Barker College

2005
TRIAL HIGHER SCHOOL CERTIFICATE

Chemistry

Staff Involved:

- ASM*
- RJP
- TER
- RZS
- KHW

95 copies

AM THURSDAY 11 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 at the top of the Part A answer sheet and at the top of ALL answer pages in Part B and Section II
- Show ALL working for calculations

Total marks – 100

Section I Pages 2 – 23

Total – 90 marks

This section has two parts, Part A and Part B

Part A – 15 marks
- Indicate all answers on the Answer Sheet provided
- Allow about 30 minutes for this part

Part B – 75 marks
- Attempt Questions 16 – 25
- Indicate all answers in the spaces provided on the paper
- Allow about 2 hours for this part

Section II Pages 24 – 25

10 marks
- Attempt Question 26
- Indicate all answers in the spaces provided on paper
- Allow about 30 minutes for this section

Section I

Total marks – 90

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 this by writing the word *correct* and drawing an arrow as follows.

correct ←

(A) ⊗ (B) ⊗ (C) ○ (D) ○

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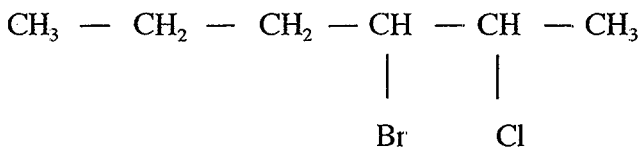
1. What is the IUPAC systematic name for the structure shown below?



(A) 3 - bromo - 2 - chloroheptane

(B) 4 - bromo - 5 - chlorohexane

(C) 3 - bromo - 2 - chlorohexane

(D) 2 - chloro - 3 - bromohexane

2. How many structural isomers are there with the molecular formula C_4H_9Cl?

(A) 2

(B) 3

(C) 4

(D) 5

3. What **TWO** substances are used to produce ethyl butanoate?

(A) Butanol and ethanoic acid.

(B) Butanol and ethane.

(C) Ethanol and butanoic acid.

(D) Butane and ethanol.

4. What does X represent in the following nuclear equation?

$$^{226}_{88}\text{Ra} \rightarrow \text{X} + {}^{222}_{86}\text{Ra}$$

(A) $^{1}_{0}\text{n}$

(B) $^{1}_{0}\text{e}$

(C) $^{4}_{2}\text{He}$

(D) $^{1}_{1}\text{H}$

5. What is the catalyst for the conversion of ethylene into ethanol?

(A) NaOH

(B) H_2SO_4

(C) Ni

(D) Pt

6. What are the conditions that most favour the fermentation of sugar?

(A) Warmth, oxygen, no water.

(B) Warmth, no oxygen, water.

(C) No warmth, no oxygen, no water.

(D) Warmth, oxygen, water.

7. Which of the following polymers is an example of a condensation polymer?

(A) Polyethylene
(B) Polyvinylchloride
(C) Polystyrene
(D) Cellulose

8. Data obtained from various combustion experiments is given in the table below.

Fuel	CH_3OH	C_2H_5OH	C_3H_7OH	C_4H_9OH
MW (g/mol)	32	46	60	74
Mass used (g)	1.74	1.83	1.39	1.47
Moles used	0.0544	0.0398	0.0232	0.0199
Mass H_2O (g)	300	300	300	300
ΔT (water) (^oC)	+17.4	+18.9	+17.7	+21.0

NB. The specific heat capacity of water is 4.18 J g^{-1} $^oC^{-1}$

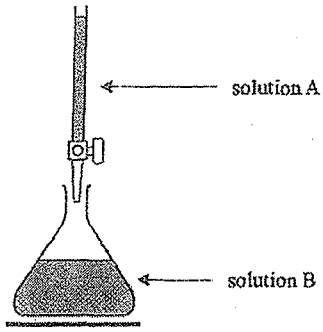
What is the heat of combustion of ethanol closest to, according to this set of experimental data?

(A) 394 kJ / mol
(B) 596 kJ / mol
(C) 2487 kJ / mol
(D) 515 kJ / mol

9. 10 mL of 0.1 M HCl is made up to 1.0 L with water. What is the pH of the resulting solution?

(A) 1
(B) 2
(C) 3
(D) 4

10. In a titration experiment, 0.1 M sodium hydroxide solution (A) was to be added to 20 mL of 0.1 hydrochloric acid solution (B) using the apparatus shown.



Which one of the following procedures should have been done before titrating?

	Conical flask washed with	**Burette washed with**
(A)	solution B	solution A
(B)	distilled water	distilled water
(C)	solution B	distilled water
(D)	distilled water	solution A

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

(A) $H_3O^+_{(aq)} + HPO_4^{2-}{}_{(aq)} \rightleftharpoons H_2O_{(l)} + H_2PO_4^-{}_{(aq)}$

(B) $H_2O_{(l)} + HCO_3^-{}_{(aq)} \rightleftharpoons H_3O^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

(C) $H_2O_{(l)} + NH_{3(g)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

(D) $H_3O^+_{(aq)} + HS^-_{(aq)} \rightleftharpoons H_2S_{(aq)} + H_2O_{(l)}$

12. What method would allow you to determine the total dissolved solids in a sample of water?

(A) AAS
(B) Electrical conductivity meter
(C) A pH meter
(D) A flame test

13. Which layer of the atmosphere contains the highest concentration of ozone?

(A) Troposphere
(B) Stratosphere
(C) Mesosphere
(D) Thermosphere

14. What is the purpose of the iron-based chemical in the Haber process?

(A) Increasing the yield of ammonia which is produced.

(B) Increasing the activation energy of the reaction.

(C) Increasing the quality of the ammonia which is produced.

(D) Increasing the rate at which the ammonia is produced.

15. The table gives the results of chemical tests for some cations and anions.

Ion	**Add cold 0.1 M HCl**	**Add 0.1 M KSCN**	**Add 0.1 M Na_2CO_3**	**Add 0.1 M $AgNO_3$**
Ca^{2+}	no change	no change	white precipitate	no change
Fe^{3+}	no change	red colour	brown precipitate	no change
Ba^{2+}	no change	no change	white precipitate	no change
Pb^{2+}	white precipitate	no change	white precipitate	no change
Cl^-	no change	no change	no change	white precipitate

When a group of students performed the above tests on an unknown solution they obtained the following results.

Add cold 0.1 M HCl	**Add 0.1 M KSCN**	**Add 0.1 M Na_2CO_3**	**Add 0.1 M $AgNO_3$**
no change	no change	white precipitate	white precipitate

Which conclusion is consistent with these results?

(A) The sample contained both $CaCl_2$ and $BaCl_2$.
(B) The sample contained both $CaCl_2$ and $PbCl_2$.
(C) The sample contained $FeCl_3$ and $PbCl_2$.
(D) The sample contained both $FeCl_3$ and $BaCl_2$.

End of Part A

Student No. .....

