

SYDNEY GRAMMAR SCHOOL



2001 HIGHER SCHOOL CERTIFICATE TRIAL EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your Class and Student Number in the boxes provided on pages 8 - 22

Collection Instructions

Hand in the following sections in 3 separate bundles

- Section I - Part A Answer sheet
- Section I - Part B Question and Answer Booklet
- Section II - Answer Booklet

Section I Pages 2 - 22

Total marks (91)

This section has two parts, Part A and Part B

Part A

Total marks (15)

- Attempt Questions 1 - 15
- Allow about 23 minutes for this Part

Part B

Total marks (76)

- Attempt Questions 16 - 30
- Allow about 112 minutes for this Part

Section II Pages 23 - 24

Total marks (30)

- Allow about 45 minutes for this Section

Section I
Total marks (91)

Part A
Total marks (15)
Attempt Questions 1-15
Allow about 23 minutes for this Part

Use the multiple-choice Answer Sheet.

Select the alternative A, B, C or D that best answers the question. Fill 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.

 (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 (C) (D)

1 Ethene is readily transformed into many useful products because of:

- (A) the high reactivity of its double bond.
- (B) its low boiling point.
- (C) its weak intermolecular forces.
- (D) its ability to be cracked into smaller molecules.

2 Many substances found in the household have common names which differ from those used in the laboratory. Three examples of household chemicals are:

baking soda, vitamin C, vinegar.

The correct chemical name for each (in order) is:

- (A) sodium bicarbonate, acetylsalicylic acid, hydrochloric acid.
- (B) sodium hydroxide, citric acid, acetic acid(aq).
- (C) sodium hydrogencarbonate, ascorbic acid, ethanoic acid(aq).
- (D) carbonic acid, 2-hydroxypropane-1,2,3-tricarboxylic acid, ethanedioic acid.

3 A systematic name for the following molecule is CYANOETHENE.



Its common name is:

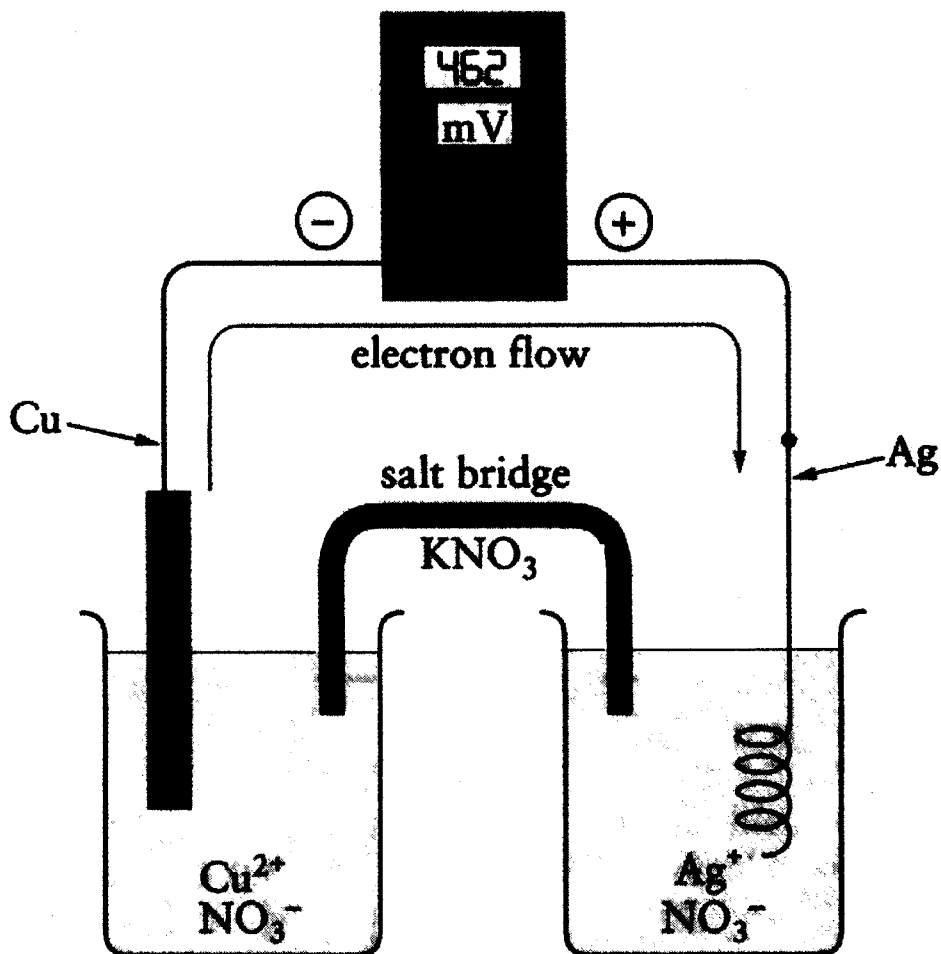
- (A) vinyl chloride.
- (B) styrene.
- (C) acrylonitrile.
- (D) PTFE.

