. Which of the following lists correctly identifies the low pH colour of each indicator?

	phenolphthalein	methyl orange	bromothymol blue
(A)	pink	red	yellow
(B)	pink	yellow	blue
(C)	colourless	red	yellow
(D)	colourless	red	blue

14. Which one of the following is least likely to be a stable isotope?
- (A) hydrogen-3
 - (B) boron-11
 - (C) chlorine-35
 - (D) potassium-39
15. The following guidelines show the concentrations of calcium carbonate in different classes of water.

Concentration of CaCO_3 (mg/L)	Class of Water
< 60	Soft, but possibly corrosive.
60-200	Good quality.
200-500	Increasing scaling problems.
>500	Severe scaling.

The calcium ion concentration of tap water in one area in NSW was found to be $1.25 \times 10^{-3} \text{ mol L}^{-1}$.

Which class of water does this fall into according to the above guidelines?

- (A) soft, but possibly corrosive water
- (B) good quality water
- (C) water with some scaling problems
- (D) water with severe scaling problems (extremely hard water)

Part B

Attempt questions 16 – 25

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.

Question 16 (3 marks)

Marks

Coal fired power stations can contribute to the problem of acid rain if the coal burnt contains sulfur impurities.

3

A recent media report quoted a politician who said that converting from coal to methane in electricity generation would eliminate the production of acid rain.

Assess the accuracy of this statement, including an appropriate chemical equation.

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Question 17 (5 marks)

Sodium hydrogencarbonate, NaHCO_3 , is a common laboratory chemical.

5

Explain why the Arrhenius acid/base definition is unable to account for the acid/base properties of this species, whereas the Lowry-Bronsted theory can.

Include chemical equations to illustrate your explanation.

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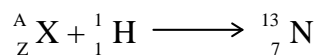
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Question 18 (5 marks)

Two radioisotopes produced by scientists are nitrogen-13 and neptunium-239.

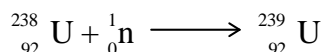
- (a) The equation to describe the production of nitrogen-13 is shown below:

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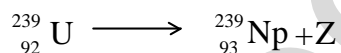
Identify X in the equation above. Include the symbol of the element, its atomic number (Z) and mass number (A).

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- (b) Np-239 can be produced from the bombardment of U-238 with a neutron. This forms U-239 as shown.

1

The U-239 then decays into Np-239 via the equation:



Identify Z in the equation above.

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- (c) A student researching the production of the above radioisotopes reported that both could be produced in a nuclear reactor such as the one located in Lucas Heights, NSW.

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Assess the accuracy of this statement.

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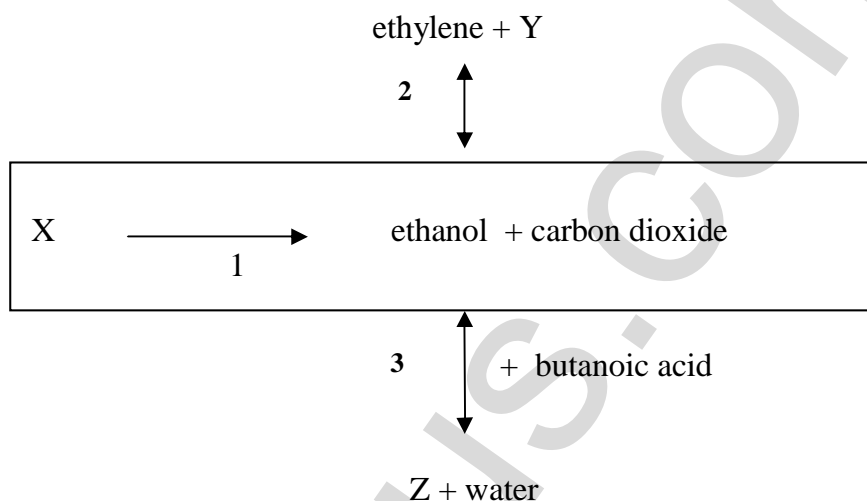
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Question 19 (9 marks)

The flow chart below represents a series of reactions (1, 2 and 3), starting with substance X in reaction 1.



- (a) Write balanced chemical equations to represent reactions 1 and 2 above. 2

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- (b) Using structural formulae, write a balanced equation to represent reaction 3 above. 2

- (c) Outline the conditions under which ethylene is converted to HDPE. 2

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Question 19 continues on page 12.

Question 19 (continued)

- (d) Assess the significance of the reaction conditions in reaction (1) in the above diagram.