Section I (continued)
Part B – 75 marks
Attempt ALL questions
Allow about 2 hours for this part
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

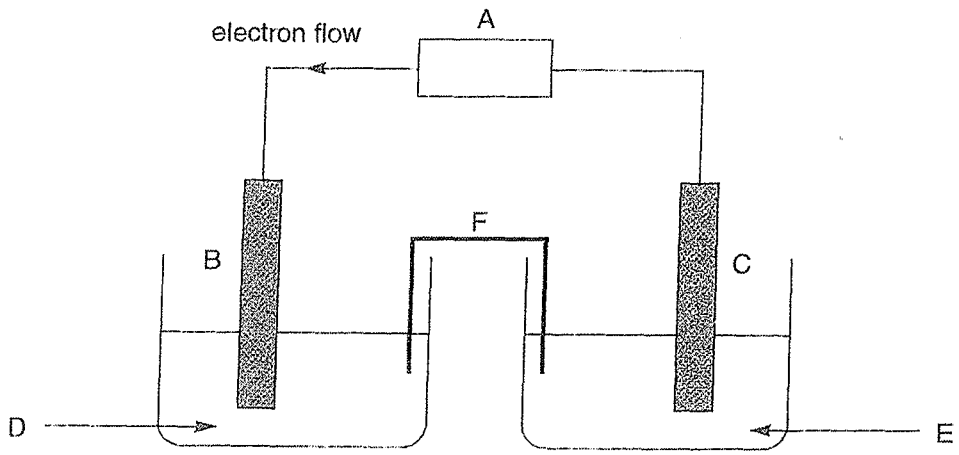
Question 16 (9 marks)

A student is provided with the materials listed below and is told to use whichever materials are needed to make a galvanic cell which will generate a current.

Apparatus:
- beakers, thermometer, power pack, light globe, insulated copper wire, voltmeter, filter paper, funnel stirring rods, emery paper

Chemicals:
- 1.0 M solutions of copper (II) nitrate, potassium nitrate, iron (II) nitrate
- De-ionised water
- Strips of copper and iron

The diagram below shows how the student set up the cell.



(a) In terms of the tabled apparatus and chemicals above, identify A – D. **2**

A: .....

B: .....

C: .....

D: .....

Question 16 continues on page 8

Marks

Question 16 (continued)

(b) Explain your choice of C. **1**

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(c) Write the half-equation, showing states, for: **2**

(i) the anode

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(ii) the cathode

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(d) Using the standard potentials table from the data sheet provided, calculate the theoretical voltage of this galvanic cell. **1**

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Question 16 continues on page 9

Marks

Question 16 (continued)

(e) Describe **TWO** changes you would expect to observe in the beakers if a current flowed for a considerable length of time. **2**

(i) .....

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(ii) .....

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(f) Explain the purpose of F. **1**

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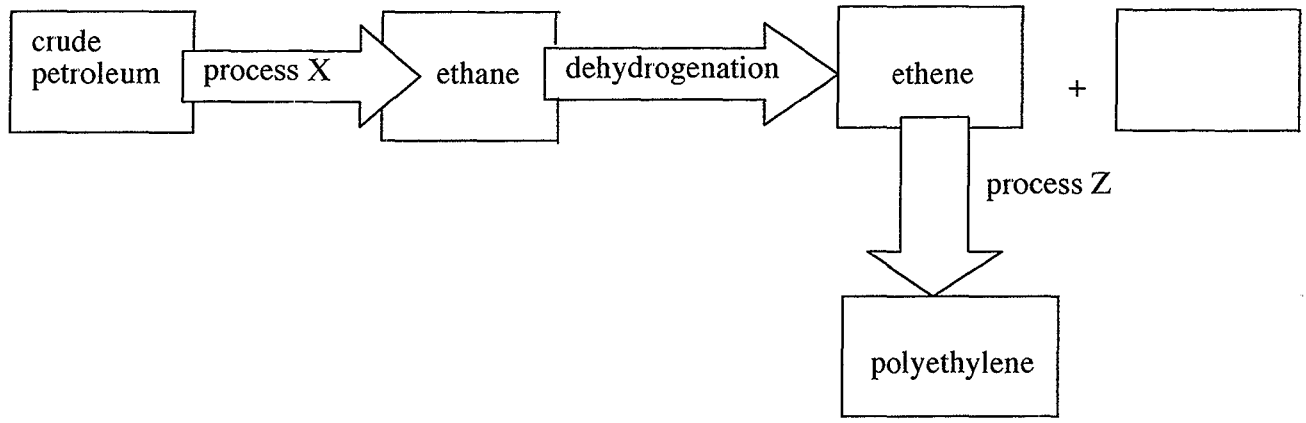
End of Question 16

Question 17 (7 marks)

The simplified flowchart below refers to a production of polyethylene from crude petroleum.



(a) Identify process X in the above flowchart. **1**

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(b) In the empty box in the flowchart, give the formula of the other product when ethene is formed by the process of dehydrogenation. **1**

(c) Identify and describe process Z. **2**

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(d) Write a structural equation to show the formation of **polyethylene** from two ethene monomers. **1**

(e) Describe a use of the polymer polyethylene in terms of its properties. **2**

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Student No. .....

Marks

Question 18 (7 marks)

Consider the following equation for the equilibrium system present inside a bottle of soda water.

$$CO_{2(g)} \rightleftharpoons CO_{2(aq)} + \text{heat}$$

(a) Explain, in terms of Le Chatelier's Principle, what would be observed if a cold bottle of soda water is taken out of the fridge and placed in the sun. **2**

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(b) At 25°C, the soda water has a pH of 4.1. This is due to the reaction of CO_2 with water, according to the equation:

$$CO_{2(aq)} + 2H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HCO_3^-{}_{(aq)}$$

(i) Calculate the concentration of hydronium ions in the soda water at 25°C. **1**

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Question 18 continues on page 12

Student No. .....

Marks

Question 18(b) (continued)

(ii) Explain the effect on the pH of a new bottle of soda water if the cap is removed. **2**

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(iii) Explain, using Le Chatelier's Principle and appropriate chemical equations, what would be **observed** if a solution of sodium hydroxide is added to the soda water. **2**

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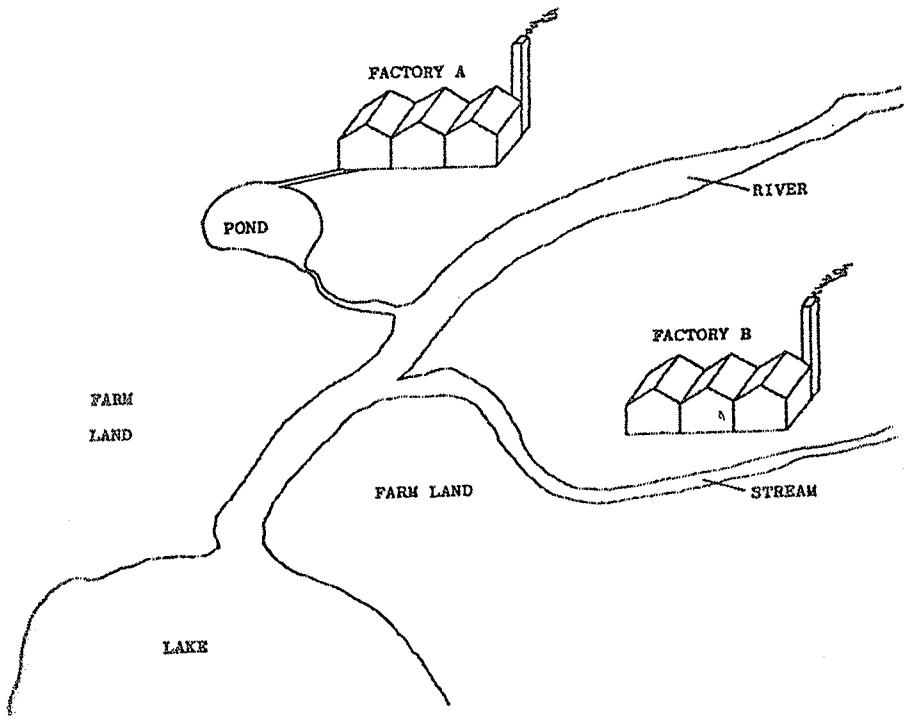
End of Question 18

Student No. .....

Marks

Question 19 (9 marks)

A schematic diagram relating two factories, A and B, with the surrounding environment is given in the figure below.



