

SYDNEY BOYS HIGH SCHOOL

HIGHER SCHOOL CERTIFICATE

TRIAL EXAMINATION

2001

CHEMISTRY

2 UNIT

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 a Periodic Table are provided at the back of this paper
- Write your name on each page
- Show all working where necessary
- This is a school -based assessment

Section 1

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 16-27
- Allow about 1 hour and 45 minutes for this part

Section II

Total marks (25)

- Attempt option Question 28
- Allow about 45 minutes for this section



TEACHER: _____ NAME: _____



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ANSWER BOOKLET

PART A: Multiple Choice grid

*** Put a cross in the correct box**

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

Section I
Total marks (75)

Part A

Total marks (15)

Attempt Questions 1 – 15

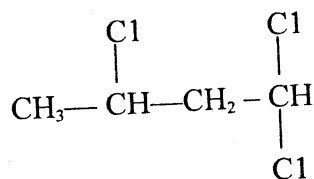
Allow about 30 minutes for Part A

Use the Multiple Choice Answer Sheet provided.

1. Which method would best remove the turbidity in water for human consumption?
 - (a) filtration
 - (b) treatment with a water softener, followed by filtration
 - (c) treatment with chlorine, followed by filtration
 - (d) treatment with a flocculation agent, followed by filtration

2. 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-21
 - (c) neon-20
 - (d) fluorine-20

3. A compound has the structural formula



Its systematic name is

- (a) 1,1,3-trichlorobutane
 - (b) 1,3-trichlorobutane
 - (c) 2,4,4-trichlorobutane
 - (d) trichlorobutane

4. Sulfur dioxide is a toxic, colorless, non-flammable gas. It can be detected in air by its pungent odor. Sulfur dioxide can be formed by reacting
 - (a) water and sulfuric acid
 - (b) acetic acid and sulfuric acid
 - (c) copper sulfide and oxygen
 - (d) sodium sulfite and oxygen

5. When preparing to perform an acid-base volumetric analysis by titration, a student carefully rinsed her burette, pipette and reaction flask with distilled water several times. Which apparatus could now be used without either rinsing with a specific reagent or drying completely?
- (a) Burette
 - (b) Reaction flask
 - (c) Pipette
 - (d) All three pieces
6. The conjugate acid of HS^- is:
- (a) H_2S
 - (b) H_2SO_4
 - (c) S
 - (d) S^{2-}
7. A certain liquid hydrocarbon decolorizes bromine water quickly in the dark. Which of the following could have been this hydrocarbon?
- (a) hexane
 - (b) cyclohexene
 - (c) 1-propanol
 - (d) octane
8. Biological Oxygen Demand is:
- (a) a measure of the number of aerobic organisms in a sample of water
 - (b) a measure of organic wastes that can be broken down by organisms in a body of water
 - (c) a measure of inorganic wastes that can be broken down by anaerobic organisms
 - (d) the quantity of oxygen needed to respire organic wastes in a body of water
9. Which group of oxides listed below would all turn moist blue litmus pink?
- (a) CuO , MgO , CaO
 - (b) CO , CO_2 , SO_3
 - (c) CO_2 , SO_3 , NO_2
 - (d) Na_2O , Al_2O_3 , CO
10. What is the pH of a solution with a hydroxide ion concentration of $7.2 \times 10^{-9} \text{ mol L}^{-1}$?
- (a) 8.14
 - (b) 9.14
 - (c) 5.86
 - (d) 4.86

11. In the chemical reaction used in police random breath testing units, the orange dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$) is reduced to chromium (III) (Cr^{3+}). Which statement describes what happens on the atomic scale?

(a) The chromium atoms gain electrons
(b) The oxygen atoms gain electrons
(c) The oxygen atoms lose electrons
(d) The chromium atoms lose electrons

12. The heat of combustion for four alkanols, in kJ mol^{-1} , is:

Methanol : 715

Ethanol : 1371

1-propanol : 2010

2-butanol : 2673

The alkanol (above) which produces the greatest amount of heat in kJ/g is:

(a) methanol
(b) ethanol
(c) 1-propanol
(d) 2-butanol

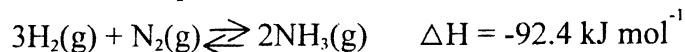
13. A student constructed a galvanic cell using two different metals in electrolytes of the nitrate of the metals (1 mol L^{-1} solution). The combination of metals which would give the greatest potential difference is:

(a) magnesium and zinc
(b) zinc and nickel
(c) manganese and silver
(d) nickel and silver

14. Which of the molecular formulae shown below would represent the greatest number of different compounds?

(a) $\text{C}_5\text{H}_{10}\text{Cl}_2$
(b) $\text{C}_4\text{H}_8\text{Cl}_2$
(c) $\text{C}_5\text{H}_{11}\text{Cl}$
(d) $\text{C}_4\text{H}_9\text{Cl}$

15. The synthesis of ammonia is represented by the following equation.



In the industrial production of ammonia, the process is carried out at a pressure of 600-1000 atmospheres and at a temperature of 750 K using an iron-based catalyst. Why is a temperature of 750 K used rather than a lower temperature?

