Student No. _____

Barker College

# 2001
## TRIAL HIGHER SCHOOL CERTIFICATE

# Chemistry

**Staff Involved:**

- KHW*
- KJB
- ASM
- JRH

**72 copies**

**PM FRIDAY 10 AUGUST**

**General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Board-approved calculators may be used
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your Barker Student Number on ALL answer pages

**Section I** Pages 2 - 6

Total marks (15)
- Indicate all answers on the Answer Sheet provided
- Allow about 25 minutes for this section

**Section II** Pages 7 - 18

Total marks (60)
- Attempt ALL questions
- Indicate all answers in the spaces provided on the Answer Sheets
- Allow about 110 minutes for this section

**Section III** Pages 19 - 22

Total marks (25)
- Attempt ALL questions
- Indicate all answers in the spaces provided on the Answer Sheets
- Allow about 45 minutes for this section

**Section I**

**Total marks (15)**

**Allow about 25 minutes for this section**

**Attempt ALL questions**

**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.**

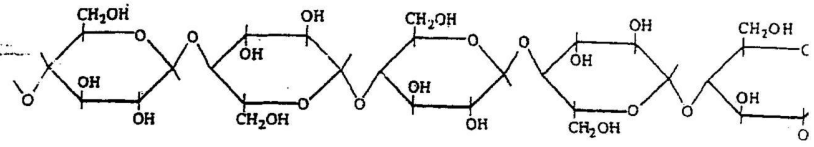
(A) ● (B) ⊗ (C) ○ (D) ○

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

*correct* ←

(A) ⊗ (B) ⊗ (C) ○ (D) ○

1. The diagram below represents an important polymer. Choose the statement that is most about this polymer.



(A) This polymer is an important petrochemical product.
(B) The monomer from which this polymer is made is starch.
(C) This polymer is a major component of biomass.
(D) This polymer is a naturally occurring addition polymer.

2. For the reaction of ethanol with oxygen, $\Delta H = -1.36 \times 10^3$ kJ / mol. A mass of 2.3 g ethanol was burned in a plentiful supply of oxygen at **STP**. Choose the statement that best describes this reaction.

(A) $6.8 \times 10$ kJ heat is absorbed from the surroundings.
(B) $1.36 \times 10^3$ kJ heat is released to the surroundings.
(C) 0.05 moles of carbon dioxide is produced.
(D) 2.24 L of carbon dioxide is produced at STP.

3. In which of the following metal and salt solution mixtures will the metal remain unreacted?

(A) Zinc in a solultion of lead nitrate.
(B) Copper in a solution of silver nitrate.
(C) Tin in a solution of aluminium sulfate.
(D) Aluminium in a solultion of iron sulfate.

4. In the compound, $HC\ell O_2$, what is the oxidation state of chlorine?

(A) –1
(B) –3
(C) +1
(D) +3

5. The decay series of uranium-238 begins with the emission of an alpha particle to form thori What is an alpha particle?

(A) A positvely charged particle with negligible mass.
(B) A nucleus that could capture 2 electrons to become helium.
(C) An isotope of the element helium with mass number of four
(D) A positive electron or positron ejected from the nucleus.

6. Which of the following compounds, when mixed with distilled water, exists as an equilibrium mixture with its ions?

(A) Hydrochloric acid
(B) Sulfuric acid
(C) Nitric acid
(D) Ethanoic acid

7. The relationship between an element's position on the periodic table and the acidic or basic nature of its oxide is best described by which one of the following statements?

(A) Elements with the lowest first ionisation energy in any period usually form acidic oxides.
(B) Elements that have medium to high melting points are more likely to make acidic oxides.
(C) Elements that form covalent bonds are more likely to make acidic oxides.
(D) Elements which are excellent conductors of electricity usually make acidic oxides.

8. The bottle of soda water illustrated represents an equilibrium system that can be described by the equation below.

$$CO_{2(g)} + H_2O_{(\ell)} \rightleftharpoons H_2CO_{3(aq)}$$

Which statement best describes what happens immediately the lid is taken off?

(A) As pressure decreases the equilibrium between $CO_{2(aq)}$ and $CO_{2(g)}$ shifts towards $CO_{2(g)}$.
(B) The pressure increases and the equilibrium moves to make more $CO_2$ in the solution.
(C) The reaction moves to the right increasing $[H_2CO_3]$, reducing $[CO_2]$ and making the soda water flat.
(D) As the concentration of $H_2CO_3$ decreases more $CO_2$ dissolves making the soda water flat.

9. Which of the following is the conjugate base of $H_2PO_4^-$?

(A) $H_2PO_4$
(B) $H_3PO_4$
(C) $HPO_4^{2-}$
(D) $PO_4^{3-}$

10. Which of the following reactions shows the transfer of a proton?

(A) Neutralisation of hydrochloric acid by potassium hydroxide.
(B) Oxidation of magnesium to form magnesium oxide.
(C) Reduction of silver ions to form silver metal.
(D) Combustion of butane to form carbon dioxide and water.

11. Buffered solutions can withstand the addition of excess acid or base without chang Which of the following substances would need to be added to 100 mL of 0.2 M eth make it a buffered solution?

(A) 100 mL of 0.2 M sodium ethanoate.

(B) 100 mL of 0.2 M ammonia.

(C) 100 mL of 0.2 M sodium hydroxide.

(D) 100 mL of 0.2 M distilled water.

12. Water molecules can form a stable bond with $H^+$. What sort of bond links the water with the $H^+$ ion?

(A) Hydrogen bond
(B) Ionic bond
(C) Covalent bond
(D) Metallic bond

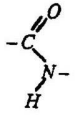
13. Ammonium chloride $(NH_4Cl)$ is a white water soluble solid. The pH of 1 mol $L^{-1}$ sc ammonium chloride is 4.6 Which ion is present in the largest concentration in this sol

(A) Chloride ions
(B) Hydrogen ions
(C) Ammonium ions
(D) Hydroxide ions

14. Which of the following diagrams represents the alkanoic acid functional group?

(A) 

(B) 

(C) 

(D) 



15. A student set up a Galvanic cell including a voltmeter. He discovered that his measured cell potential was far less than the theoretical potential calculated from a table of standard reduction potentials. Which of the following would be a plausible explanation for this?

(A) His electrodes were not inert.

(B) His electrolyte was at a concentration less than 1 mol $L^{-1}$.

(C) His cell voltage was not measured at STP.

(D) His external power source was fluctuating.