Factory A discharges waste water into the pond. The waste water is continuously monitored and is free of chemical pollutants. Small fish, however, cannot survive in the pond.

Factory B processes heavy metals. Most of the land between the factories and the lake is used for intensive farming. Periodically the lake develops a bloom of algae resulting in the loss of some aquatic species and the development of an unpleasant smell. Analysis of the small fish from the river and lake show traces of heavy metals, whilst larger fish show significantly higher concentrations of heavy metals.

(a) Identify the most likely cause of the algal bloom. **1**

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Question 19 continues on page 14

Marks

Question 19 (continued)

(b) Eutrophication of the lake usually results in algal bloom.

Outline a test that could be used to monitor the possible eutrophication of the lake. **2**

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(c) The small fish from the river and lake show traces of heavy metals.

(i) Identify **ONE** heavy metal. **1**

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(ii) Account for the need to monitor the heavy metal identified in (i). **2**

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Question 19 continues on page 15

Marks

Question 19 (continued)

(d) Outline the methods that could be used to purify and sanitise a mass water supply such as the lake. **3**

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End of Question 19

Student No. .....

Marks

Question 20 (6 marks)

Acid rain, predominantly sulfuric acid, is having a major corrosive effect on the monuments of the Parthenon in Athens. These monuments are made of marble (calcium carbonate).

(a) Explain, using appropriate equations, the formation and effects of acid rain. **4**

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(b) Over a two year period, 5·0 g of marble corrodes from a statue.

How many grams of sulfur dioxide are needed to cause this corrosion? **2**

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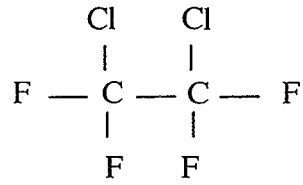
Student No. .....

Marks

Question 21 (8 marks)

(a) What is the systematic name of the CFC in the diagram? **1**



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(b) Describe, using a Lewis electron-dot diagram, the bonding within ozone. **2**

(c) Discuss, using relevant equations, how CFCs, like the one shown in (a), damage the ozone layer. **3**

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(d) Identify alternative chemicals used to replace CFCs. **2**

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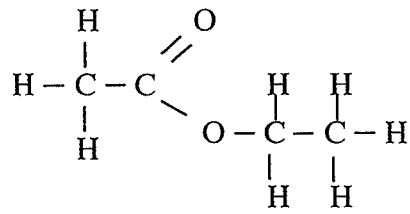
Student No. .....

Marks

Question 22 (10 marks)

A compound "X" has a boiling point of 163°C. A compound "Y" has a boiling point of 78°C. When "X" and "Y" were reacted together in the presence of concentrated sulfuric acid, they formed a compound with the following structural formula.



(a) Name and draw the structural formula for compound "X". Justify your choice. **4**

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(b) Explain the purpose of the concentrated sulfuric acid. **2**

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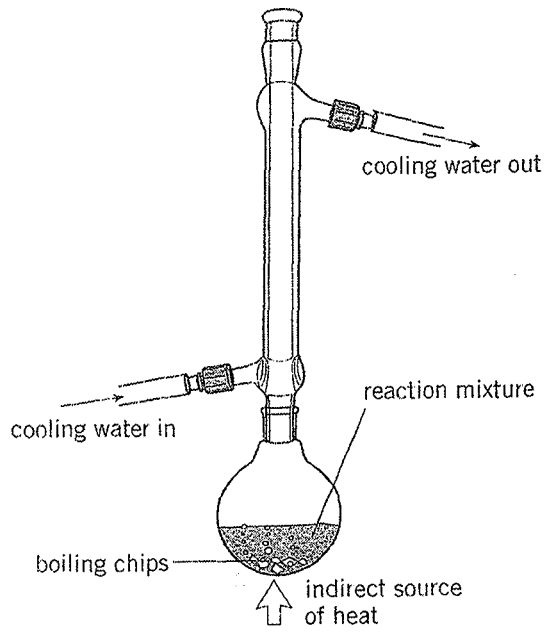
Question 22 continues on page 19

Question 22 (continued) **Marks**

(c) The apparatus shown below was used in the above chemical reaction.



(i) Name the experimental procedure. **1**

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(ii) Explain why this experimental procedure is better than simply combining the reactants in a beaker. **1**

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(iii) Outline **TWO** safety features this apparatus provides. **2**

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End of Question 22

Student No. .....

Marks

Question 23 (7 marks)

In the early twentieth century, Fritz Haber developed a method for producing ammonia.

(a) Write a balanced chemical equation, showing states, for this reaction. **1**

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(b) Ammonia is used as a cleaning agent. State **ONE** other use of ammonia. **1**

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(c) Describe the conditions under which Fritz Haber developed the industrial synthesis of ammonia and evaluate its significance on human society at that time. **3**

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(d) Explain why it is essential to monitor the temperature and pressure inside the Haber reaction vessel. **2**

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Student No. .....

Marks

Question 24 (7 marks)

A student compared the properties of two monoprotic acids, hydrochloric acid (HCl) and benzoic acid (C_6H_5COOH). Both acid solutions were 0.100 M concentration and 20.0 mL of acid was used for each test. The table below shows some of the results of the tests conducted.

Test	Hydrochloric acid (HCl)	Benzoic acid (C_6H_5COOH)
1. Electrical conductivity (mA)	80	50
2. pH	?	2.6
3. Volume of KOH solution needed for complete neutralization (mL)	18.2 mL	–

(a) Explain why the electrical conductivity of the two acid solutions have different values. **2**

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(b) Determine the expected pH of the hydrochloric acid solution. **1**

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(c) (i) Write a balanced chemical equation, showing states, for the reaction between hydrochloric acid and potassium hydroxide. **1**

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Question 24 continues on page 22

Marks

Question 24(c) (continued)

(ii) Calculate the concentration of the KOH solution used in Test 3. **2**

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(iii) Identify an indicator that could be used to determine the 'end-point' for the reaction between benzoic acid and potassium hydroxide. **1**

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End of Question 24

Student No. .....

Marks

Question 25 (5 marks)

Analyse progress in the development of a named biopolymer. **5**

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End of Section I

Student No. .....

Section II
10 marks
Attempt Question 26
Allow about 30 minutes for this section
Use the spaces provided on the paper.

Marks

Shipwrecks, Corrosion and Conservation

Question 26 (10 marks)

(a) The ocean has many minerals dissolved in it. Some of these minerals are involved in the chemical process of corrosion.

Identify **TWO** different sources of the minerals dissolved in sea water. **2**

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(b) Describe how the work of Galvani, Volta, Davy and Faraday increased our understanding of electron transfer reactions. **5**

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Question 26 continues on page 25

Question 26 (continued) **Marks**

(c) (i) Identify the main metal used to construct ships. **1**

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(ii) Although aluminium is a very reactive metal with a low reduction potential, it is used in many structures exposed to oxidizing conditions.

Explain why aluminium can be used this way. **2**

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End of Paper

Student No. .....