(a) This will change the equilibrium constant to increase the yield of ammonia
(b) This economically uses the heat produced in the compression stage of the process
(c) This temperature is necessary to prevent condensation of the gases
(d) This temperature increases the rate at which the reaction occurs

TEACHER: _____ NAME: _____

Section I

Part B

Total marks (60)

Attempt Questions 16 – 27

Allow about 1 hour and 45 minutes for Part B

Part B is divided into three sections. Answer the questions in the spaces provided. Show all relevant working in questions involving calculations.

Part B1 –Section I - (Q16 to Q19)

16. Vinyl chloride is a significant monomer used in the production of polymers.

- (a) Give the common AND systemic name for the polymer made from vinyl chloride. (2 marks)

- (b) Draw the structure of this polymer (1 mark)

- (c) State ONE use of this polymer and a property which makes it useful for this purpose. (2 marks)

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

Question 16 continued on page 7

TEACHER: _____ NAME: _____

Question 16 (continued)

- (e) Cellulose may be used in the future as the raw material for what we now call *petrochemicals*. Why would cellulose be a good raw material to build petrochemicals? (1 mark)

17. (a) Describe the method which you would use to determine the total dissolved solids content of a sample of water taken from a local lake. Mention any precautions that you would need to take. (2 marks)

- (b) Water supplies in many areas are described as 'hard'. Identify the ions that cause hardness. What are two major effects of hardness in any of the following water supplies: agriculture, industry and households? (3 marks)

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18. During your chemistry course you compared and evaluated the use of a mercury cell to a dry cell or lead/acid battery. Evaluate the use of a mercury cell in comparison to either a dry cell or a lead/acid battery. (3 marks)

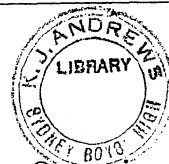
19. Ethanol has been suggested as an alternative to petrol as a fuel.

(a) i. Ethanol can be made industrially by the fermentation of glucose. Write a balanced chemical equation for the fermentation of glucose. (1 mark)

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

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



**Part B2 - Section I - (Q20 to Q23)**

20. 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 mark)

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

- iii The CFC “Freon-12” is dichlorodifluoromethane. Draw the structural formula of this compound. (1 mark)

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

	Density of Liquid/ $g\ mL^{-1}$	Melting Point/ $^{\circ}C$	Boiling Point/ $^{\circ}C$
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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Question 20 (continued)

21. In February the Richmond River in northern NSW experienced its most extensive fish kill recorded to date. NSW fisheries sampling data are shown in the table below.

Table 1: Water quality parameters recorded during the survey conducted along the lower Richmond River on 9 February (records taken at approx. 0.3 m depth)

Site	Dissolved O ₂ (mg/L)	pH	Conductivity (ms/cm)	Turbidity (NTU)	Temp. (°C)
Dungarubba	0.07	6.4	0.010	24	26.3
Broadwater	0.06	6.4	0.090	25	25.9
Laws Pt	0.01	6.4	0.090	29	25.9
Goat Is.	0.40	6.2	0.114	25	25.4
Wardell	0.08	6.3	0.114	32	25.2
Pimlico	0.03	6.4	0.125	32	26.4

A Fisheries spokesperson suggested that the fish kill was caused by low oxygen levels in the water.

- (a) Identify an additional item of information you need to assess the correctness of this statement. (1 mark)

- (b) Suggest a reason for the water being sampled at a depth of 0.3 m. (1 mark)

- (c) Explain why a low level of dissolved oxygen might be linked to: (i) water turbidity, (ii) water temperature. (2 marks)

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22. (a) Compare the relative strengths of equal concentrations of citric, acetic and hydrochloric acids. (2 marks)

- (b) Relate the strengths of the three acids to the degree of ionisation of their molecules. (2 marks)

- (c) Explain these differences in terms which would have been understood by Arrhenius, Lavoisier and Davy. (3 marks)

TEACHER: _____ NAME: _____

23. A student determined the concentration of acetic acid (ethanoic acid) in some white vinegar by titrating a sample of the vinegar that had been diluted, accurately, by a factor of 5. A standardised $0.0750 \text{ mol L}^{-1}$ sodium hydroxide solution was used for the titration. The student's results are shown below.