Student No. _____

**Section II**
**Total marks (60)**
**Attempt ALL questions**
**Allow about 110 minutes for this section**

Use the spaces provided on the paper

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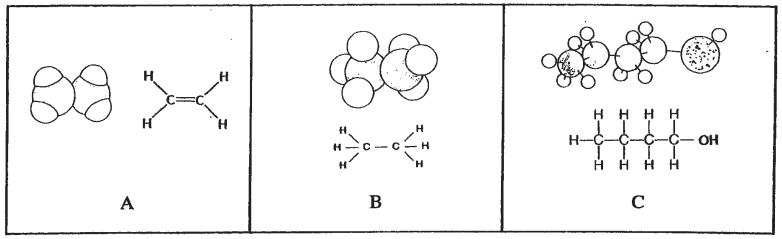
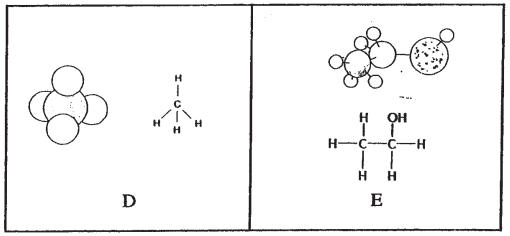
**Marks**

**Question 16 [6 marks]**

The following illustrations represent the molecules of five carbon compounds that are important as sources of energy or raw materials for the production of other materials.




(a) State the systematic name for compound A and describe a simple laboratory test to distinguish it from compound B.

Compound A: _____ **1**

Laboratory test: _____

_____

_____

_____ **1**

**Question 16 continued over page**





**Marks**

(b) From the compounds above, identify, by letter, the compound that shows the following property. Justify your choice for (i), (ii) and (iii) only.

(i) The most water soluble compound: _____

Reason: _____

_____ **1**

(ii) The compound with the highest boiling point: _____

Reason: _____

_____

_____

_____ **1½**

(iii) The compound which would make addition polymers: _____

Reason: _____

_____ **1**

(iv) The compound which would give the lowest heat of combustion: _____ **½**

Student No. _____

Marks

**Question 17 [5 marks]**

Chlorine is used for the manufacture of $C_2H_3C\ell$, a monomer that undergoes **addition** polymerisation.

(a) Draw the full structural formula for $C_2H_3C\ell$

1

(b) Give the systematic name for the monomer $C_2H_3C\ell$.

_____

1

(c) Draw the structural formula of the polymer that is produced from $C_2H_3C\ell$ with at least three monomer units and name it using the common name.

_____

1

(d) In terms of its **structure** and **properties**, evaluate the usefulness of this polymer for garden hoses and water pipes.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

2

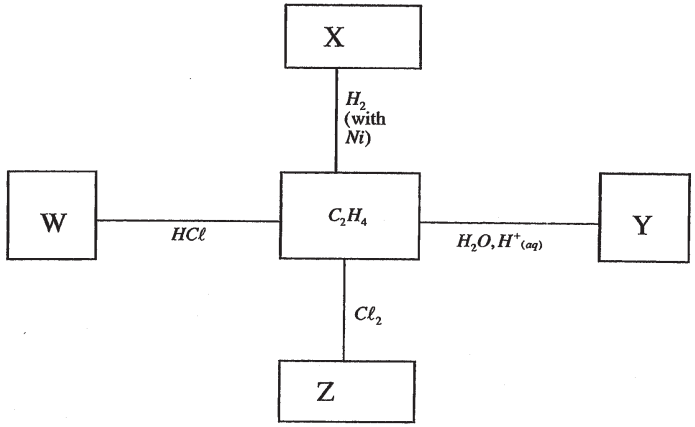


Student No. _____

Marks

**Question 18 [10 marks]**

The diagram below shows the reactions of the hydrocarbon $C_2H_4$.




The products of these reactions are represented by the letters W, X, Y, Z.

(a) Name the raw material from which $C_2H_4$ is currently obtained.

_____

1

(b) Identify and describe the process by which it is obtained.

_____

_____

_____

2

(c) State the systematic name and write the structural formula for the product Z.

_____

_____

1

Question 18 continued over page

Student No. _____

Question 18 (Continued)

Marks

(d) Explain the use of *Ni* in the production of X.

_____

_____

_____ 1

(e) The product Y is predicted to be a future alternative fuel. Name and describe the biochemical process which produces Y from glucose. Use relevant equations and state the necessary conditions for this process to occur.

_____

_____

_____

_____

_____

_____ 3

(f) Evaluate the **present** usefulness of cellulose as a raw material for the production of compound Y.

_____

_____

_____

_____

_____

_____ 2

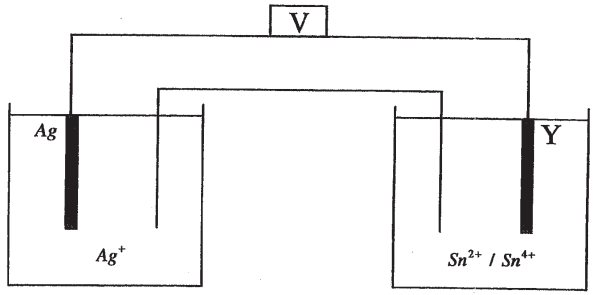


Student No. _____

Marks

**Question 19 [4 marks]**

An HSC chemistry student is investigating possible new power sources and constructs an electrochemical cell from two standard half-cells using $Ag^{+}_{(aq)} / Ag_{(s)}$ and $Sn^{4+}_{(aq)} / Sn^{2+}_{(aq)}$, as in the diagram below.




(a) Using arrows and labels clearly indicate the direction of electron flow and migration of ions. 1

(b) Write the equation for the reaction that occurs at the anode.

_____ 1

(c) Describe **TWO** factors that would have to be considered when selecting an appropriate chemical for the salt bridge.

_____

_____ 1

(d) Showing all steps in your working calculate the maximum EMF that this experimental cell could produce.

_____

_____

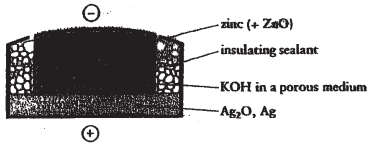
_____ 1

Student No. _____

Marks

**Question 20 [4 marks]**

The diagram below represents a silver oxide button cell.




The overall cell reaction is expressed in the following word equation:

I. Zinc (solid) + silver oxide → zinc oxide + silver (solid)

The reduction half equation is expressed in the following word equation:

II. Silver oxide + water + $2e$ → silver (s) + hydroxide ions

(a) Write reaction I above as a balanced symbol equation.

_____

_____ 1

(b) Identify the substance that is acting as the reductant and justify your choice.

_____

_____ 1

(c) From the information given, deduce and write a balanced symbol equation for the oxidation half reaction.

_____ 1

(d) State **ONE** advantage, apart from size, of this cell over the conventional dry cell.

_____

_____ 1



Student No. _____

Marks

**Question 21 [2 marks]**

Some isotopes such as $^{235}U$ undergo fission when bombarded by neutrons. Some isotopes, however, undergo nuclear reactions that produce new elements. These elements are called **transuranic elements**. Outline the way that transuranic elements are formed in a nuclear reaction and give **ONE** example of a transuranic element.

_____

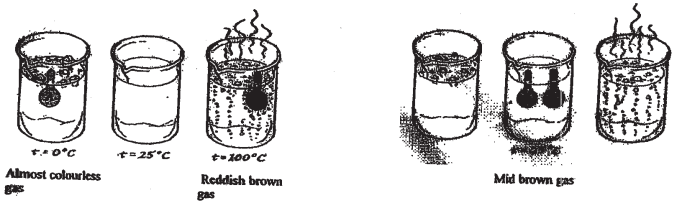
_____

_____

_____ 2

**Question 22 (7 marks)**

Two sealed tubes, containing identical equilibrium mixtures of dark brown $NO_2$ and colourless $N_2O_4$ are placed into beakers of hot water and iced water as shown in the diagram below. They are then moved to a beaker of water at room temperature. The observations made by students of the two tubes have been added to the labelled diagrams.