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Question 20 (5 marks)

To determine the concentration of Fe^{2+} ions in a sample of tank water, a student conducted a titration of a sample against a standard solution of potassium permanganate.

The reaction that occurs during the titration can be represented:



The unknown Fe^{2+} solution was titrated against 20.00mL of standard 0.0250M potassium permanganate in three trials.

An average of 32.50 mL of the tank water sample was required to change the colour of the solution in the conical flask from purple to colourless, which is the end-point in this titration.

- (a) Calculate the change in oxidation number of manganese (Mn) that occurs as the titration proceeds and hence determine if the Mn is oxidized or reduced during the titration.

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Question 20 continues on page 13.

Question 20 (continued)

- (b) Calculate the moles of potassium permanganate present in the conical flask during each trial. 1

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- (c) Calculate the mass of iron present as Fe^{2+} in 100 mL of the tank water. 3

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Question 21 (5 marks)

In order to determine the concentration of a solution of acetic (ethanoic) acid, a student prepared a solution of NaOH, which then had to be standardised.

The acetic acid concentration was calculated to be 0.1155 M.

- (a) Identify one property of NaOH which makes it unsuitable for use as a primary standard. 1

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- (b) Calculate the pH of the acetic acid solution, assuming that 1% of the acetic acid molecules are ionised in solution. 1

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Question 21 continues on page 14.

Question 21 (continued)

- (c) The student chose phenolphthalein as the indicator for this titration.

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Explain, using equations to illustrate your answer, why this was an appropriate choice.

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Question 22 (6 marks)

A student wanted to construct a galvanic cell using a piece of silver metal, a strip of magnesium metal, and suitable other reagents.

- (a) In the space below, draw and label the galvanic cell the student constructed.

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- (b) Write the two half equations for the reactions occurring in the cell.

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- (c) Calculate the expected voltage produced by the student's cell.

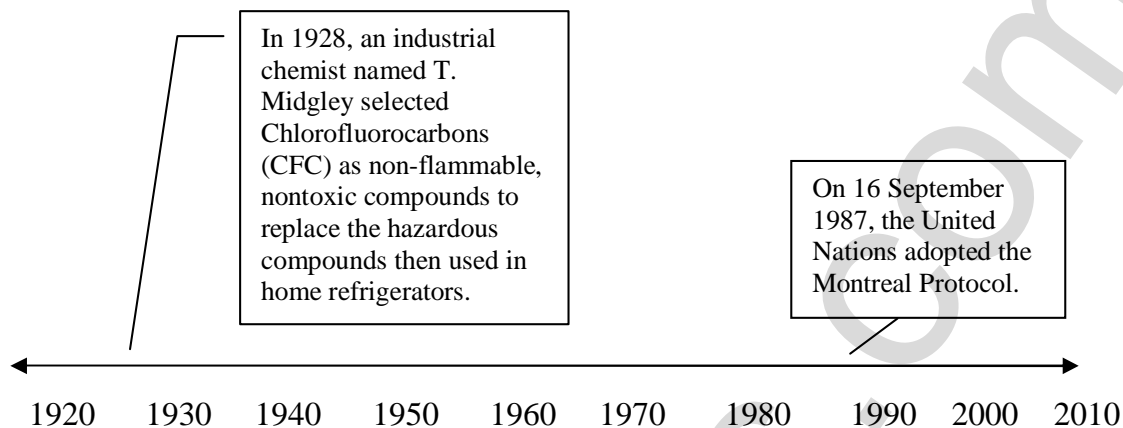
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Question 23 (7 marks)

With reference to the incomplete timeline below, evaluate the role that human activity and technology have played in altering the concentration of ozone in the stratosphere during the time period shown.

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Include relevant equations in your answer.

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Question 24 (6 marks)

As part of your studies of chemistry, you gathered and processed information on features of your town's water supply.

- (a) Describe what is meant by the term 'catchment' area. 1

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- (b) For an identified possible water contaminant, describe a suitable chemical test to determine its presence in a water source. 2

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- (c) Explain how Sydney's drinking water is generally considered safe, and of a high quality, despite possible sources of catchment area contamination. 3

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Question 25 (9 marks)

To determine the mass of $\text{CO}_2(\text{g})$ dissolved in a 250 mL bottle of soft drink, a student carried out the following steps:

1. Weigh the unopened bottle of soft drink (with the cap on).
2. Carefully remove the cap, wait for 20 seconds, then reweigh the bottle and cap.
3. Place the *open* bottle on an electronic balance connected to a data logger and record the mass of the bottle over the course of 12 hours.

