2004
Higher School Certificate
Trial Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your student number and/or name at the top of every page

Total Marks – 100

Section I
Total marks (75)
This section has two parts, Part A and Part B

Part A
Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Part B
Total marks (60)
Attempt questions 16 – 29
Allow about 1 hour 45 minutes for this part

Section II (Page 19)
Total marks (25)
Attempt ONE question from Questions 30-34
Allow about 45 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME: .....

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Section I

Total marks (75)

Part A

Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
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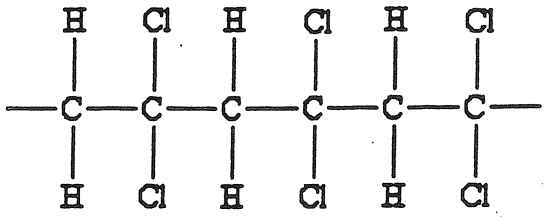
STUDENT NUMBER/NAME: .....

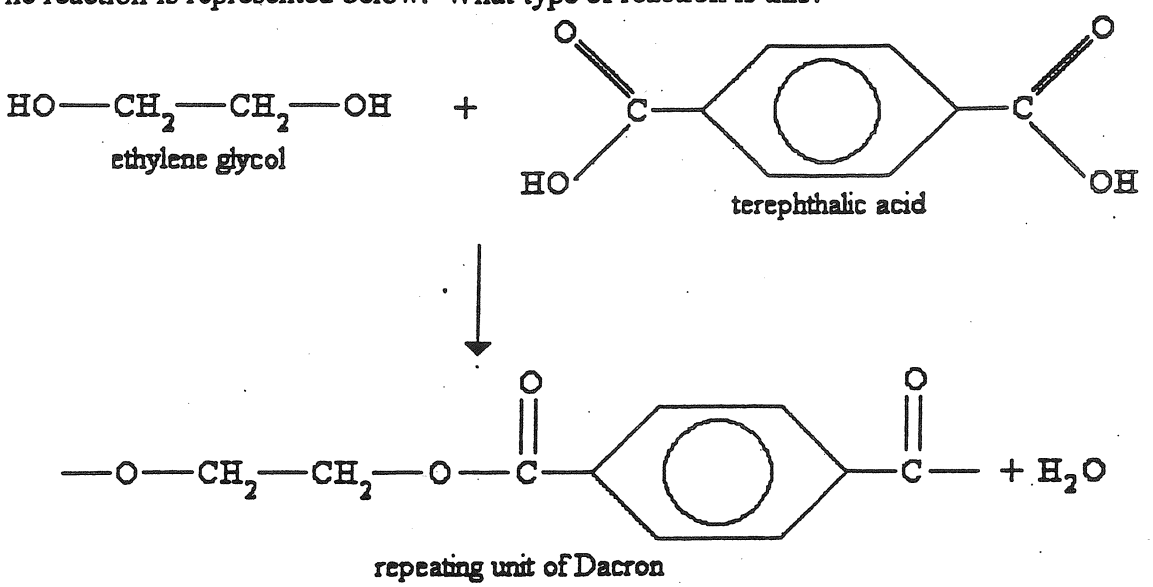
1. Saran is a polymer used to make packaging film and seat covers. Shown below is a representation of a Saran chain.



Which of the following is the monomer from which Saran is made?

(A) 1,1-dichloroethane
(B) 1,2-dichloroethane
(C) 1,1-dichloroethene
(D) 1,2-dichloroethene

2. When ethylene glycol is reacted with terephthalic acid a polyester (Dacron) is formed. The reaction is represented below. What type of reaction is this?



(A) addition polymerisation
(B) condensation polymerisation
(C) substitution
(D) dehydration

3. When a lead strip is placed a solution of silver nitrate the lead becomes coated with greyish furry growth. Which is the correct interpretation of the observation?

(A) Lead from solution has deposited on the original lead.
(B) Silver has deposited on the lead.
(C) The lead has reacted with the water which has caused a deposit similar to rust.
(D) Lead nitrate has formed a precipitate.

4. Water hardness is used to describe water that contains significant amounts of specific ions. Hard water will not lather easily with soaps. These ions are:

(A) Na^+ and Cl^- ions
(B) NH_4^+ and OH^- ions
(C) Hg^{2+} and Pb^{2+} ions
(D) Mg^{2+} and Ca^{2+} ions

5. The table below lists some physical and chemical properties of four different carbon compounds.

Compound	Boiling point (°C)	Reactivity in bromine water	Solubility in Water
W	-89	unreactive	insoluble
X	-104	reactive	insoluble
Y	78	unreactive	soluble
Z	138	unreactive	slightly soluble

Which alternative best identifies compounds W, X, Y and Z ?