Barker College

2005
TRIAL HIGHER SCHOOL CERTIFICATE

Chemistry

ANSWER SHEET

Staff Involved:
- ASM*
- RJP
- TER
- RZS
- KHW

AM THURSDAY 11 AUGUST

95 copies

Section I
Part A – Multiple Choice
Choose the best response and fill in the response oval completely

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

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Chemistry

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- Show ALL working for calculations

Total marks – 100

Section I Pages 2 – 23

Total – 90 marks

This section has two parts, Part A and Part B

Part A – 15 marks
- Indicate all answers on the Answer Sheet provided
- Allow about 30 minutes for this part

Part B – 75 marks
- Attempt Questions 16 – 25
- Indicate all answers in the spaces provided on the paper
- Allow about 2 hours for this part

Section II Pages 24 – 25

10 marks
- Attempt Question 26
- Indicate all answers in the spaces provided on paper
- Allow about 30 minutes for this section

Section I

Total marks – 90

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 this by writing the word *correct* and drawing an arrow as follows.

correct ←

(A) ⊗ (B) ⊗ (C) ○ (D) ○

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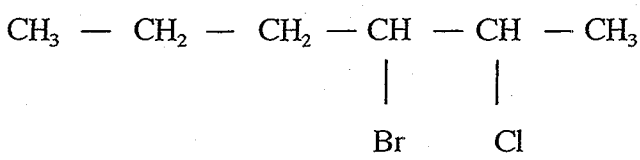
1. What is the IUPAC systematic name for the structure shown below?



(A) 3 - bromo - 2 - chloroheptane
(B) 4 - bromo - 5 - chlorohexane
(C) 3 - bromo - 2 - chlorohexane
(D) 2 - chloro - 3 - bromohexane

2. How many structural isomers are there with the molecular formula C_4H_9Cl?

(A) 2
(B) 3
(C) 4
(D) 5

3. What **TWO** substances are used to produce ethyl butanoate?

(A) Butanol and ethanoic acid.
(B) Butanol and ethane.
(C) Ethanol and butanoic acid.
(D) Butane and ethanol.

4. What does X represent in the following nuclear equation?

$$^{226}_{88}Ra \rightarrow X + {}^{222}_{86}Ra$$

(A) $^{1}_{0}n$
(B) $^{1}_{0}e$
(C) $^{4}_{2}He$
(D) $^{1}_{1}H$

5. What is the catalyst for the conversion of ethylene into ethanol?

(A) NaOH
(B) H_2SO_4
(C) Ni
(D) Pt

6. What are the conditions that most favour the fermentation of sugar?

(A) Warmth, oxygen, no water.

(B) Warmth, no oxygen, water.

(C) No warmth, no oxygen, no water.

(D) Warmth, oxygen, water.

7. Which of the following polymers is an example of a condensation polymer?

(A) Polyethylene
(B) Polyvinylchloride
(C) Polystyrene
(D) Cellulose

8. Data obtained from various combustion experiments is given in the table below.

Fuel	CH_3OH	C_2H_5OH	C_3H_7OH	C_4H_9OH
MW (g/mol)	32	46	60	74
Mass used (g)	1.74	1.83	1.39	1.47
Moles used	0.0544	0.0398	0.0232	0.0199
Mass H_2O (g)	300	300	300	300
ΔT (water) (^oC)	+17.4	+18.9	+17.7	+21.0

NB. The specific heat capacity of water is 4.18 J g^{-1} $^oC^{-1}$

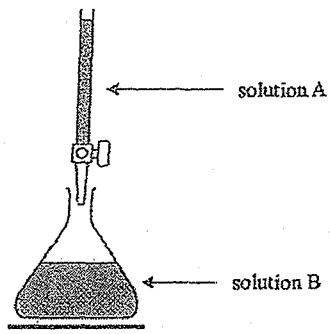
What is the heat of combustion of ethanol closest to, according to this set of experimental data?

(A) 394 kJ / mol
(B) 596 kJ / mol
(C) 2487 kJ / mol
(D) 515 kJ / mol

9. 10 mL of 0.1 M HCl is made up to 1.0 L with water. What is the pH of the resulting solution?

(A) 1
(B) 2
(C) 3
(D) 4

10. In a titration experiment, 0.1 M sodium hydroxide solution (A) was to be added to 20 mL of 0.1 hydrochloric acid solution (B) using the apparatus shown.



Which one of the following procedures should have been done before titrating?

	Conical flask washed with	**Burette washed with**
(A)	solution B	solution A
(B)	distilled water	distilled water
(C)	solution B	distilled water
(D)	distilled water	solution A

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

(A) $H_3O^+_{(aq)} + HPO_4^{2-}{}_{(aq)} \rightleftharpoons H_2O_{(l)} + H_2PO_4^-{}_{(aq)}$

(B) $H_2O_{(l)} + HCO_3^-{}_{(aq)} \rightleftharpoons H_3O^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

(C) $H_2O_{(l)} + NH_{3(g)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

(D) $H_3O^+_{(aq)} + HS^-_{(aq)} \rightleftharpoons H_2S_{(aq)} + H_2O_{(l)}$

12. What method would allow you to determine the total dissolved solids in a sample of water?

(A) AAS
(B) Electrical conductivity meter
(C) A pH meter
(D) A flame test

13. Which layer of the atmosphere contains the highest concentration of ozone?

(A) Troposphere
(B) Stratosphere
(C) Mesosphere
(D) Thermosphere

14. What is the purpose of the iron-based chemical in the Haber process?

(A) Increasing the yield of ammonia which is produced.

(B) Increasing the activation energy of the reaction.

(C) Increasing the quality of the ammonia which is produced.

(D) Increasing the rate at which the ammonia is produced.

15. The table gives the results of chemical tests for some cations and anions.

Ion	**Add cold 0.1 M HCl**	**Add 0.1 M KSCN**	**Add 0.1 M Na_2CO_3**	**Add 0.1 M $AgNO_3$**
Ca^{2+}	no change	no change	white precipitate	no change
Fe^{3+}	no change	red colour	brown precipitate	no change
Ba^{2+}	no change	no change	white precipitate	no change
Pb^{2+}	white precipitate	no change	white precipitate	no change
Cl^-	no change	no change	no change	white precipitate

When a group of students performed the above tests on an unknown solution they obtained the following results.

Add cold 0.1 M HCl	**Add 0.1 M KSCN**	**Add 0.1 M Na_2CO_3**	**Add 0.1 M $AgNO_3$**
no change	no change	white precipitate	white precipitate

Which conclusion is consistent with these results?

(A) The sample contained both $CaCl_2$ and $BaCl_2$.
(B) The sample contained both $CaCl_2$ and $PbCl_2$.
(C) The sample contained $FeCl_3$ and $PbCl_2$.
(D) The sample contained both $FeCl_3$ and $BaCl_2$.

End of Part A

Student No. .....

Section I (continued)
Part B – 75 marks
Attempt ALL questions
Allow about 2 hours for this part
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

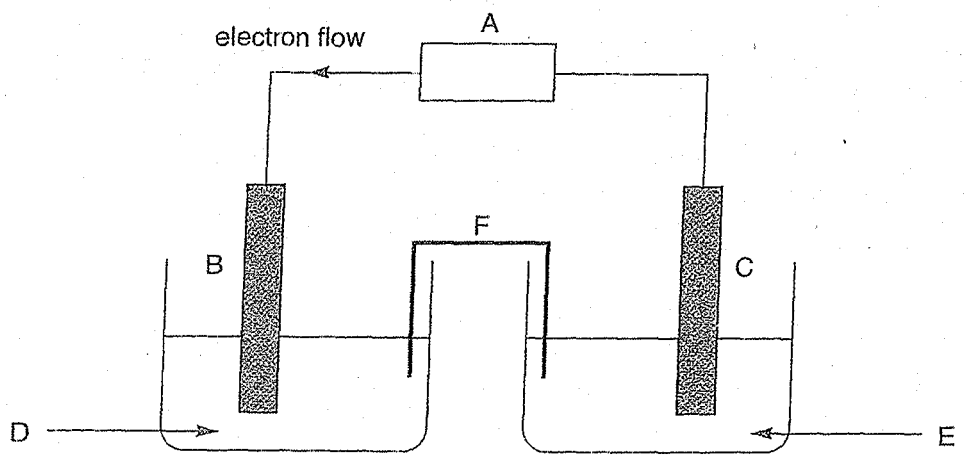
Question 16 (9 marks)

A student is provided with the materials listed below and is told to use whichever materials are needed to make a galvanic cell which will generate a current.