Volume of diluted vinegar = 25.0 mL	
Volume of standardised sodium hydroxide solution (mL):	
1 st titration	24.2
2 nd titration	23.5
3 rd titration	23.7
4 th titration	23.6

- (a) Name the vessel in which the vinegar solution could be diluted accurately. (1 mark)

- (b) The following indicators were available for the student to use.

Indicator	Colour Change	pH range
Methyl orange	Red-yellow	3.1 – 4.4
Bromocresol green	Yellow-blue	3.8 – 5.4
Bromothymol blue	Yellow-blue	6.2 – 7.6
Phenolphthalein	Colourless-red	8.3 – 10.0

Which of these indicators would be best for this titration? Explain why. (2 marks)

- (c) Calculate the concentration (in mol L^{-1}) of acetic acid (ethanoic acid) in the undiluted vinegar. (3 marks)



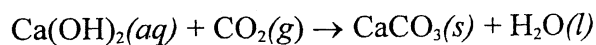
TEACHER: _____ NAME: _____



Part B3 - Section I - (Q24 to Q27)

24. (a) Describe a chemical test used to identify the carbonate anion. (1 mark)

- (b) 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.



Calculate the volume of carbon dioxide gas, measured at 25°C and 101.3 kPa, needed to produce 0.80g of calcium carbonate by the reaction. (2 marks)

25. Nuclear reactors, such as the ANSTO reactor at Lucas Heights, produce radioisotopes for use in medicine or industry.

- (a) Name a radioisotope with either a medical or industrial application. (1 mark)

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Question 25 (Continued)

- (b) Describe its use and relate this to the chemical properties of the radioisotope. (2 marks).

- (c) Describe how it is produced in a nuclear reactor. (1 mark)

26. (a) Using structural formulae, write a balanced equation for the reaction between ethanol and butanoic acid. (1 mark)

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Question 26 (continued)

- (b) During your practical investigation you prepared an ester using reflux. Identify the apparatus used to heat the reaction mixture safely. Explain two reasons for refluxing. Describe two purposes for using concentrated sulfuric acid in the reaction mixture. (6 marks)

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Question 27 on page 16

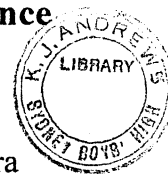
27. Describe the use of atomic absorption spectroscopy (AAS), in detecting concentrations of metal ions in solutions and assess its impact on scientific understanding of the effects of trace elements. (6 marks)

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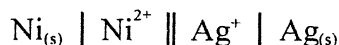
Section II - (Q28) This sheet should be REMOVED for your convenience

Attempt ONE question – Option Question 28

Allow about 45 minutes for this section. Answer the question in a writing booklet. Extra writing booklets are available. Show all relevant working in questions involving calculations.

28. Shipwrecks and Salvage. (25 marks)

- (a) Often when describing a galvanic cell a useful shorthand notation is used. This question refers to the galvanic cell:



- i. An external voltage can be used to reverse the cell reaction, making an electrolytic cell. State Faraday's First Law as it applies to this cell. (1 mark)
 - ii. Calculate the minimum voltage which must be applied to electrolyse this cell, under standard conditions. (1 mark)
 - iii. Describe THREE factors that affect the rate of this electrolysis reaction. (3 marks)
- (b) Steel is the main structural material for bridges, cars and buildings. The controlling of its corrosion is extremely important. Describe the conditions under which rusting occurs and explain the process of rusting, using diagrams and chemical equations. (4 marks)
- (c) A 0.5M potassium bromide solution is electrolysed with two graphite electrodes. Describe the observations that would be made and relate these to the half-reactions that occur. State what would happen to red and blue litmus paper if placed at the cathodic surface. Describe the observations made when the electrolysis involves a 0.5M copper sulfate solution. (7 marks)
- (d) The ship RMS Titanic sank on its first voyage across the Atlantic Ocean in 1912. In 1985, deep-sea researcher, Bob Ballard was able to use deep-sea submersibles to locate, explore and photograph the wreck lying on the ocean floor in 3810 metres of water.
- i. The environmental conditions at the wreck of the RMS Titanic have been described as "extremely cold, totally dark with tremendous pressures due to the depth of the water". Predict how these conditions would affect the rate of corrosion of this shipwreck's steel hull. (2 marks)
 - ii. Explain how bacterial activity contributes to corrosion at great depth. (2 marks).
 - iii. A small wooden trinket box was obtained from the Titanic site. State and explain a conservation method that could be applied to the wooden box. (3 marks).
- (e) Luigi Galvani first generated an electric current by using two different metal wires placed separately on a freshly extracted frog muscle. List two chemical conditions which enabled the generation of the electric current. (2 marks).