(a) An equation describing the equilibrium mixture is:

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

(dark brown) (colourless)

(i) In which direction (right or left as written) is the equilibrium reaction exothermic.

_____ 1

(ii) In terms of Le Chatelier's principal explain the students' observations.

_____

_____

_____

_____

_____ 2

Question 22 continued over page

Student No. _____

Question 22 (a) (Continued)

Marks

(iii) Given that Sydney's air is full of oxides of nitrogen and following on from the student's experimental observations, predict what you would expect to see as you look over the Sydney skyline on a still hot summer day.

Explain your prediction.

_____

_____

_____

_____ 1

(b) Evidence shows that the overall **global** concentration of $NO_2$ in the atmosphere has not increased significantly over the last century.

Discuss the human activities that generate localised increases in $NO_2$ concentrations and the chemical processes which prevent localised increases from being dispersed globally.

Explain how these chemical processes pose a further threat to the environment.

_____

_____

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_____

_____ 3



Student No. _____

Marks

**Question 23 (5 marks)**

Esterification is an important industrial process for producing organic substances. Esterification can be carried out on a small scale in the school laboratory.

(a) Some students reacted methanol with butanoic acid. Name the ester they produced and using structural formulae write a chemical equation to describe this reaction.

Name of ester: _____

2

(b) Some specific conditions apply to the process of esterification, for example, refluxing and the addition of sulfuric acid.

Explain **ONE** reason for using reflux apparatus and **ONE** reason for adding sulfuric acid.

Reflux apparatus: _____

_____

Adding sulfuric acid: _____

_____ 2

(c) Describe **ONE** characteristic of esters and how they are most commonly used.

_____

_____ 1

Student No. _____

Marks

**Question 24 (4 marks)**

The reaction between hydrogen sulfide gas $(H_2S)$ and water is an acid – base reaction according to Bronsted-Lowry theory.

(a) Write a balanced symbol equation for this reaction.

_____ 1

(b) Define a Bronsted-Lowry acid.

_____

_____ 1

(c) Identify the Bronsted-Lowry acid and its conjugate base in the above reaction.

B-L Acid: _____ Conjugate base: _____ 1

(d) Explain, with the inclusion of electron dot diagrams, how the reaction can also be classified as a Lewis acid-base reaction.

_____

_____

_____ 1





Student No. _____

Marks

**Question 25 (7 marks)**

To determine the concentration of acetic acid in a particular brand of vinegar, a student first diluted 25 mL of the vinegar accurately to 100 mL and then titrated 10 mL of the diluted solution with 0.097 M sodium hydroxide. The average titre was 17.2 mL.

(a) Calculate the concentration of the diluted solution and then the concentration of the original vinegar.

_____

_____

_____

_____

_____

_____ 2

(b) Determine the mass of acetic acid in 100 mL of the original full strength vinegar.

_____

_____

_____

_____ 2

(c) If the student mistakenly rinsed the burette with water before filling it with $NaOH$, what would be the effect on his calculated concentration of vinegar compared to its real concentration?

_____

_____ 1

(d) Explain why the sodium hydroxide solution made from the molar mass of $NaOH$ dissolved in 1 litre of water had to be standardised before using, in order for the titration to be accurate.

_____

_____

_____ 1

(e) From the following table choose the most suitable indicator for determining the end-point in the titration of acetic acid and sodium hydroxide.

| Indicator | pH range | Colour range (low pH–high pH) |
|---|---|---|
| Thymol blue | 1.2 – 2.8 | Red-yellow |
| Bromocresol green | 3.8 – 5.4 | Yellow-blue |
| Methyl red | 4.4 – 6.2 | Pink-yellow |
| Bromothymol blue | 6.0 – 7.6 | Yellow-blue |
| Thymol blue | 8.0 – 9.6 | Yellow-blue |

_____ 1

Student No. _____

Marks

**Question 26 (6 marks)**

Year 12 students were asked to plan and perform an experiment to assess the value of ethanol as a fuel.

(a) State **ONE** factor that would have to be included in a risk and hazard assessment for this experiment.

_____

_____

_____ **1**

(b) They have decided to compare the heats of combustion of ethanol with three other easily obtainable alcohols and graph the results.

(i) Write a balanced symbol equation for the combustion of ethanol.

_____ **1**

(ii) Draw a labelled diagram of the apparatus they would use to determine the heat of combustion and how it would be set up for such an experiment.

**1**

Question 26 continued over page



 Student No. _____

Marks

(iii) Identify the measurements they would need to make.

_____

_____ **1**

(iv) When the data has been obtained, what formula could they apply to quantify the heat of combustion of each alcohol?

_____

_____ **1**

(v) When graphing this information, what labels would be put on the horizontal and vertical axes?

Vertical axis: _____

Horizontal axis: _____ **1**

Student No. _____

**Section III – Option**
**Total marks (25)**
**Allow about 45 minutes for this section**
**Attempt ALL questions**

Use the spaces provided on the paper

**Question 27 – Shipwrecks and Salvage (25 marks)** **Marks**

(a) The hulls of ships are made of steel alloys which corrode rapidly to form rust. Aluminium, however, is quite resistant to corrosion.

(i) Compare the standard reduction potentials of iron and aluminium and justify from these values which metal should corrode more readily. **2**

(ii) Assess your answer to (i) in the light of the opening statement and explain any anomalies. **1**

(iii) Define the term *passivating metal* and give **ONE** example of a passivating metal. **1**

(iv) Describe how rust forms on the hull of a ship giving the necessary chemical equations for each step of the process. Identify the product that is called rust. **5**

Question 27 continued over page



 Student No. _____

**Marks**

(v) Steel ships are often protected from rusting by bolting blocks of magnesium to their hulls. Explain how this prevents rusting, and name the process involved. **2**

(vi) State **ONE** reason that large ocean going vessels are not built of aluminium even though it does not rust. **1**

(b) (i) Year 12 performed, either in class or at home, some open-ended investigations to determine the rate of iron corrosion when temperature, electrolyte concentration, oxygen concentration or pH was varied. Assess the impact of **ONE** of these on the corrosion rate of iron. **3**

Question 27 continued over page

Student No. _____

Question 27 (b) (Continued) **Marks**

(ii) Scientists were immensely surprised when the Titanic was discovered, to find such a large extent of rusting. They had expected, due to the variables mentioned in (i) to find it reasonably uncorroded. Outline the biological mechanisms that have largely contributed to its corrosion.

_____

_____

_____

_____

_____

_____

_____

_____ **3**

(c) Outline the contribution of Galvani to understanding the process of electron transfer.