Apparatus:
- beakers, thermometer, power pack, light globe, insulated copper wire, voltmeter, filter paper, funnel stirring rods, emery paper

Chemicals:
- 1.0 M solutions of copper (II) nitrate, potassium nitrate, iron (II) nitrate
- De-ionised water
- Strips of copper and iron

The diagram below shows how the student set up the cell.



(a) In terms of the tabled apparatus and chemicals above, identify A – D. **2**

A: voltmeter (½)

B: copper strip (½)

C: iron strip (½)

D: copper(II) nitrate solution (½)

↳ labels like anode & cathode would be unacceptable

Question 16 continues on page 8

Student No. .....

Marks

Question 16 (continued)

(b) Explain your choice of C. *Reasoning must justify their choice 1

The arrow indicates electron transfer from C → B. Therefore oxidation occurs at C and the electrons move to B. Oxidation occurs at the anode. Iron being the more reactive metal will be oxidised.

(c) Write the half-equation, showing states, for: 2

(i) the anode

$Fe_{(s)} \longrightarrow Fe^{2+}_{(aq)} + 2\bar{e}$ ($\frac{1}{2}$) for states ($\frac{1}{2}$) for symbols + balancing

(ii) the cathode

$Cu^{2+}_{(aq)} + 2\bar{e} \longrightarrow Cu_{(s)}$ (As above)

(d) Using the standard potentials table from the data sheet provided, calculate the theoretical voltage of this galvanic cell. 1

Anode = 0.44V

Cathode = 0.34V

Total EMF = 0.78V Right or wrong only (1)

Question 16 continues on page 9

Student No. .....

Marks

Question 16 (continued)

Describe = provide characteristics & features

(e) Describe **TWO** changes you would expect to observe in the beakers if a current flowed for a considerable length of time. **2**

(1) each

(i) 1 Mass of copper electrode would increase OR would get bigger

2 Iron electrode would decrease in mass OR would slowly disappear

(ii) 3 The blue $Cu(NO_3)_2$ solution would fade OR become colourless

Any 2 - if 3 is used they must mention 'blue'

(f) Explain the purpose of F. **1**

F is the salt bridge. It enables the migration (½) of ions into the electrolytes maintaining their electrical neutrality (½)

("It completes the circuit" does not explain)

Explain = relate cause and effect ; make relationships between things evident ; provide why and/or how.

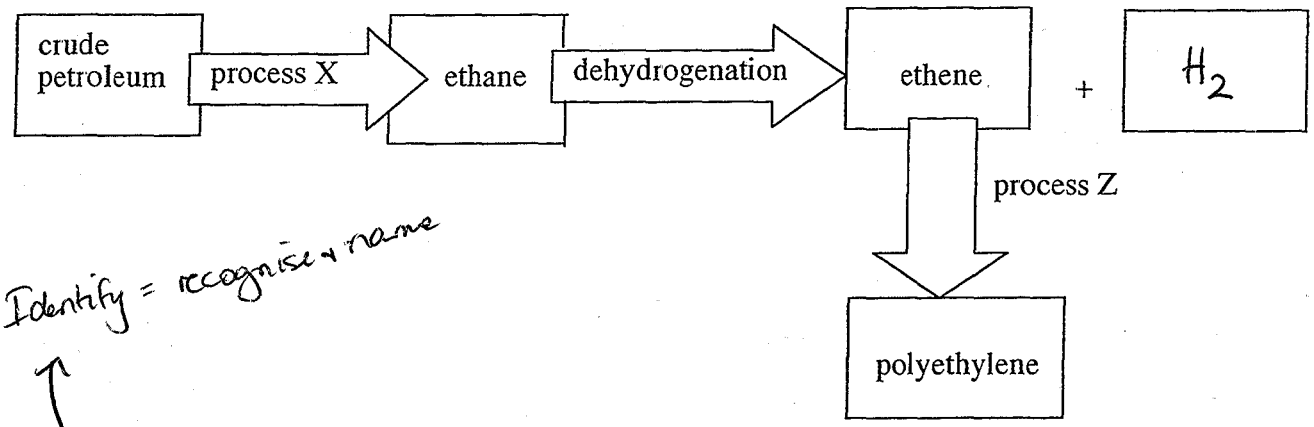
End of Question 16

Student No. .....

Marks

Question 17 (7 marks)

The simplified flowchart below refers to a production of polyethylene from crude petroleum.



Identify = recognise + name

(a) Identify process X in the above flowchart. **1**

Fractional Distillation
(must have both words - no ½ marks)

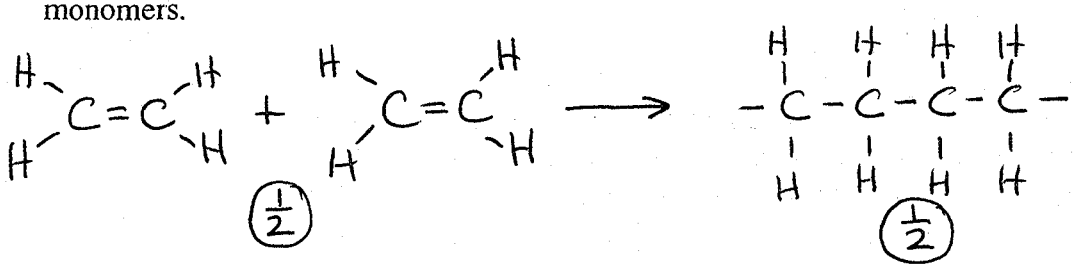
(b) In the empty box in the flowchart, give the formula of the other product when ethene is formed by the process of dehydrogenation. **1**

(c) Identify and describe process Z. **2**

(½) Addition polymerisation

(½) The double bonds in the ethene monomers opens out to form bonds with adjacent monomers making a very long (½) chain with no loss of any atoms (½)

(d) Write a structural equation to show the formation of **polyethylene** from two ethene monomers. **1**



(½) (½)

(e) Describe a use of the polymer polyethylene in terms of its properties. **2**

USE	PROPERTIES
LDPE - • Wrapping materials • squashable bags • and squeezable bottles (1)	A lot of branching of the polymer chain makes close packing impossible so the polymer is soft and flexible (1)
OR	
HDPE • Plastic utensils • toys • strong bags • Building materials (1)	No chain branching, the polymer chains pack closely giving hardness, density rigidity and strength for these uses. (1)

Student No. .....

Marks

Question 18 (7 marks)

Consider the following equation for the equilibrium system present inside a bottle of soda water.

$$CO_{2(g)} \rightleftharpoons CO_{2(aq)} + \text{heat}$$

(a) Explain, in terms of Le Chatelier's Principle, what would be observed if a cold bottle of soda water is taken out of the fridge and placed in the sun. 2

(1) Observations – bubbles of gas will be seen rising through the liquid

(1) Le Chateliers Principle states that an equilibrium will shift in the direction that minimises changes when it is disturbed by an external influence. By placing the cold bottle in the sun the system is heated. To minimise this disturbance the reaction $CO_{2(aq)} \rightarrow CO_{2(g)}$ will be favoured to use up the additional heat. $CO_{2(g)}$ is seen as bubbles

(b) At 25°C, the soda water has a pH of 4.1. This is due to the reaction of CO_2 with water, according to the equation:

$$CO_{2(aq)} + 2H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HCO_3^-{}_{(aq)}$$

(i) Calculate the concentration of hydronium ions in the soda water at 25°C. 1

$[H_3O^+] = 10^{-pH} = 10^{-4.1} = 7.9 \times 10^{-5}\ mol\ L^{-1}$

– (½) for no or incorrect units

Question 18 continues on page 12

Student No. .....