They obtained the following data.

Initial mass of bottle and lid: 335.8 g

Mass of bottle and lid after opening: 335.2 g

time (hr)	mass of bottle (g)
0.0	332.1
0.5	330.2
1.0	329.1
1.5	328.5

time (hr)	mass of bottle (g)
2.0	328.2
4.0	327.7
8.0	327.4
12.0	327.2

- (a) Calculate the total volume of CO_2 dissolved in the soft drink (at 25 °C and 100 kPa). **3**

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- (b) Explain how the pH of the soft drink would have changed over the course of the student's experiment, including an appropriate chemical equation. **3**

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Question 25 continues on page 18.

Question 25 (continued)

- (c) In another experiment, a student decides to determine the H_2CO_3 concentration in the soft drink by titration with NaOH , and to use this data to calculate the mass, and hence volume, of $\text{CO}_2(\text{g})$ dissolved.

3

They:

1. Take a 250 mL bottle of soft drink, open it, and pour the contents into a 500 mL conical flask.
2. Add two drops of a suitable indicator.
3. Titrate the carbonic acid in the soft drink using standardised $\text{NaOH}(\text{aq})$.

Explain, making reference to each method, why a combination of the two methods would give the most accurate result.

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Section II

Total marks: 25

Attempt ONE question from Questions 26 – 30

Allow about 45 minutes for this Section.

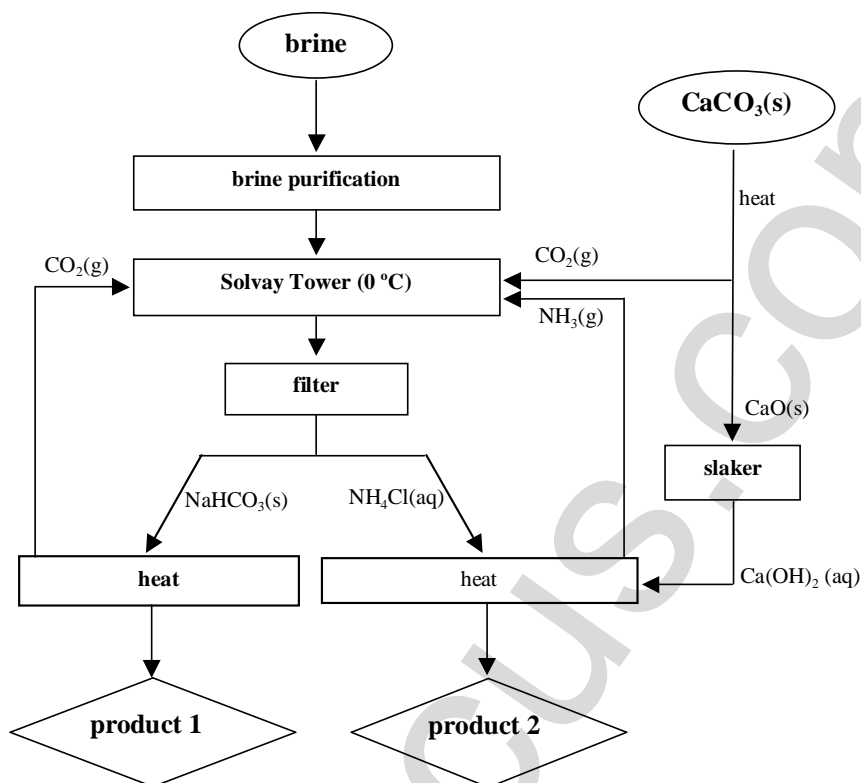
Answer the questions in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

	Pages
Question 26 – Industrial Chemistry.....	20 - 21
Question 27 – Shipwrecks, Corrosion and Conservation.....	22 - 23
Question 28 – The Biochemistry of Movement.....	24
Question 29 – The Chemistry of Art.....	25 - 26
Question 30 – Forensic Chemistry.....	27

Question 26 - Industrial Chemistry (25 marks)

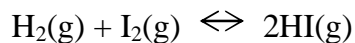
(a) The Solvay process can be represented by the following flowchart.



