Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS ASSOCIATION OF NEW SOUTH WALES

2001
TRIAL HIGHER SCHOOLCERTIFICATE EXAMINATION

Chemistry

Morning Session
Wednesday 15 August 2001

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using a blue or black pen
- Draw diagrams using pencil
- Use the Multiple Choice Answer Sheet provided
- Write your answers for Part B in the spaces provided
- Section II – write your answers in the Answer Book provided
- A Data Sheet and Periodic Table are provided separately

Section I Pages 3 – 19

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 – 28
- Allow about 1 hour 45 minutes for this part.

Section II Pages 21 – 31

Total marks (25)
- Attempt ONE question from Questions 29 – 33
- Allow about 45 minutes for this section

Catholic Trials 2001

Section I
Total marks (75)

Part A
Total marks (15)
Attempt Questions 1 – 15
Allow about 30 minutes for Part A

Use the Multiple Choice Answer Sheet provided.

1 When long chain hydrocarbons in crude oil are catalytically cracked to produce smaller molecules, the following reaction can occur:

$$C_{11}H_{24} \rightarrow C_9H_{20} + X$$

What is the name of molecule X?

(A) ethane
(B) propane
(C) ethene
(D) propene

2 A certain liquid hydrocarbon decolorizes bromine water quickly in the dark. Which of the following could have been this hydrocarbon?

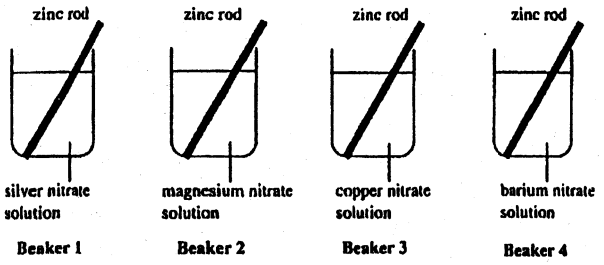
(A) cyclohexene
(B) hexane
(C) 1-propanol
(D) octane

3 In an experiment in a particle accelerator with the isotope sodium–24, a neutron is captured by the Na–24 nucleus, forming a new isotope of sodium. This new isotope decays by alpha-particle emission, producing a daughter nucleus.

The daughter nucleus is:

(A) aluminium–28
(B) fluorine–20
(C) neon–20
(D) fluorine–21

4 A zinc rod is placed in four different solutions, as shown in the diagrams below.



You would notice a displacement reaction in beakers

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

5 Ethanol is widely used as a solvent in cosmetics, food flavorings and medicines. What possible intermolecular forces can ethanol exert on other molecules?

(A) covalent bonds, dispersion forces
(B) dipole/dipole interactions, dispersion forces
(C) covalent bonds, hydrogen bonds, dispersion forces
(D) dispersion forces, dipole/dipole interactions, hydrogen bonds

6 Naturally colored compounds which occur in some flowers can be used as a test for

(A) the presence of electrolytes in soil
(B) chemical indicators in soil
(C) the acidity and basicity of soil
(D) the color range of compounds in soil

7 Sulphur dioxide is a toxic, colorless, non-flammable gas. It can be detected in air by its pungent odor. Sulphur dioxide can be formed by reacting

(A) water and sulphuric acid
(B) acetic acid and sulphuric acid
(C) sodium sulphite and oxygen
(D) copper sulphide and oxygen

8 Lavoisier, in 1780, thought that acids contained oxygen (among other things). Which of these acids shows this idea is false?

(A) nitric acid
(B) hydrochloric acid
(C) sulphuric acid
(D) phosphoric acid

9 Which one of the following species can be amphiprotic in water?

(A) HCO_3^-
(B) HCl
(C) NH_3
(D) PO_4^{3-}

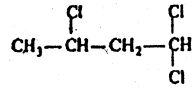
10 The pH of four acids of the same concentration is shown in this table:

ACID	CONCENTRATION (mol L^{-1})	pH
W	0.1	5.1
X	0.1	2.9
Y	0.1	2.1
Z	0.1	1.0

The acid with the greatest degree of ionisation is

(A) *W*
(B) *X*
(C) *Y*
(D) *Z*

11 A compound has the structural formula



Its systematic name is

(A) trichlorobutane
(B) 1,3-trichlorobutane
(C) 2,4,4-trichlorobutane
(D) 1,1,3-trichlorobutane

12 Which method would best remove the turbidity in water for human consumption?

(A) filtration
(B) treatment with a flocculating agent, followed by filtration
(C) treatment with chlorine, followed by filtration
(D) treatment with a water softener, followed by filtration

13 Which one of the following, if present in water in high concentration, would *NOT* be classed as "heavy metal pollution"?