Marks

Question 18(b) (continued)

(ii) Explain the effect on the pH of a new bottle of soda water if the cap is removed. **2**

(½) By removing the cap $CO_2(g)$ escapes and the $[CO_2(g)]$ in the system decreases.

(½) The equilibrium shifts to make more $CO_2(g)$ causing $[CO_2(aq)]$ to decrease. This

(½) in turn favours $H_3O^+ + HCO_3^- \rightarrow 2H_2O + CO_2(g)$ reducing $[H_3O^+]$. As $[H_3O^+]$ reduces, pH increases (½)

(iii) Explain, using Le Chatelier's Principle and appropriate chemical equations, what would be **observed** if a solution of sodium hydroxide is added to the soda water. **2**

Adding sodium hydroxide would reduce the $[H^+]$ because $H^+ + OH^- \rightarrow H_2O$ (½)

As $[H^+]$ reduces $CO_{2(aq)} + 2H_2O \rightarrow H_3O^+ + HCO_3^-$ is favoured (½) In turn, $CO_{2(g)} \rightarrow CO_{2(aq)}$ redresses the decreased $[CO_{2\,aq}]$ (½) and with less $CO_2(g)$ the soda water goes flat (½)

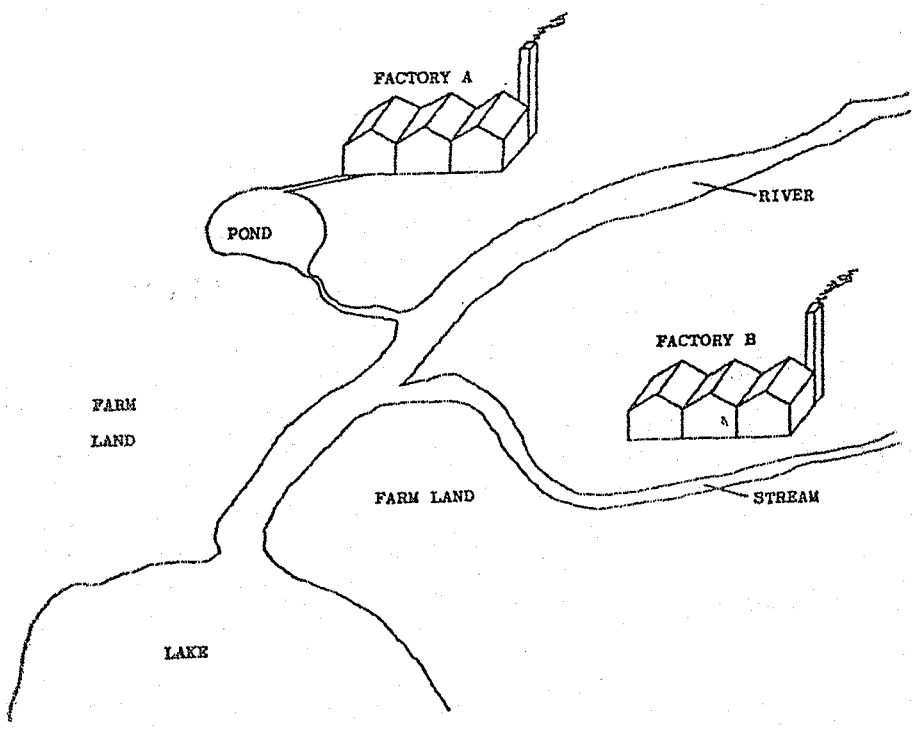
End of Question 18

Student No. .....

Marks

Question 19 (9 marks)

A schematic diagram relating two factories, A and B, with the surrounding environment is given in the figure below.



Factory A discharges waste water into the pond. The waste water is continuously monitored and is free of chemical pollutants. Small fish, however, cannot survive in the pond.

Factory B processes heavy metals. Most of the land between the factories and the lake is used for intensive farming. Periodically the lake develops a bloom of algae resulting in the loss of some aquatic species and the development of an unpleasant smell. Analysis of the small fish from the river and lake show traces of heavy metals, whilst larger fish show significantly higher concentrations of heavy metals.

(a) Identify the most likely cause of the algal bloom. **1**

Phosphates (½) and nitrates from fertilisers (½)
used on the farms (1) (½) for fertilizers only
Must say (½) phosphate or nitrates (½) fertilisers.

Question 19 continues on page 14

Student No. .....

Marks

Question 19 (continued)

Give main features off ① for phosphates(1) ② by colorimetry (1)

(b) Eutrophication of the lake usually results in algal bloom.

Outline a test that could be used to monitor the possible eutrophication of the lake. 2

* Referring to Conquering Chemistry – p270 – measuring levels of phosphates is the best indicator of possible eutrophication This is done by Colourimetry. $[PO_4^{3-}] > 0.05$ for lakes dams and ponds, or $> 0.1 mgL^{-1}$ for streams ⇒ algal bloom.

(BOD - 2 samples are collected from the waterway. One is immediately tested for D.O. The other is kept in the dark for 5 days, then D.O. is measured. The difference in DO between the two is the BOD. > 100 ppm

(c) The small fish from the river and lake show traces of heavy metals.

(i) Identify **ONE** heavy metal. p 210 1

Lead (cadmium, zinc, mercury, copper, chromium, arsenic, nickel)

Account for = GIVE REASONS FOR

(ii) Account for the need to monitor the heavy metal identified in (i). 2

What it does 1

Lead is poisonous to human beings. In smaller concentrations it can retard the intellectual development of young children and in larger concentrations can cause brain and neurological disorders. Its concentration in the environment must be monitored, to prevent this risk to humans, and to devise ways of preventing future Pb^{2+} pollution.

Why it is in environment 1

It gets into the soil and waterways by leaching from tips where lead batteries, old lead based paints, old building and plumbing materials with lead components are dumped. Until recently lead in petrol led to accumulation of lead in soils and atmosphere near major roads. Industrial effluent can release lead into major waterways where it bioaccumulates through the food chain.

Question 19 continues on page 15

Student No. .....

Marks

Question 19 (continued)

(d) Outline the methods that could be used to purify and sanitise a mass water supply such as the lake. 3

Purification

1. Coarse grate to remove large debris

2. Aeration - water is sprayed to increase D.O. + sunlight

3. Clarification - pH raised by adding lime or NaOH → Fe^{3+} or Al^{3+} added to form large precipitates → fine clay suspensions (coagulation) stick to these → the heavier (flocs) precipitates then settle to bottom + removed as sludge.

4. Filtration - clarified water passes through coarse sand or sand + charcoal filler. → Clear, colourless, odourless water.

Sanitation - Gaseous Chlorine added to kill bacteria and viruses - ($[Cl_2] > 1$ ppm right to the customer)

5. Fluoridation - F^- compounds (NaF) added to strengthen children's tooth enamel.

Throughout the process water quality is monitored to meet the required standards set by NHU

The 3 major parts needed (1) each.

End of Question 19

Student No. .....

Marks

Question 20 (6 marks)

Acid rain, predominantly sulfuric acid, is having a major corrosive effect on the monuments of the Parthenon in Athens. These monuments are made of marble (calcium carbonate).

(a) Explain, using appropriate equations, the formation and effects of acid rain. 4

(1) Formation Sulfur dioxide and nitrogen oxides are soluble in water, so excesses of these pollutants in the atmosphere dissolve in atmospheric water making sulfuric and nitric acids which fall as acid rain.