- (i) Identify the products of this process. 1
- (ii) Outline criteria used to locate a chemical industry such as a Solvay plant. 2
- (iii) Explain how the products of the Solvay tower are formed, including a relevant chemical equation in your answer. 3
- (b) Compare the mercury, diaphragm and membrane methods of sodium hydroxide production, including appropriate chemical equations, and evaluate their impact on society and the environment. 6
- (c) (i) As part of your practical studies for this Option, you were required to carry out a saponification reaction. 3
- Describe the method you used to do this, including one risk you minimised during your investigation.
- (ii) You have studied soap and three types of detergents in this Option. 4
- Explain the cleaning action of these substances, and compare their effects in hard water. Include a relevant diagram to illustrate your answer.

Question 26 (continued)

- (d) (i) The reaction between hydrogen gas and iodine gas occurs at moderate temperatures, and can be represented by the equation



Equilibrium concentrations of each species are given in the table below.

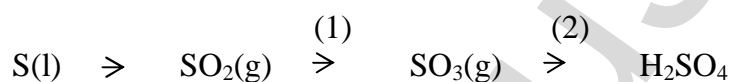
Equilibrium concentrations of H₂, HI and I₂

[H ₂] (M)	[HI] (M)	[I ₂] (M)
0.50	2.8	0.45

Calculate the value of the equilibrium constant, K for this equilibrium mixture.

2

- (ii) An abbreviated sequence of reactions in the production of sulfuric acid from elemental sulfur is shown in the diagram below.

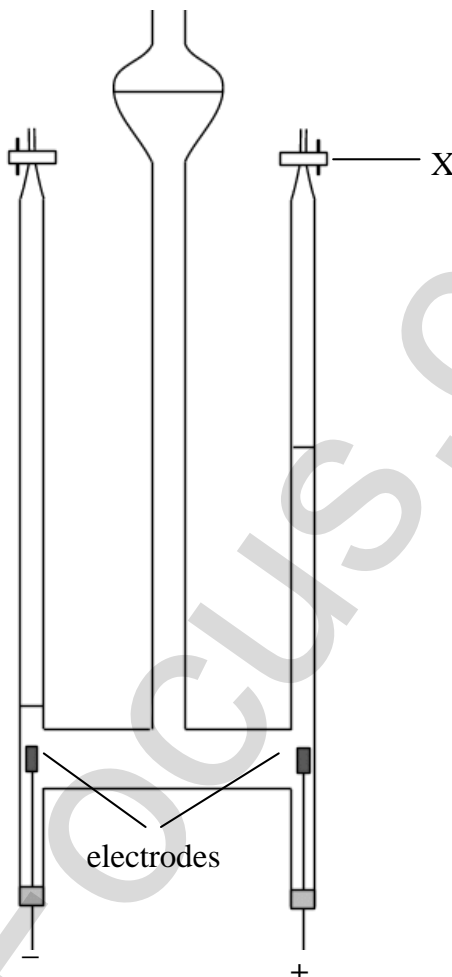


Describe the way in which conversions (1) and (2) are achieved, and justify the chemistry you describe. Include appropriate chemical equations in your answer.

4

Question 27 - Shipwrecks, Corrosion and Conservation (25 marks)

- (a) (i) A dilute solution of sodium chloride was added to the apparatus shown below and an electric current applied across the two electrodes.



- Identify the gas that would be collected from the tap marked X in the above diagram. **1**
- (ii) Outline factors which may affect the rate of an electrolysis reaction such as the one occurring in the diagram above. **2**
- (iii) Compare the products of the electrolysis reaction occurring in the above apparatus when dilute and concentrated sodium chloride solution is used. Explain your comparison, using appropriate equations and E° values. **3**

Question 27 continues on page 23.

Question 27 (continued)

- (b) The composition of a marine artefact is a significant factor that affects the procedures used in its preservation and restoration. **6**

Justify differences in the procedures used to treat and restore marine artefacts of different compositions. In your answer, refer to at least TWO artefacts of different compositions, one of them being a metallic artefact. Include relevant equations in your answer.

- (c) (i) As part of your practical studies for this Option, you were required to undertake investigations to compare the rate of corrosion of materials at different oxygen concentrations. **3**

Justify the procedure you followed to collect data in this investigation and ensure its validity.

- (ii) Explain how changes in the aqueous environment surrounding a metallic artefact can affect its rate of corrosion. Include relevant equations in your answer. **4**

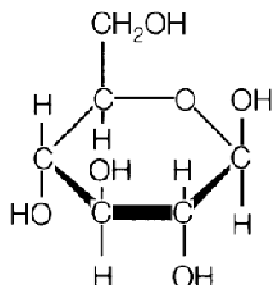
- (d) (i) In 1800, Volta developed his famous Voltaic Pile, consisting of vertical stacks of alternating metallic discs (eg zinc and silver). The plates were separated by cloth or paper that had been soaked in brine. **2**

With the aid of suitable equations, outline the role that electron transfer and ion movement play in producing an electric current from the cell.