_____

_____

_____

_____

_____

_____

_____ **2**

(d) A concentrated aqueous solution of copper nitrate was electrolysed using inert electrodes.

(i) Write half equations for the reactions that occurred at the electrodes.

Anode: _____ **1**

Cathode: _____ **1**

**Question 27 continued over page**



Student No. _____

Question 27 (d) (Continued) **Marks**

(ii) Describe the electrode processes if the electrolysis in (i) was repeated using copper electrodes.

Anode: _____

_____

_____

Cathode: _____

_____

_____

_____ **2**

(iii) Discuss **ONE** factor that would affect the rate of the electrolysis reactions in (i) and (ii) above.

_____

_____

_____ **1**

**END OF PAPER**

Student No. _____

Barker College

Preview Before Printing
Date: 24/7/01
*Please Note:* This is the final copy as it will be printed. If there are any further alterations please contact Delcy IMMEDIATELY in the Print Room. Otherwise the paper will be printed as is in one or two days from now. *Thank You*

# 2001
## TRIAL HIGHER SCHOOL CERTIFICATE

# Chemistry

## ANSWER SHEET

**Staff Involved:** **PM FRIDAY 10 AUGUST**

- KHW* – pp 7–10 + m/c
- KJB – pp 21–24
- ASM – 17–20
- JRH – 11–16

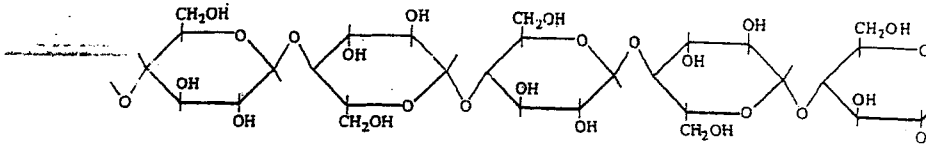
**72 copies**

**Section I – Multiple Choice**

**Choose the best response and fill in the response oval completely**

| | | | | |
|---|---|---|---|---|
| 1. | A | B | ● | D |
| 2. | A | B | C | ● |
| 3. | A | B | ● | D |
| 4. | A | B | C | ● |
| 5. | A | ● | C | D |
| 6. | A | B | C | ● |
| 7. | A | B | ● | D |
| 8. | ● | B | C | D |
| 9. | A | B | ● | D |
| 10. | ● | B | C | D |
| 11. | ● | B | C | D |
| 12. | A | B | ● | D |
| 13. | ● | B | C | D |
| 14. | ● | B | C | D |
| 15. | A | ● | C | D |

1. The diagram below represents an important polymer. Choose the statement that is most about this polymer.



(A) This polymer is an important petrochemical product.
(B) The monomer from which this polymer is made is starch.
(C) This polymer is a major component of biomass.
(D) This polymer is a naturally occurring addition polymer.

2. For the reaction of ethanol with oxygen, $\Delta H = -1.36 \times 10^3$ kJ / mol. A mass of 2.3 g ethanol was burned in a plentiful supply of oxygen at **STP**. Choose the statement that best describes this reaction.

(A) $6.8 \times 10$ kJ heat is absorbed from the surroundings.
(B) $1.36 \times 10^3$ kJ heat is released to the surroundings.
(C) 0.05 moles of carbon dioxide is produced.
(D) 2.24 L of carbon dioxide is produced at STP.

3. In which of the following metal and salt solution mixtures will the metal remain unreacted?

(A) Zinc in a solultion of lead nitrate.
(B) Copper in a solution of silver nitrate.
(C) Tin in a solution of aluminium sulfate.
(D) Aluminium in a solultion of iron sulfate.

4. In the compound, $HC\ell O_2$, what is the oxidation state of chlorine?

(A) –1
(B) –3
(C) +1
(D) +3

5. The decay series of uranium-238 begins with the emission of an alpha particle to form thori What is an alpha particle?

(A) A positvely charged particle with negligible mass.
(B) A nucleus that could capture 2 electrons to become helium.
(C) An isotope of the element helium with mass number of four
(D) A positive electron or positron ejected from the nucleus.

6. Which of the following compounds, when mixed with distilled water, exists as an equilibrium mixture with its ions?

(A) Hydrochloric acid
(B) Sulfuric acid
(C) Nitric acid
(D) Ethanoic acid

7. The relationship between an element's position on the periodic table and the acidic or basic nature of its oxide is best described by which one of the following statements?

(A) Elements with the lowest first ionisation energy in any period usually form acidic oxides.
(B) Elements that have medium to high melting points are more likely to make acidic oxides.
(C) Elements that form covalent bonds are more likely to make acidic oxides.
(D) Elements which are excellent conductors of electricity usually make acidic oxides.

8. The bottle of soda water illustrated represents an equilibrium system that can be described by the equation below.

$$CO_{2_{(g)}} + H_2O_{(\ell)} \rightleftharpoons H_2CO_{3_{(aq)}}$$

Which statement best describes what happens immediately the lid is taken off?

(A) As pressure decreases the equilibrium between $CO_{2_{(aq)}}$ and $CO_{2_{(g)}}$ shifts towards $CO_{2_{(g)}}$.
(B) The pressure increases and the equilibrium moves to make more $CO_2$ in the solution.
(C) The reaction moves to the right increasing $[H_2CO_3]$, reducing $[CO_2]$ and making the soda water flat.
(D) As the concentration of $H_2CO_3$ decreases more $CO_2$ dissolves making the soda water flat.

9. Which of the following is the conjugate base of $H_2PO_4^-$?

(A) $H_2PO_4$
(B) $H_3PO_4$
(C) $HPO_4^{2-}$
(D) $PO_4^{3-}$

10. Which of the following reactions shows the transfer of a proton?

(A) Neutralisation of hydrochloric acid by potassium hydroxide.
(B) Oxidation of magnesium to form magnesium oxide.
(C) Reduction of silver ions to form silver metal.
(D) Combustion of butane to form carbon dioxide and water.



11. Buffered solutions can withstand the addition of excess acid or base without chang Which of the following substances would need to be added to 100 mL of 0.2 M eth make it a buffered solution?

(A) 100 mL of 0.2 M sodium ethanoate.
(B) 100 mL of 0.2 M ammonia.
(C) 100 mL of 0.2 M sodium hydroxide.
(D) 100 mL of 0.2 M distilled water.

12. Water molecules can form a stable bond with $H^+$. What sort of bond links the water with the $H^+$ ion?

(A) Hydrogen bond
(B) Ionic bond
(C) Covalent bond
(D) Metallic bond

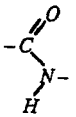
13. Ammonium chloride $(NH_4Cl)$ is a white water soluble solid. The pH of 1 mol $L^{-1}$ sc ammonium chloride is 4.6 Which ion is present in the largest concentration in this sol

(A) Chloride ions
(B) Hydrogen ions
(C) Ammonium ions
(D) Hydroxide ions

14. Which of the following diagrams represents the alkanoic acid functional group?

(A) 

(B) 

(C) 

(D) 

15. A student set up a Galvanic cell including a voltmeter. He discovered that his measured cell potential was far less than the theoretical potential calculated from a table of standard reduction potentials. Which of the following would be a plausible explanation for this?