Either (1) $SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$ // $2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$

$2H_2SO_{3(aq)} + O_{2(g)} \rightarrow 2H_2SO_{4(aq)}$ // $2HNO_2 + O_2 \rightarrow 2HNO_3$

Effects Although rain is generally acidic due to $CO_{2(aq)}$, the excess of H^+ through $H_2SO_4 + HNO_3$ has

(1) for stating (1) for explain

a) increasing acidity in lakes resulting in fish kills, + reduced fertility of aquatic species. (pH<4 - no living organisms)

b) damage to plants because the acidity prevents normal uptake of nutrients and photosynthetic processes

c) erosion of marble and limestone buildings.

($CaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + H_2O_{(l)}$, $CaSO_4$ is soluble)

(b) Over a two year period, 5·0 g of marble corrodes from a statue.

How many grams of sulfur dioxide are needed to cause this corrosion? 2

(½) 1 mole of SO_2 produces 1 mole H_2SO_4 which corrodes 1 mole $CaCO_3$

(½) $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O$

$n_{CaCO_3} = 5g / 100.09\ g\,mol^{-1} = 0.05\ mol$ (½)

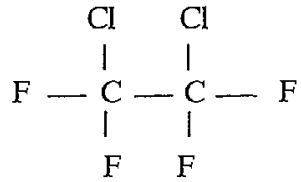
$m_{SO_2} = 0.05\ mol \times 64.07\ g\,mol^{-1} = 2.0\ g$ (½)

Student No. .....

Marks

Question 21 (8 marks)

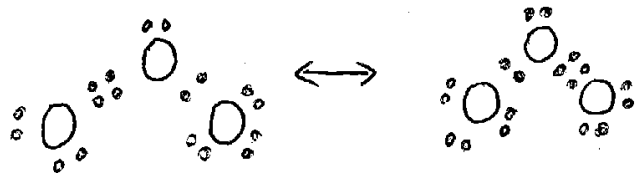
(a) What is the systematic name of the CFC in the diagram? **1**



1,2 – dichloro – 1,1,2,2 – tetrafluoroethane

(b) Describe, using a Lewis electron-dot diagram, the bonding within ozone. **2**

Must have both configurations and ⟷



(1) for only 1 configuration (−½) if no arrow both ways

(c) Discuss, using relevant equations, how CFCs, like the one shown in (a), damage the ozone layer. **3**

* Discuss = identify issues; provide points for and/or against.

Identifying the issues (1)

CFC destruction of ozone is an issue of concern in the 21st century because CFCs are not easily decomposed in the atmosphere, are not soluble so removed by rain, diffuse slowly from the troposphere to the stratosphere, where one chlorine atom breaks off and in the series of reactions described below can destroy thousands of ozone molecules. Destruction of ozone leads to more UVB which causes cancers in humans and damages plant growth.

Relevant Equations 1. CFCs release a Cl atom energised by U.V.C.

eg $CCl_2F + UVC \rightarrow CClF_2 + Cl$ (½)

(1½) 2. $Cl + O_3 \rightarrow ClO + O_2$ (½) ClO contains an unpaired electron so is highly reactive.

3. ClO reacts with a free O atom $ClO + O \rightarrow O_2 + Cl$ (½) This free Cl atom can then attack another ozone molecule and the process occurs again and again in a chain reaction.

For & against (½) Although other reactions with Cl + ClO can stop the chain reaction, the number of ozone molecules destroyed, and the concentration of CFCs due to our use of them over the past 50 years, makes repairing the damage to the ozone layer difficult.

(d) Identify alternative chemicals used to replace CFCs. **2**

Hydrochlorofluorocarbons HCFCs (1)

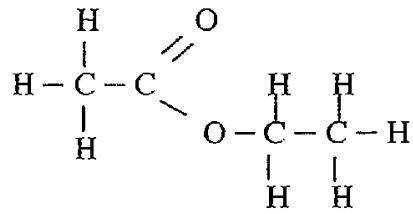
Hydrofluorocarbons HFCs (1)

Student No. .....

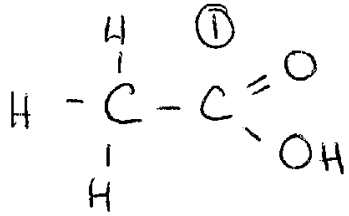
Marks

Question 22 (10 marks)

A compound "X" has a boiling point of 163°C. A compound "Y" has a boiling point of 78°C. When "X" and "Y" were reacted together in the presence of concentrated sulfuric acid, they formed a compound with the following structural formula.



(a) Name and draw the structural formula for compound "X". Justify your choice. **4**



ethanoic (1) acid

Because alkanoic (½) acids can form stronger intermolecular forces, due to 3 polar (½) bonds plus ability to form H-bonds, than alkanols with only 1 polar bond and ability to H-bond, the acid has the higher B.P. (½) must be X. 2-Carbon (½) atoms identifies X as ethanoic acid.

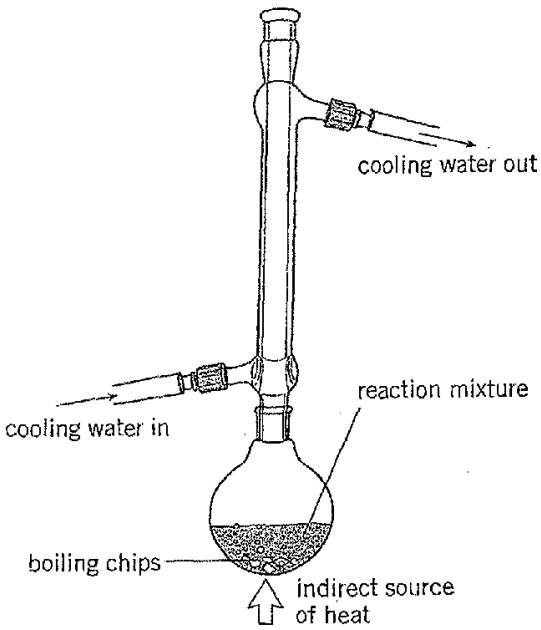
(b) Explain the purpose of the concentrated sulfuric acid. **2**

H_2SO_4 acts as a catalyst (½), speeding up (½) the reaction, and by removing (½) water pushes the equilibrium towards products OR drives the reaction to completion. (½)

Question 22 continues on page 19

Question 22 (continued) **Marks**

(c) The apparatus shown below was used in the above chemical reaction.



OUTLINE = indicate the main features of; sketch in general terms

(i) Name the experimental procedure. **1**

Refluxing

(ii) Explain why this experimental procedure is better than simply combining the reactants in a beaker. **1**

The reactants and products are volatile gases and would be lost as vapours before a significant yield was obtained. This apparatus condenses the vapours back to the flask reducing loss and makes it possible to react the mixture at higher T.

(iii) Outline **TWO** safety features this apparatus provides. **2**

① The heat is provided by a water bath to prevent volatile reactants igniting with bunsen flame

② The condenser is not stoppered to prevent pressure build up of gases

③ Water goes in at bottom of condenser and out at top to ensure a full sleeve of water

④ The apparatus is firmly supported by 2 clamps — one on flask, one on condenser.

Any 2 ✓ (1) mark each (1/2) each if identified only.

End of Question 22

Student No. .....

Marks

Question 23 (7 marks)

In the early twentieth century, Fritz Haber developed a method for producing ammonia.

(a) Write a balanced chemical equation, showing states, for this reaction. Must have double arrow **1**

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

(b) Ammonia is used as a cleaning agent. State **ONE** other use of ammonia. **1**

Fertilisers, explosives

(c) Describe the conditions under which Fritz Haber developed the industrial synthesis of ammonia and evaluate its significance on human society at that time. **3**

- Pre World War I Europe
- Germany's supplies of nitrates for fertilisers and explosives came from Chile.
- England blockaded these supplies putting Germany's munitions industry and agriculture at a disadvantage in terms of political power
- Fritz Haber invented ammonia synthesis from nitrogen and hydrogen, thus enabling Germany to feed its population and make munitions for war
- His invention enabled Germany to wage war →
- Enormous loss of life, social upheaval and destruction.