(A) sodium ion
(B) mercury ion
(C) lead ion
(D) copper ion

14 A chemist has a solution containing 180 ppm of phosphate ions. He takes 10 mL of this solution, and adds 90 mL of distilled water to it. The phosphate ion concentration in this 100 mL solution is

(A) 18 ppm
(B) 20 ppm
(C) 160 ppm
(D) 200 ppm

15 The pH of water solutions of oxygen gas (O_2) and oxide ion (O^{2-}) are compared. Which line in the table below gives the correct comparison?

	O_2 DISSOLVED IN WATER	O^{2-} DISSOLVED IN WATER
(A)	pH < 7	pH < 7
(B)	pH = 7	pH > 7
(C)	pH > 7	pH > 7
(D)	pH = 7	pH = 7

Section I
Part B

Total marks (60)
Attempt Questions 16 – 28
Allow about 1 hour and 45 minutes for Part B

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (3 marks) **Marks**

Alkenes, and their derivatives, are important substances in the production of addition polymers. Polystyrene is an *addition polymer*.

(a) (i) Draw the structural formula of the monomer from which polystyrene is formed. 1

(ii) Give the systematic name of this monomer. 1

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(b) Explain the meaning of the term *addition polymer*. 1

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Question 17 (3 marks) **Marks**

Cellulose may be used in the future as the raw material for what we now call *petrochemicals*.

(a) Give one reason why we need alternative sources for the compounds presently obtained from the petrochemical industry. 1

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(b) Why would cellulose be a good raw material to build petrochemicals? 1

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(c) Cellulose is a *condensation polymer* of glucose. Explain the meaning of the term *condensation polymer*. 1

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Question 18 (3 marks) **Marks**

Ethanol has been suggested as an alternative to petrol as a fuel.

(a) (i) Ethanol can be made industrially by the fermentation of glucose. What is the other product obtained from the fermentation of glucose? 1

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(ii) Another method of making ethanol industrially is by reaction of ethene with water. Name the catalyst used in this industrial process. 1

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(b) Give one advantage, *OR* one disadvantage, of using ethanol as an alternative fuel. 1

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Question 19 (7 marks)

A student wished to find the heat of combustion of ethanol, C_2H_5OH.

He used a spirit burner (containing ethanol) to heat 250 g of water in a beaker. The water temperature rose from 15°C to 31°C. During this combustion, the burner lost 0.90 g in mass, due to ethanol burning.

(a) Calculate the heat of combustion of ethanol, in kJ mol^{-1}. 6

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(b) A databook gives the heat of combustion as -1360 kJ mol^{-1}. Give one reason to account for the discrepancy between this value and the one you calculated in (a). 1

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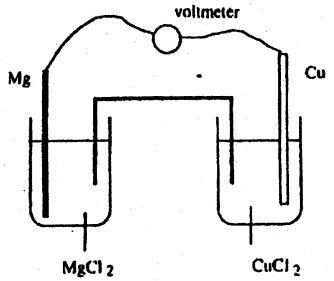
Marks

Question 20 (4 marks)

The diagram shows an electrochemical cell. The concentrations of the two solutions are 1 mol L^{-1}.



(a) Apart from a reading on the meter, give one observation you could make that would show a reaction is taking place. 1

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(b) Calculate the reading on the voltmeter under standard conditions. 3

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Question 21 (3 marks) **Marks**

(a) Name the ester formed between the reaction of ethanol and propanoic acid. 1

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(b) If you carry out this reaction in the laboratory, you will have to heat the reaction mixture to speed up the reaction. This heating is best done under reflux. Give *TWO* reasons why refluxing the reaction mixture is good technique. 2

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Question 22 (7 marks) **Marks**

This table gives the solubility of carbon dioxide in water at various temperatures.