(A) His electrodes were not inert.

(B) His electrolyte was at a concentration less than 1 mol $L^{-1}$.

(C) His cell voltage was not measured at STP.

(D) His external power source was fluctuating.

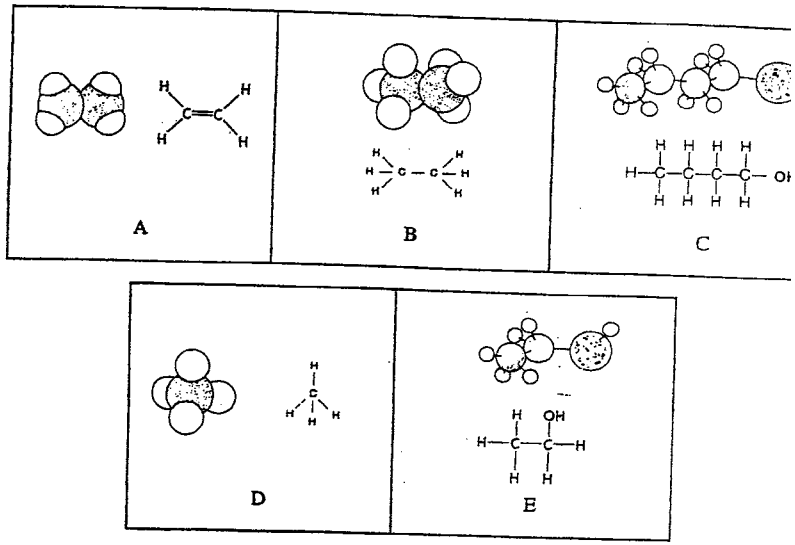


Student No. _____

**Section II**
**Total marks (60)**
**Attempt ALL questions**
**Use the spaces provided on the paper**

**Question 16 [6 marks]**

The following illustrations represent the molecules of five carbon compounds that are important as sources of energy or raw materials for the production of other materials.




(a) State the systematic name for compound A and describe a simple laboratory test to distinguish it from compound B.

Compound A: Ethene

Laboratory test: In the absence of UV light, add Bromine water to both A & B. In A the Bromine water will decolourise but not in B.

Question 16 continued over page

**Marks**

(b) From the compounds above, identify, by letter, the compound that shows the following property. Justify your choice. ~~For~~ (i) (ii) and (iii).

(i) The most water soluble compound: E (½)

Reason: The hydroxyl group makes hydrogen bonds with water molecules (½) 1

(This is also true for C but it has a long non-soluble tail)

(ii) The compound with the highest boiling point: C (½)

Reason: It has -OH group to make hydrogen bonds between molecules (½) and has the largest MW therefore the most dispersion forces between (½) molecules. 1½

(iii) The compound which would give the lowest heat of combustion: D

~~Reason:~~

Switch around

½

(iv) The compound which would make addition polymers: A (½)

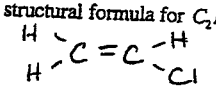
Reason: It has a double bond which can open out to add another monomer either end. (½) 1



**Question 17 [5 marks]**

Chlorine is used for the manufacture of $C_2H_3Cl$, a monomer that undergoes **addition** polymerisation.

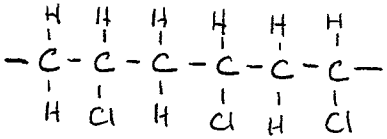
(a) Draw the full structural formula for $C_2H_3Cl$



(b) Give the systematic name for the monomer $C_2H_3Cl$.

Chloroethene

(c) Draw the structural formula of the polymer that is produced from $C_2H_3Cl$ with at least three monomer units and name it using the common name.

 (½)

Polyvinylchloride (½)

(d) In terms of its **structure** and **properties**, evaluate the usefulness of this polymer for garden hoses and water pipes.

essential points are underlined

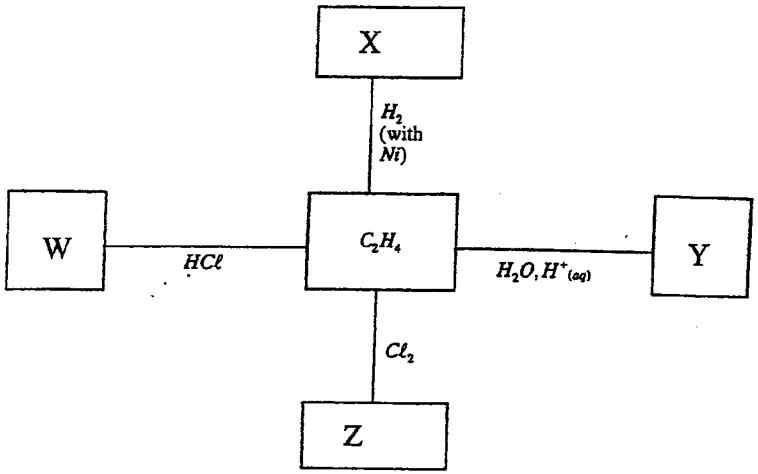
Inclusion of the chlorine molecule into the linear polymer chain stiffens the structure and reduces its ability to flop around. Thus for water pipes PVC is rigid rather than flexible. It is light and can easily be joined with a solvent adhesive. PVC breaks down after prolonged exposure to sunlight, and becomes brittle so for use in garden hoses a UV absorbe is added and a plasticiser is added to soften it.

Student No. _____

Marks

**Question 18 [10 marks]**

The diagram below shows the reactions of the hydrocarbon $C_2H_4$.




The products of these reactions are represented by the letters W, X, Y, Z.

(a) Name the raw material from which $C_2H_4$ is currently obtained.

Oil

1

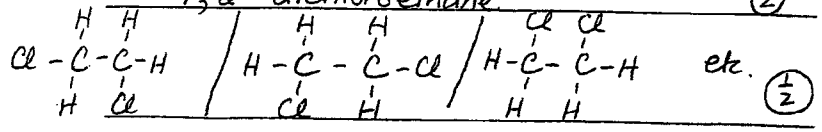
(b) Identify and describe the process by which it is obtained.

Catalytic (½) cracking of long chain hydrocarbons (½) produces shorter chain hydrocarbons (½) and ethene, $C_2H_4$ (½)

2

(c) State the systematic name and write the structural formula for the product Z.

1,2 - dichloroethane (½)




1

**Question 18 continued over page**



Student No. _____

Question 18 (Continued)

(d) Explain the use of *Ni* in the production of X.

Nickel is a catalyst (½) which provides a lower energy pathway OR which speeds up the reaction of $C_2H_4$ with $H_2$ (½)

(e) The product Y is predicted to be a future alternative fuel. Name and describe the biochemical process which produces Y from glucose. Use relevant equations and state the necessary conditions for this process to occur.

Product Y (ethanol) is produced by fermentation. Glucose from the starch in plants (½) is decomposed to give ethanol and carbon dioxide.