- (ii) Analyse the impact of the work of Davy and Faraday on our current understanding of electron-transfer reactions and its applications. **4**

Question 28 - The Biochemistry of Movement (25 marks)

- (a) (i) Identify the molecule shown below. 1



- (ii) Outline how the human body makes use of the molecule shown in (a i) above. 2
- (iii) Explain the chemical process that takes place when human cells store the above molecule for later use and state where the storage occurs. 3
- (b) Evaluate the role that models have played in the development of our understanding of enzyme structure and function. 6
- (c) (i) As part of your practical studies for this Option, you were required to undertake a second-hand investigation to analyse the relationship between the structure of glycerol and its viscosity and solubility in water.
- Draw the structural formula of glycerol and describe the major ideas you learned from this investigation. 3
- (ii) Assess the role that esters of glycerol (TAGS) play in the human body. 4
- (d) (i) Describe the general structure and appearance of a skeletal muscle cell. 2
- (ii) Analyse the role that calcium ions and ATP play in the contraction of skeletal muscle. 4

Question 29 - The Chemistry of Art (25 marks)

- (a) (i) The picture below is a replica of a cave diagram from Lascaux Caves in France. Much of the body of the animal is drawn in an earthy-red colour.



- Suggest a mineral which may have been used to produce the earthy-red colour featured in the body of the animal. 1
- (ii) Apart from the use in cave drawings such as the one above, outline other uses of pigments by indigenous cultures such as Australian Aboriginals. 2
- (iii) Explain how the properties of certain materials allow them to be used as pigments in paintings such as the one shown above. 3
- (b) Analyse trends in the first ionisation energy and electronegativity of elements in Periods 2 and 3 and explain them in terms of atomic structure. 6
- (c) (i) As part of your practical studies for this Option, you were required to undertake a number of first-hand investigations.

Typical results for one such investigation are shown in the table below:

Metal ion	Flame colour
Potassium	Lilac
Sodium	Yellow
Strontium	Red

- Justify a procedure which could be followed to safely produce results such as those shown in the table above. 3

Question 29 continues on page 26.

Question 29 (continued)

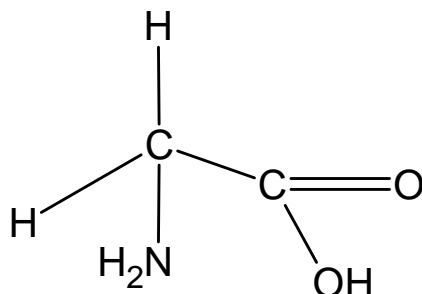
- (ii) Account for the different flame colours observed in terms of the Bohr model of the atom. Include an appropriate diagram in your answer. 4
- (d) (i) Explain why copper can be classed as a transition element. 2
- (ii) Anhydrous copper (II) sulfate is white, whereas copper (II) sulfate in solution is blue.

When concentrated hydrochloric acid is added to copper (II) sulfate solution, a green solution forms.

Account for the colour changes described above, including appropriate diagrams to assist in your explanation. 4

Question 30 - Forensic Chemistry (25 marks)

- (a) (i) To which group of chemicals would the following molecule belong? **1**



- (ii) Describe the nature of a peptide bond, including a diagram to assist in your description. **2**
- (iii) Explain how the technique known as electrophoresis may be useful to the work of a forensic chemist. **3**
- (b) Evaluate the significance of the various types of chromatography to forensic investigations, giving specific examples of where each type may be used. **6**
- (c) (i) As part of your practical studies for this Option, you were required to undertake a number of first-hand investigations.

Typical results for one such investigation are shown in the table below:

Metal ion	Flame colour
Barium	Green
Calcium	Red
Sodium	Yellow

- Justify a procedure which could be followed to safely produce results such as those shown in the table above. **3**
- (ii) Account for the unique patterns in the emission spectra of elements such as sodium and mercury using an appropriate model of the atom. Include a diagram to assist in your explanation. **4**
- (d) (i) Explain how DNA could be used to show that two individuals were related. **2**
- (ii) Assess the impact of DNA analysis in forensic investigations on individuals and society. **4**

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