	W	X	Y	Z
(A)	C_2H_6	C_2H_4	C_2H_5OH	$C_5H_{11}OH$
(B)	C_2H_4	C_2H_6	$C_5H_{11}OH$	C_2H_5OH
(C)	$C_5H_{11}OH$	C_2H_5OH	C_2H_4	C_2H_6
(D)	$C_5H_{11}OH$	C_2H_4	C_2H_5OH	C_2H_6

6. Heart pacemakers are often powered by lithium-silver chromate button cells. The overall cell reaction is:

$$2\,Li_{(s)} + Ag_2Cr_2O_{4\,(s)} \rightarrow Li_2Cr_2O_{4\,(s)} + 2\,Ag_{(s)}$$

What is the anode in this cell ?

(A) $Ag_{(s)}$
(B) $Li_{(s)}$
(C) Ag^+
(D) $Cr_2O_4^{2-}$

7. Which of the following statements identifies the conjugate base of the acid HNO_3?

(A) NaOH is the conjugate base of the acid HNO_3
(B) OH^- is the conjugate base of the acid HNO_3
(C) NO_3 is the conjugate base of the acid HNO_3
(D) NO_3^- is the conjugate base of the acid HNO_3

8. The table shows the colours of three indicators at different hydrogen ion concentrations.

[HCl] mol L^{-1}	10^{-2}	10^{-4}	10^{-6}
Methyl Orange	red	orange	yellow
Bromothymol Blue	yellow	yellow	green
Phenol Red	yellow	red	red

What is the pH of a solution that showed the following indicator colours?

Methyl Orange	Yellow
Bromothymol Blue	Green
Phenol Red	Red

(A) 2
(B) 4
(C) 6
(D) 8

9. What is a correct name for the compound with the molecular formula CH_2O_2?

(A) ethanoic acid
(B) ethanol
(C) methanol
(D) methanoic acid

10. Identify the pH at the neutralisation point when sodium hydroxide is neutralised by hydrochloric acid.

(A) pH = 0
(B) pH = 7
(C) pH > 7
(D) pH < 7

11. Nitrogen dioxide, NO_2, a brown gas and dinitrogen tetroxide, N_2O_4, a colourless gas are in equilibrium according to the equation-:

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

If a sealed tube of the gases is placed in an ice-water bath the colour fades from brown to almost colourless. Which conclusion is correct?

(A) The forward reaction is exothermic
(B) The reverse reaction is exothermic
(C) The pressure has increased.
(D) The pressure has not changed

12. Identify the compound in the atmosphere which reacts with chlorofluorocarbons (CFC's).

(A) water
(B) carbon monoxide
(C) ozone
(D) carbon dioxide

13. Sulfuric acid reacts with pyrosulfuric acid according to the equation-:

$$H_2SO_{4\,(l)} + H_2S_2O_{7\,(l)} \rightleftharpoons H_3SO_4^{+}{}_{(l)} + HS_2O_7^{-}{}_{(l)}$$

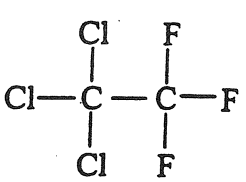
Identify a method of increasing the concentration of $H_3SO_4^{+}$ in the mixture at equilibrium.

(A) increase the pressure on the system
(B) add H_2SO_4
(C) add a catalyst
(D) add $HS_2O_7^{-}$

14. Select the molecule from below that possesses a coordinate covalent bond.

(A) carbon dioxide
(B) water
(C) ozone
(D) oxygen

15. What is the correct systematic name of this compound?



(A) 1,1,1,2,2,2-chlorofluoroethane
(B) 1,1,1-trifluoro - 2,2,2-trichloromethane
(C) 1,1,1,2,2,2-chlorofluoromethane
(D) 1,1,1-trichloro - 2,2,2-trifluoroethane

STUDENT NUMBER/NAME: .....

Section I – continued

Part B

Total marks (60)
Attempt questions 16 – 29
Allow about 1 hour 45 minutes for this part

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Question 16 (4 marks) **Marks**

Ethane can be cracked to form ethene and hydrogen at 850°C.
The reaction is strongly endothermic.