$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + 2CO_2$ (½)

Fermentation needs yeast, temperature of ~ 37 °C and alcohol concentration less than 15%

(f) Evaluate the **present** usefulness of cellulose as a raw material for the production of compound Y.

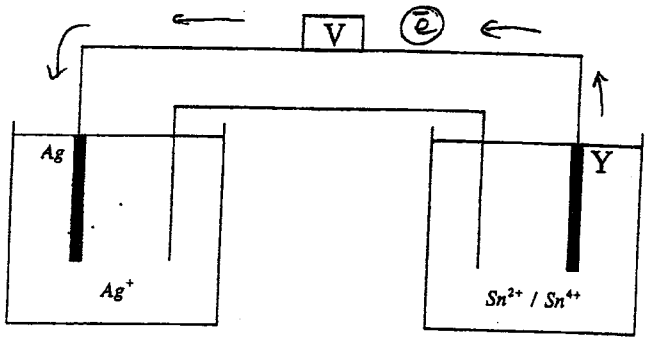
Ethanol from plants comes from decomposition of starch to gl then fermentation. Cellulose in plants is far more abundant than starch and like starch is a glucose polymer. Cellu however does not naturally decompose to glucose and therefore is not a natural source of ethanol by ferment. Research programmes are aimed at finding ways of breaking down cellulose to its glucose monomers so that fermentation then produces ethanol. Such methods have been found but are still costly and inefficient and have therefore not been implemented widely.

Student No. _____

Marks

**Question 19 [4 marks]**

An HSC chemistry student is investigating possible new power sources and constructs an electrochemical cell from two standard half-cells using $Ag^+_{(aq)} / Ag_{(s)}$ and $Sn^{4+}_{(aq)} / Sn^{2+}_{(aq)}$, as in the diagram below.




(a) Using arrows and labels clearly indicate the direction of electron flow and migration of ions. See diagram (1) 1

(b) Write the equation for the reaction that occurs at the anode.

$Sn^{2+} \rightarrow Sn^{4+} + 2\bar{e}$ (1) 1

(c) Describe TWO factors that would have to be considered when selecting an appropriate chemical for the salt bridge.

The ions must be soluble (½)

The ions must not react with any ions in solution to form a precipitate. (½) 1

(d) Showing all steps in your working calculate the maximum EMF that this experimental cell could produce.

$Sn^{2+} \rightarrow Sn^{4+} + 2\bar{e}$ -0.15V

$Ag^+ + \bar{e} \rightarrow Ag$ 0.8V (½) working

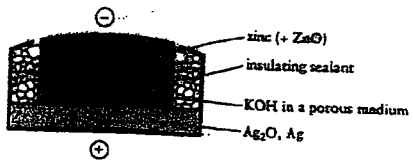
Total cell emf = 0.65V (½) answer 1



Student No. _____

**Question 20 [4 marks]**

The diagram below represents a silver oxide button cell.




The overall cell reaction is expressed in the following word equation:

I. Zinc (solid) + silver oxide → zinc oxide + silver (solid)

The reduction half equation is expressed in the following word equation:

II. Silver oxide + water + 2e + silver (s) + hydroxide ions

(a) Write reaction I above as a balanced symbol equation.

$Zn_{(s)} + Ag_2O_{(s)} \rightarrow ZnO_{(s)} + 2Ag_{(s)}$

(b) Identify the substance that is acting as the reductant and justify your choice.

Zinc - the reductant undergoes oxidation and in the overall equation zinc is oxidised

(c) From the information given, deduce and write a balanced symbol equation for the oxidation half reaction.

$Zn \rightarrow Zn^{2+} + 2\bar{e}$

(d) State ONE advantage, apart from size, of this cell over the conventional dry cell.

Voltage stays constant for most of cell's life
Provides a higher current
Has a longer life
} ANY ONE

DEFINITELY NOT RECHARGEABLE / CHEAPER / SAFER DISPOSAL

Student No. _____

Marks

**Question 21 [2 marks]**

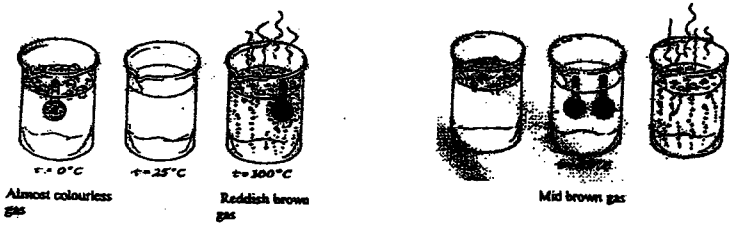
Some isotopes such as $^{235}U$ undergo fission when bombarded by neutrons. Some isotopes, however, undergo nuclear reactions that produce new elements. These elements are called **transuranic elements**. Outline the way that transuranic elements are formed in a nuclear reaction and give **ONE** example of a transuranic element.

main ideas defined

Elements with $Z > 92$ are made by bombarding other nuclei with neutrons or with high speed positive particles from accelerators or cyclotrons. The particles fuse with the target nuclei making new, heavier nuclei of transuranic elements eg neptunium, americium, plutonium etc (½) (½) (½) 2

**Question 22 (7 marks)**

Two sealed tubes, containing identical equilibrium mixtures of dark brown $NO_2$ and colourless $N_2O_4$ are placed into beakers of hot water and iced water as shown in the diagram below. They are then moved to a beaker of water at room temperature. The observations made by students of the two tubes have been added to the labelled diagrams.




(a) An equation describing the equilibrium mixture is:

$$2\,NO_{2(g)} \rightleftharpoons N_2O_{4(g)} + \text{heat}$$

(dark brown) (colourless)

(i) In which direction (right or left as written) is the equilibrium reaction exothermic.

right 1

(ii) In terms of Le Chatelier's principal explain the students' observations.

(½) for stating Le Chatelier's

(1) for correctly relating it to the diagram

As the temperature changes, the equilibrium shifts to counteract or minimise the effect of the temperature change. By adding heat to the tube at 0°C the reaction moves to the left to use up the extra heat and thus makes more $NO_2$ which is darker. 2

Question 22 continued over page



Student No. _____

Question 22 (a) (Continued)

(iii) Given that Sydney's air is full of oxides of nitrogen and following on from the student's experimental observations, predict what you would expect to see as you look over the Sydney skyline on a still hot summer day.

Explain your prediction.

A brown haze (½) would be visible because the mixture of $NO_2$ & $N_2O_4$ equilibrium would shift towards more $NO_2$ as the temperature increases (½)

(b) Evidence shows that the overall **global** concentration of $NO_2$ in the atmosphere has not increased significantly over the last century.

Discuss the human activities that generate localised increases in $NO_2$ concentrations and the chemical processes which prevent localised increases from being dispersed **globally**.

Explain how these chemical processes pose a further threat to the environment.

(½) High temperature combustion in CARS, TRUCKS and POWER STATIONS produces NO from $N_2$ & $O_2$ in air which further reacts with $O_2$ to form $NO_2$.