(d) Explain why it is essential to monitor the temperature and pressure inside the Haber reaction vessel. **2**

The synthesis reaction is an equilibrium, that favours formation of $N_2 + H_2$ under normal T + P, and is exothermic in the direction of products. Higher T is needed to speed up rate of reaction but increased T favours reactants. Higher P will favour products. To get a good yield T and P are at compromise levels and must be monitored

Student No. .....

Marks

Question 24 (7 marks)

A student compared the properties of two monoprotic acids, hydrochloric acid (HCl) and benzoic acid (C_6H_5COOH). Both acid solutions were 0.100 M concentration and 20.0 mL of acid was used for each test. The table below shows some of the results of the tests conducted.

Test	Hydrochloric acid (HCl)	Benzoic acid (C_6H_5COOH)
1. Electrical conductivity (mA)	80	50
2. pH	?	2.6
3. Volume of KOH solution needed for complete neutralization (mL)	18.2 mL	–

(a) Explain why the electrical conductivity of the two acid solutions have different values. **2**

HCl is a strong acid, completely ionising in solution. $[HCl] = [H^+]$ → high conductivity (1)

BUT

Benzoic acid is a weak acid which only partially ionises $[H^+] < [C_6H_5COOH]$ and (1)

∴ conductivity is lower.

{ For HCl, $[H^+] = 0.1$ M BUT For C_6H_5COOH, $[H^+] < 0.1$ M because strong acid, $HCl \rightarrow H^+ + Cl^-$ BUT weak acid, $C_6H_5COOH \rightleftarrows H^+ + C_6H_5COO^-$ }

(b) Determine the expected pH of the hydrochloric acid solution. **1**

pH = 1 ($pH = -\log[H^+] = -\log 0.1$) [no half marks]

(c) (i) Write a balanced chemical equation, showing states, for the reaction between hydrochloric acid and potassium hydroxide. **1**

$HCl_{(aq)} + KOH_{(aq)} \longrightarrow KCl_{(aq)} + H_2O_{(l)}$

(-½) if no states or states incorrect

Question 24 continues on page 22

Marks

Question 24(c) (continued)

(ii) Calculate the concentration of the KOH solution used in Test 3. **2**

$n_{HCl} = cV = 0.100 \times 0.020 = 2 \times 10^{-3}$ mole $(\frac{1}{2})$

The neutralisation has a 1:1 mole ratio

$\therefore$ 0.0182 mL of KOH $= 2 \times 10^{-3}$ mol $(\frac{1}{2})$

$\therefore c_{KOH} = \frac{0.100 \times 0.020 (\frac{1}{2})}{0.0182} = 0.10989 = 0.110 \text{ mol L}^{-1} (\frac{1}{2})$

If $c_1v_1 = c_2v_2$
(1) for working
(1) for correct answer

(iii) Identify an indicator that could be used to determine the 'end-point' for the reaction between benzoic acid and potassium hydroxide. **1**

Phenolphthalein (end point in basic region)

End of Question 24

Analyse = identify trends, patterns + relationships as well as contradictions in data + information.

Student No. .....

Marks

Question 25 (5 marks)

Analyse progress in the development of a named biopolymer. **5**

Possible named biopolymers Bipol, PHA, PHB, PHV, PHB-PHV copolymer, PLA, Protein based polymers - PBP, Cyclodextrins - CD, Modified Cellulose polymers.

See text + attached articles for more information

Biopolymers are naturally occurring polymers. An example of a biopolymer is poly(hydroxybutanoate), PHB, a stiff, brittle plastic with properties similar to poly(propylene).

Maurice Limoigne first produced PHB in 1925. PHB can be produced in a lab by feeding bacteria a diet rich in nutrients until large colonies form. and then withdrawing glucose. The bacteria automatically start secreting PHB which provides them with an energy store. In the 1980s the three genes in *Alcaligenes eutrophus* needed for the production of PHB were successfully cloned and transferred into *E. coli*, a common bacterium which was well-researched, reproduced quickly and had an easily manipulated physiology. Cargill Dow transported the PHB gene into corn and maize plants and allowed crops of PHB-producing plants to be grown and harvested.

PHB is widely used as it is easily biodegradable and renewable. It was first introduced into the medical industry, to make non-toxic and decomposable sutures, and to make plastics in the chemical engineering industry. Monsanto first put PHB on the shelves in the form of shampoo bottles, but was unsuccessful due to the cost. Cost is still the major problem associated with the production of PHB. After being researched for over 20 years, the technology required to produce PHB is not a problem.

PHB is more expensive to produce than petroleum-based polymers, which means research is slowed down. Whilst PHB wouldn't have a market in areas where plastics should be non-biodegradable, such as in piping, it would be potentially successful for use in plastic bags and containers. For the research into PHB to be successful, PHB must be produced for less money than petroleum-based alternatives or these alternatives must be made more expensive.

Cargill Dow are currently working on the biopolymer being produced by plants. This could well be the way of the future if they can produce something that is cost effective and maintain the useful properties of the compound.

Success 1 - 2003 edn. (p9)

End of Section I

Student No. .....

Section II
10 marks
Attempt Question 26
Allow about 30 minutes for this section
Use the spaces provided on the paper.

Marks

Shipwrecks, Corrosion and Conservation

Question 26 (10 marks)

(a) The ocean has many minerals dissolved in it. Some of these minerals are involved in the chemical process of corrosion.

Identify **TWO** different sources of the minerals dissolved in sea water. **2**

1. Leaching from terrestrial rocks by rain & streams.
2. Hydrothermal Vents in mid-ocean ridges

(b) Describe how the work of Galvani, Volta, Davy and Faraday increased our understanding of electron transfer reactions. SEE ACTIVITY 1 in LAB MANUAL 5

Galvani - observed electrical impulses causing twitching in frog legs. The conditions provided two different metals & the electrolyte of the frog tissue fluids. Wrongly concluded that the electricity spontaneously came from the animal.

Volta - Concluded from Galvani's experiments that the two different metals and electrolyte produced the electricity and built the first galvanic cell using copper and tin (later, silver and zinc) discs separated by brine soaked cardboard. Volta understood the need for the 3 components of the cell and large voltaic piles became a popular way of producing electricity. He did not understand, however, that the source was transfer of electrons

(1) for each description

(1) for expressing a progression of understanding of electron transfer

Davy - Used larger improved versions of voltaic piles to decompose water and to isolate Gp1 metals from their compounds through electrolysis. He recognised that the electricity came from a chemical reaction between the metals and the electrolyte

Faraday - The exact process of electron transfer was still not fully understood, but Faraday made the connection between increasing mass at the electrode and the amount of electricity passing through the electrolyte. He quantified this relationship in his Laws of Electrolysis.

Question 26 continues on page 25

Student No. .....

Question 26 (continued) **Marks**

(c) (i) Identify the main metal used to construct ships. **1**

Steel / Iron

(ii) Although aluminium is a very reactive metal with a low reduction potential, it is used in many structures exposed to oxidizing conditions.

Explain why aluminium can be used this way. **2**

(1) Aluminium immediately reacts with oxygen to form aluminium oxide on its surface

(1) Aluminium oxide is a dense, tough, shiny layer on the surface that is impenetrable by air or water and so no further oxidation of the aluminium metal can occur, once the oxide layer covers it. The oxide layer protects the aluminium

End of Paper