(a) Construct the equation for this reaction. **1**

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(b) Justify the use of a high temperature for this reaction. **1**

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(c) Describe what is observed when ethane and ethene gases are bubbled separately through bromine water. **2**

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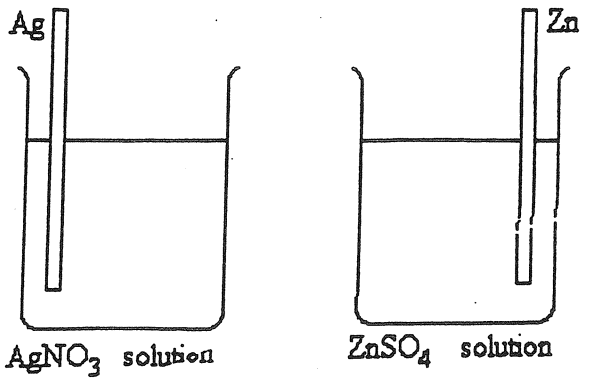
Question 17 (5 marks) **Marks**

Two beakers are set up as follows:



(a) One the diagram include additional components needed to obtain an electric current from this arrangement. **1**

(b) Label on the diagram:- **2**

(i) the cathode and anode
(ii) the direction of electron movement

(c) Construct the equation for the cell reaction **1**

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(d) Determine the cell voltage under standard conditions. **1**

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STUDENT NUMBER/NAME: .....

Question 18 (4 marks) **Marks**

Cellulose is a naturally occurring *condensation polymer* that makes up a major proportion of biomass. Its structure is represented below.

$$-O-C_6H_{10}O_4-O-C_6H_{10}O_4-O-C_6H_{10}O_4-O-C_6H_{10}O_4-O-C_6H_{10}O_4-O-$$

(a) Identify the monomer from which cellulose forms. **1**

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(b) Explain what is meant by the term *condensation.* **1**

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(c) Using an example to illustrate your answer, explain how the formation of an *addition polymer* is different to the formation of a condensation polymer. **2**

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Question 19 (3 marks) Marks

A student designed an experiment to investigate the displacement of metals from solution. She placed an iron nail into one test tube containing some dilute copper sulfate solution and a piece of copper wire into a separate test tube containing some dilute iron (II) sulfate solution. Her observations are recorded in the table below.

test tube	metal	solution	Observations
1	iron	copper sulfate	A red/brown deposit appeared on the nail. The blue colour of the solution faded.
2	copper	iron (II) sulfate	No changes were observed.

(a) Write an ionic equation for the reaction occurring in test tube 1. 1

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(b) Referring to the Table of Standard Potentials explain the recorded observations. 2

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Question 20 (4 marks)

During your practical work you performed a first-hand investigation to carry out the fermentation of glucose.

(a) With the aid of a relevant equation, explain any changes in mass observed during this fermentation process. 2

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(b) Justify the conditions under which this fermentation was carried out. 2

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STUDENT NUMBER/NAME: .....

Question 21 (5 marks) **Marks**

Low sulfur diesel fuels used in coal mining must have a sulfur content of less than 0.05% sulfur by mass.

(a) Calculate the volume of sulfur dioxide at 25°C and 100 kPa produced by burning 1.0 kg of low (0.05%) sulfur diesel. **2**

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(b) Discuss the impact on the environment of using high sulfur fuels. **3**

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STUDENT NUMBER/NAME: .....

Question 22 (4 marks) **Marks**

The phosphate buffer system operates in the internal fluid of all cells. This buffer system is represented by the chemical equation below:

$$H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$$

(a) Define the term 'buffer' and identify the key components of any buffer system. 2

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(b) Using relevant equations explain what happens if: 2

(i) H^+ ions are added to this system.

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(ii) OH^- ions are added to this system.

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STUDENT NUMBER/NAME: .....

Question 23 (5 marks) **Marks**

A student used indicator paper to estimate the pH of three different acids, to the nearest integer value. Each acid was at a concentration of 0.10 mol L^{-1} in aqueous solution. The table below records these measurements:

Acid	pH
acetic	3
citric	2
hydrochloric	1

(a) Compare the hydrogen ion concentrations in these three solutions. 2

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(b) Account for the differences in these values. 3

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STUDENT NUMBER/NAME: .....

Question 24 (6 marks) **Marks**

A bottle of vinegar is labelled *4.0% w/v* (4.0 g per 100 mL of solution) acetic acid (ethanoic acid).

(a) Describe the laboratory procedure you would use to verify this concentration. 3

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(b) Calculate the volume of 0.118 mol L^{-1} NaOH required to neutralise the acid in 5.0 mL of this vinegar. 3

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STUDENT NUMBER/NAME: .....