$N_2 + O_2 \rightarrow 2NO$ (½)

$2NO + O_2 \rightarrow 2NO_2$ (½)

(½) Increased $[NO_2]$ locally are washed out of the atmosphere by dissolving in rain, so do not spread globally. (1)

(½) $NO_2$ dissolved in rain, however,

$NO_2 + H_2O \rightarrow HNO_2 + HNO_3$

(½) Acid rain is a further environmental threat. It (½) increases acidity in lakes, killing aquatic organisms, destroys forests, and decomposes marble buildings (1)

Student No. _____

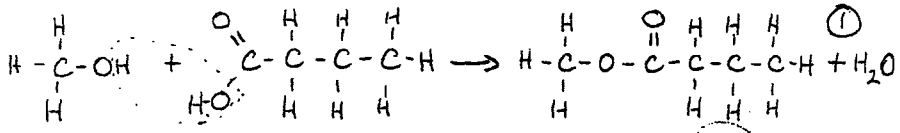
Marks

**Question 23 (5 marks)**

Esterification is an important industrial process for producing organic substances. Esterification can be carried out on a small scale in the school laboratory.

(a) Some students reacted methanol with butanoic acid. Name the ester they produced and using structural formulae write a chemical equation to describe this reaction.

Name of ester: methyl butanoate (1) (½)



(1)

Take off (½) if water as a product is left out.

2

(b) Some specific conditions apply to the process of esterification, for example, refluxing and the addition of sulfuric acid.

Explain **ONE** reason for using reflux apparatus and **ONE** reason for adding sulfuric acid.

Reflux apparatus: Refluxing uses a cooling condenser to prevent the loss of any volatile reactants or products (1)

Adding sulfuric acid: Acts as a catalyst to speed up the reaction (1)
OR Removes water from product ∴ increases yield

2

(c) Describe **ONE** characteristic of esters and how they are most commonly used.

They have a very sweet smell (½)
-used in flavourings or perfumes
- solvents
- plasticisers in PVC

} any one (½)

1



Student No. _____

**Question 24 (4 marks)**

The reaction between hydrogen sulfide gas $(H_2S)$ and water is an acid – base reaction accord to Bronsted-Lowry theory.

(a) Write a balanced symbol equation for this reaction.

$H_2S + H_2O \rightarrow HS^- + H_3O^+$

(1) no half marks

(b) Define a Bronsted-Lowry acid.

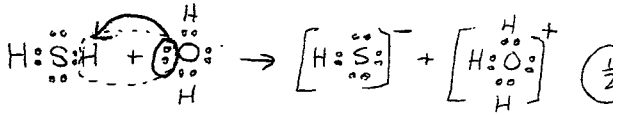
A B-L acid is a proton donor

(1) no half marks

(c) Identify the Bronsted-Lowry acid and its conjugate base in the above reaction.

B-L Acid: $H_2S$ (½) Conjugate base: $HS^-$ (½)

(d) Explain, with the inclusion of electron dot diagrams, how the reaction can also be classified as a Lewis acid-base reaction.



A Lewis acid is an electron pair acceptor a a Lewis base is an electron pair donor. The water molecule acts as a Lewis base donating a pair of electrons to the hydrogen ion which acts as a Lewis acid accepting the electron pair.

(½)

**Question 25 (7 marks)** — Marks

To determine the concentration of acetic acid in a particular brand of vinegar, a student first diluted 25 mL of the vinegar accurately to 100 mL and then titrated 10 mL of the diluted solution with 0.097 M sodium hydroxide. The average titre was 17.2 mL.

(a) Calculate the concentration of the dilute ~~solution~~ vinegar and then the concentration of the original vinegar.

$C_{(dil)} = \frac{0.097 \times 17.2}{10} = 0.167 \text{ mol L}^{-1}$ (½) (½)

$C_{original} = \frac{0.167 \times 100}{25} = 0.667 \text{ mol L}^{-1}$ (½) (½) — 2

(b) Determine the mass of acetic acid in 100 mL of the original vinegar.

Moles of acetic acid in 100mL = 0.0667 mol (½)

Molar mass of acetic acid = 60.052 g mol$^{-1}$ (½)

Mass of acetic acid in 100mL = $0.0667 \times 60.052$

$= 4.01$ g (1) — 2

(c) If the student mistakenly rinsed the burette with water before filling it with *NaOH*, what would be the effect on his calculated concentration of vinegar compared to its real concentration?

His calculated concentration would be greater than the actual — 1

(d) Explain why the sodium hydroxide solution made from the molar mass of *NaOH* dissolved in 1 litre of water had to be standardised before using, in order for the titration to be accurate.

NaOH absorbs $CO_2$ + $H_2O$ so the initial mass that is used to make the solution is not necessarily accurate. — 1

(e) From the following table choose the most suitable indicator for determining the end-point in the titration of acetic acid and sodium hydroxide.

| Indicator | pH range | Colour range (low pH–high pH) |
|---|---|---|
| Thymol blue | 1.2 – 2.8 | Red-yellow |
| Bromocresol green | 3.8 – 5.4 | Yellow-blue |
| Methyl red | 4.4 – 6.2 | Pink-yellow |
| Bromothymol blue | 6.0 – 7.6 | Yellow-blue |
| Thymol blue | 8.0 – 9.6 | Yellow-blue |

Thymol blue pH 8.0 – 9.6 — 1



Student No. _____

**Question 26 (6 marks)**

Year 12 students were asked to plan and perform an experiment to assess the value of ethanol as a fuel.

(a) State **ONE** factor that would have to be included in a risk and hazard assessment for this experiment.

Need those

Ethanol is flammable – care with heating

" " volatile – ventilate room or fume ho

" " irritant to eyes – wear goggles

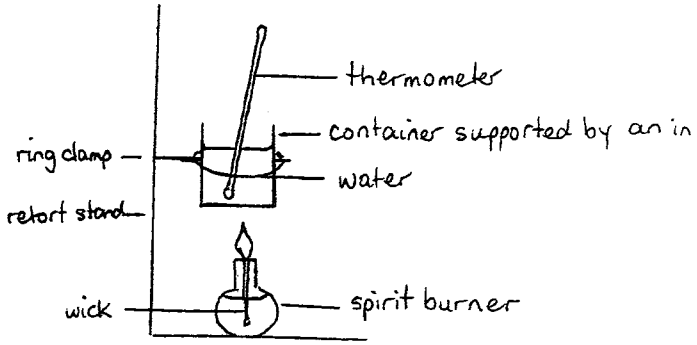
(b) They have decided to compare the heats of combustion of ethanol with three other easily obtainable alcohols and graph the results.

(i) Write a balanced symbol equation for the combustion of ethanol.

$C_2H_5OH + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

OR $2C_2H_5OH + 7O_2 \rightarrow 4CO_2 + 6H_2O$

(ii) Draw a labelled diagram of the apparatus they would use to determine the heat of combustion and how it would be set up for such an experiment.




Question 26 continued over page

Student No. _____

Marks

(iii) Identify the measurements they would need to make.

Change in temperature of water, Mass of water, Mass of fuel used up ($\Delta T_{H_2O}$, $\Delta$mass fuel, mass of water) 1

(iv) When the data has been obtained, what formula could they apply to quantify the heat of combustion of each alcohol?