TEMPERATURE/°C	SOLUBILITY/g of CO_2 per 100 g of water
0	0.33
10	0.23
20	0.17
30	0.13
40	0.097

(a) Describe the trend in the solubility of carbon dioxide with change in temperature. 1

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(b) The dissolving of carbon dioxide in water involves an equilibrium process. Write a balanced equation for a reversible reaction of carbon dioxide with water. 2

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(c) One test for carbon dioxide is to bubble the gas through a solution of calcium hydroxide, when a white precipitate of calcium carbonate is formed. 4

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

Calculate the volume of carbon dioxide gas, measured at 25°C and 101.3 kPa, needed to produce 0.50 g of calcium carbonate by the reaction.

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Question 23 (4 marks) **Marks**

Ammonia is a weak base in water solution. It reacts with water according to the equation

$$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

(a) (i) Why is ammonia classed as a *base* in this reaction? 1

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(ii) Why is ammonia classed as a *weak* base in this reaction? 1

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(b) What is the hydrogen ion concentration (mol L^{-1}) in a solution of pH 8.50? 1

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(c) Give the formula of the conjugate acid of the hydroxide ion, OH^-. 1

H_2O

Question 24 (6 marks) **Marks**

In a titration, a student finds that 30.0 mL of a 0.300 mol L^{-1} sulphuric acid solution is needed to react with 25.0 mL of a sodium hydroxide solution.

The equation for the titration reaction is

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(a) Calculate the concentration of the sodium hydroxide solution, in mol L^{-1}. 3

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(b) Describe the correct technique for conducting titrations. 3

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Question 25 (5 marks) **Marks**

This is a description of a test to identify the presence of chloride ions (Cl^-) in a water sample—

- acidify the sample with dilute nitric acid
- add a solution of silver nitrate ($AgNO_3$), when the appearance of a white precipitate shows the presence of Cl^-.

(a) The white precipitate is silver chloride, AgCl. Write a balanced equation for its formation in this test. Include states in your equation. 2

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(b) The dilute nitric acid is added to remove carbonate ions from the water. This is necessary because white silver carbonate may precipitate when silver nitrate is added. How does the nitric acid remove carbonate ions from the water? 1

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(c) Select either an anion or a cation from the list below. Describe a chemical test that would identify the ion you selected. 2

ANIONS	CATIONS
carbonate	barium
sulphate	lead

Cation or anion selected .....

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Question 26 (8 marks) **Marks**

The equation below shows the synthesis of ammonia from its elements. ΔH for the reaction is also given, showing that the forward reaction is exothermic—

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ mol}^{-1}$$

The Haber process uses this reaction, carried out in the presence of a catalyst, at a moderate temperature and high pressure.

(a) Identify ONE industrial use for ammonia. 1

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(b) Identify a catalyst used in the Haber process. 1

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(c) (i) Cooler reaction temperatures will increase the yield of ammonia. Explain. 1

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(ii) Cooler reaction temperatures will slow down the formation of ammonia. Explain. 1

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Question 26 continued on page 18

Question 26 (continued) Marks

(d) Analyse the impact of increased pressure on the reaction system above. 4

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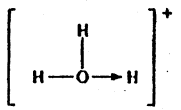
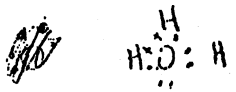
Question 27 (2 marks)

The H_3O^+ ion contains a coordinate covalent bond. The structural formula of the ion can be written like this—



Using dots (•) to represent electrons from oxygen, and crosses (×) to represent electrons from hydrogen, draw the Lewis diagram of the H_3O^+ ion. 2



Question 28 (5 marks) Marks

Ozone (O_3) and oxygen (O_2) are allotropes of the element oxygen. Ozone is present in the upper atmosphere where it acts as a "shield" to incoming ultraviolet radiation.

(a) (i) Chlorofluorocarbons (CFCs) can lower the concentration of ozone in the upper atmosphere. Name the element present in CFCs that is directly responsible for the destruction of ozone molecules in the upper atmosphere. 1

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(ii) Identify one source of CFCs in the upper atmosphere. 1

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(iii) The CFC "Freon–12" is dichlorodifluoromethane. Draw the structural formula of this compound. 1

(b) The table below shows some properties of oxygen and ozone. 2

	Density of liquid/g mL^{-1}	Melting Point/°C	Boiling Point/°C
Oxygen, O_2	1.15	-219	-183
Ozone, O_3	1.61	-193	-111

Select one of these properties. Account for the difference in this property between O_2 and O_3 in terms of their molecular structure and/or bonding.

Property selected.....

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