Question 25 (6 marks) Marks

(a) Identify the steps you followed in performing a first hand investigation to measure the sulfate content of lawn fertiliser. 3

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(b) Describe how you calculated the percentage of sulfate in the fertiliser including relevant equations in your answer. 3

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Question 26 (2 marks)

(a) Identify ONE factor that can affect water quality. 1

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(b) Describe how this factor will affect the quality of water in a freshwater lake. 1

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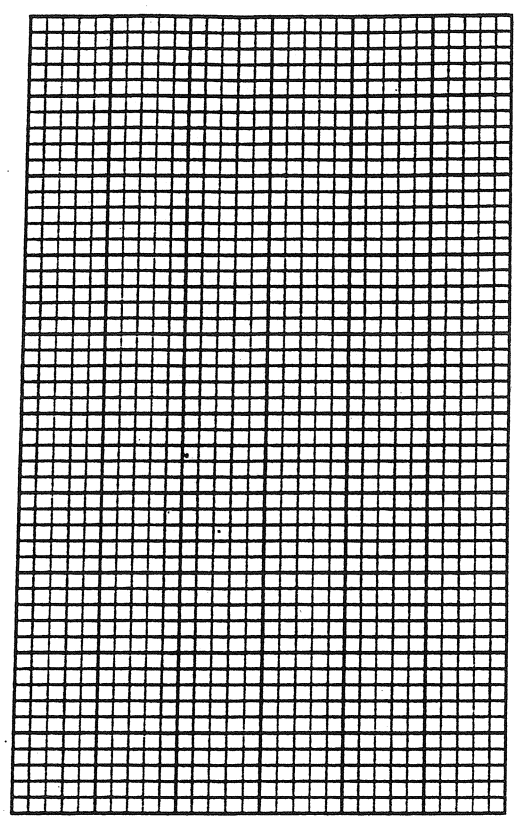
Question 27 (4 marks) **Marks**

A sample of river water was analysed for nickel using Atomic Absorption Spectroscopy (AAS).
A 25mL sample was diluted to 250mL with distilled water, and measured with the AAS instrument. An average absorbance reading of 0.350 was obtained, for the diluted sample. The results for a set of nickel standards is included in the table below.

Standard nickel concentration $g.mL^{-1}$	Absorbance
2.0×10^{-6}	0.134
4.0×10^{-6}	0.272
6.0×10^{-6}	0.416

(a) Construct a calibration graph for the standard nickel solutions. **2**



(b) Using the graph, determine the concentration of nickel in the original sample of river water. **2**

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Question 28 (3 marks) **Marks**

When ammonia reacts with hydrochloric acid, the ammonium ion is formed.

(a) Draw an electron dot formula for the ammonium ion. 1

(b) Explain the term "coordinate covalent bond" using this example. 2

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STUDENT NUMBER/NAME: .....

Question 29 (5 marks)

The table below shows the percentage yield of ammonia using the Haber process at a pressure of 30 MPa.

Temperature (Kelvin)	Percentage yield of ammonia
200	94
300	66
400	44
500	22
600	9

(a) Use the table values to predict whether the production of ammonia is endothermic or exothermic. Justify your answer. **2**

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(b) Predict how an increase in temperature would affect the rate of production of ammonia. **1**

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(c) Identify and explain the effect of increased pressure on the production of ammonia. **2**

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End of Section I

STUDENT NUMBER/NAME: .....

Section II

Total marks (25)

Attempt ONE question from Questions 30 – 34
Allow about 45 minutes for this part

Answer the question in a separate writing booklet. Extra writing booklets are available.

STUDENT NUMBER/NAME: .....

Question 30 – Industrial Chemistry (25 marks) **Marks**

(a) 0.100 mole of iodine, I_2, and 0.100 mole of I^- (in the form of KI) is added to water to make 1 L of solution. In this solution the following equilibrium is established at 25°C.

$$I_2 + I^- \Leftrightarrow I_3^-$$

(i) Write an expression for the equilibrium constant. 1

(ii) At equilibrium the solution contains 2.0×10^{-2} mole each of iodine and iodide ion, and 8.0×10^{-2} mole of the I_3^- ion. Calculate the value of the equilibrium constant for this reaction at 25°C. 2

(iii) Describe the effect on the equilibrium state and the value of the equilibrium constant, of adding some potassium iodide crystals. 2

(iv) If the solution is cooled in an ice bath the equilibrium constant decreases. What conclusion can be made concerning the energy of reaction? 1

(b) Predict and explain the different products of the electrolysis of molten sodium chloride and a concentrated solution of sodium chloride. 4

(c) During your course you performed a first hand investigation to carry out a chemical step involved in the Solvay process for the production of sodium carbonate. Describe the chemical step and the results obtained and relate them to the sequence of steps used in the commercial production of sodium carbonate. 4

(d) Describe the steps and chemistry involved in the commercial production of sulfuric acid. In your answer analyse the process to predict ways in which the output of sulfuric acid is maximised. 5

(e) Explain how the effect of hard water on the action of early soaps led to the development of new synthetic cleaning agents and associated environmental problems. 6

End of Question 30