$\Delta H = m C \Delta T$ 1

(v) When graphing this information, what labels would be put on the horizontal and vertical axes?

Vertical axis: Heat of combustion

Horizontal axis: No. carbon atoms 1



Student No. _____

**Section III – Option**
**Total marks (25)**
**Attempt ALL questions**
**Use the spaces provided on the paper**

**Question 27 – Shipwrecks and Salvage (25 marks)** M

(a) The hulls of ships are made of steel alloys which corrode rapidly to form rust. Aluminium, however, is quite resistant to corrosion.

(i) Compare the standard reduction potentials of iron and aluminium and justify from these values which metal should corrode more readily.

Fe → $E^\circ = -0.41V$ (½) Al → $E^\circ = -1.66V$ (½)

The more positive value for Al would suggest that it corrodes more readily (1)

(ii) Assess your answer to (i) in the light of the opening statement and explain any anomalies.

Corrosion of Al forms a waterproof and air proof coating thus preventing further corrosion. Corrosion of Fe forms flaky rust which allows more water and air in to continue corrosion. 1

(iii) Define the term *passivating metal* and give **ONE** example of a passivating metal.

A reactive metal that corrodes to form an unreactive coating on its surface that prevents further corrosion eg Aluminium 1

(iv) Describe how rust forms on the hull of a ship giving the necessary chemical equations for each step of the process. Identify the product that is called rust.

- At a point of stress on the hull iron atoms lose electrons and form $Fe^{2+}$. $Fe \rightarrow Fe^{2+} + 2\bar{e}$ These are anodic sites
- The electrons migrate through the hull to a place where they reduce dissolved oxygen to hydroxide ions. This is the cathodic site

$2\bar{e} + \frac{1}{2}O_2 + H_2O \rightarrow 2OH^-$ (or double it) (1)

- The $Fe^{2+}$ ions and $OH^-$ ions migrate towards each other through the electrolyte (salt water) $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2(s)$ (1)
- $Fe(OH)_2$ is further oxidised to form hydrated iron(III) oxide

$Fe(OH)_2 + \frac{1}{2}O_2 \rightarrow 2(Fe_2O_3 \cdot H_2O$ (1)

- Hydrated iron(III) oxide, $Fe_2O_3 \cdot H_2O$ is the rust. (1) 5

(½) for each step supported by an equation.

(-½) important fact left out. eg $Fe^{2+}$ $OH^-$ moving through the salt water. $Fe^{2+}$ may further oxidised. Anode ion

Question 27 continued over page

Marks

(v) Steel ships are often protected from rusting by bolting blocks of magnesium to their hulls. Explain how this prevents rusting, and name the process involved.

If well explained equations may not be necessary.

Magnesium is more reactive (½) than iron so when connected to iron in an electrolyte, (sea water), magnesium will be oxidised, giving up electrons, and any $Fe^{2+}$ formed will be reduced back to Fe. Magnesium is the anode and Fe becomes the cathode (½) at which $O_2$ is reduced or $Fe^{2+}$ is reduced. This is called cathodic protection (½) 2

Anode
$Mg \rightarrow Mg^{2+} + 2e^-$
Cathode (½)
$Fe^{2+} + 2e^- \rightarrow Fe$
OR
$O_2 + H_2O + 2e^- \rightarrow 2OH^-$

(vi) State **ONE** reason that large ocean going vessels are not built of aluminium even though it does not rust.

Any one of these.

Aluminium is not as strong and much more expensive. Sodium chloride also weakens the aluminium oxide coating and facilitates corrosion. 1

(b) (i) Year 12 performed, either in class or at home, some open-ended investigations to determine the rate of iron corrosion when temperature, electrolyte concentration, oxygen concentration or pH was varied. Assess the impact of **ONE** of these on the corrosion rate of iron.

Makes a judgement of the outcomes, the results value, quality

Temperature
[electrolyte]
pH
[O]

no other factors to be given marks or only mark one if all are discussed.

1 mark – Makes a basic statement of the trend without detail, no application & recommendation

2 marks – gives detail of results and outlines trends. Makes some attempt at application; recommendations.

3 marks – Gives details of results. Analyses the results to show a trend and any limitations. Applies these trends to corrosion theory correctly & makes recommendations. 3

Question 27 continued over page







M

(ii) Scientists were immensely surprised when the Titanic was discovered, to find such a large extent of rusting. They had expected, due to the variables mentioned in (i) to find it reasonably uncorroded. Outline the biological mechanisms that have largely contributed to its corrosion.

The answer doesn't have to follow this outline but to get 3 marks sufficient detail needs to be given + equations.

Complete detail with no equations – 2 marks

Incomplete detail, some facts + equations – 1 mark

At depth slime forming bacteria cover the iron hull and create an anaerobic environment. (½) Sulfate-reducing bacteria SRB's within the slime reduce sulfates to hydrogen sulfide

$SO_4^{2-} + 10H^+ + 8e^- \rightarrow H_2S + 4H_2O$ (½) Electrons for the reduction by SRB's are obtained from oxidation of the iron hull $Fe \rightarrow Fe^{2+} + 2e^-$ (½) $Fe^{2+}$ reacts with water to produce $Fe(OH)_2$ and further oxidation with small amounts of $O_2$ produces $Fe_2O_3 \cdot H_2O$ (rust) (½) $H^+$ producing bacteria accelerate the reduction of sulfates (½) $Fe^{2+}$ also forms FeS which is hard and black. (½)

(c) Outline the contribution of Galvani to understanding the process of electron transfer.

- Credited with the first generation of electric current (½)
- Joined two different metal wires and put the unjoined ends into the spinal cord of a frog. It caused the frog's muscles to twitch (½) • He compared this to his observations of twitching frog muscles when static charge was applied (½) and wrongly concluded that the muscle generated electricity
- He had actually set up an electrochemical cell and so such cells are named after him. (½)

(d) A concentrated aqueous solution of copper nitrate was electrolysed using inert electrodes.

(i) Write half equations for the reactions that occurred at the electrodes.

Anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ or $H_2O \rightarrow \frac{1}{2}O_2 + 2H^+ +$

Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

Question 27 continued over page

Student No. _____

Question 27 (d) (Continued)

(ii) Describe the electrode processes if the electrolysis in (i) was repeated using copper electrodes.

Anode: The copper anode would slowly go into solution (½)

$Cu \longrightarrow Cu^{2+} + 2\bar{e}$ (½)

Cathode: The copper cathode would steadily increase in mass (½) as the $Cu^{2+}$ ions from the solution are reduced at $Cu^{2+} + 2\bar{e} \rightarrow Cu$ (½)

(iii) Discuss **ONE** factor that would affect the rate of the electrolysis reactions in (i) and (ii) above.

Any one of these (½)

- Changing surface area of the electrodes
- Changing the distance between electrodes
- Changing concentration of electrolyte
- Changing depth electrodes are immersed
- Changing the voltage

(½) changes the amount of current which directly affects the rate of formation of electrolysis product.

END OF PAPER