4 In which of the following reactions does the first reactant act as a base?
(States have been omitted for clarity.)

- (A) $\text{H}_3\text{O}^+ + \text{S}^{2-} \rightleftharpoons \text{HS}^- + \text{H}_2\text{O}$
- (B) $\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{PO}_4^- + \text{OH}^-$
- (C) $2\text{NH}_3 + 2\text{Na} \rightleftharpoons 2\text{NaNH}_2 + \text{H}_2$
- (D) $2\text{CrO}_4^{2-} + 2\text{H}^+ \rightleftharpoons \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O}$

- 5 Scientific instrumentation used in chemical analysis is made to exploit one or more chemical principles. Which of the following lists an instrument with a correct principle upon which it relies?
- (A) AAS: electrons in anions emit characteristic wavelengths when allowed to relax after being excited by a flame.
 - (B) UV-visible spectrometer: chemical species in solution absorb characteristic wavelengths but the intensity of absorption is unrelated to concentration.
 - (C) AAS: atoms emit photons of light when nuclear transitions are allowed.
 - (D) UV-visible spectrometer: chemical species absorb UV-visible light if the energy of photons corresponds to that required for electronic transitions.
- 6 Cellulose is an example of a condensation polymer which is predominantly found in plant cell walls. It is known as a condensation polymer because:
- (A) the monomers are anhydrous.
 - (B) it absorbs water from the atmosphere.
 - (C) water is a by-product of this polymerisation process.
 - (D) water is a requirement of this polymerisation process.
- 7 The product of the dehydration of ethanol is:
- (A) ethane.
 - (B) ethyne.
 - (C) ethene.
 - (D) ethanoic acid.

- 8 Study the diagram of a simple galvanic cell shown below.



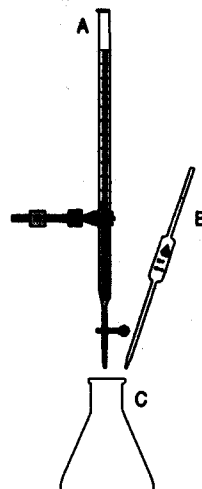
In this set up:

- (A) the copper electrode is the cathode.
 - (B) the silver electrode is the site of reduction.
 - (C) the Cu^{2+} ions are being oxidised.
 - (D) there is a net flow of positive charge from the right beaker to the left.
- 9 Biopolymer chemistry is a new and rapidly expanding field. It is envisaged that in the future many materials will be made from or contain biopolymers. Which of the following statements is true?
- (A) The majority of manufactured biopolymers are produced by the modification of cellulite.
 - (B) Biopolymers can only be produced by plants.
 - (C) The petrochemical industry is the main source of biopolymers.
 - (D) A major advantage of biopolymers is that they will degrade naturally.

- 10 When a strip of cleaned magnesium is added to a solution of copper sulfate a metal displacement reaction occurs. The magnesium seems to disappear and solid copper deposits at the bottom of the beaker. This occurs because:
- (A) the magnesium is more electronegative than the copper.
 - (B) the copper displaces the magnesium from solution.
 - (C) magnesium is more soluble than copper.
 - (D) the pull of the copper ions on electrons is greater than that of magnesium ions.

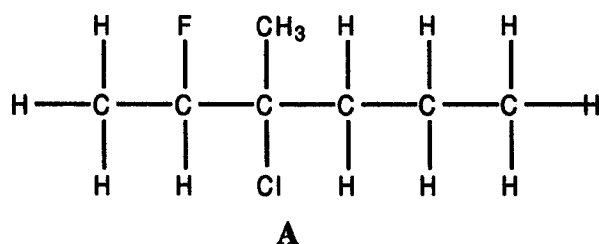
The following two questions refer to a titration of household ammonia solution with hydrochloric acid.

- 11 Before beginning the titration, which pieces of equipment shown in the diagram below (not using scientific code) should be rinsed with the appropriate reagent rather than water?



- (A) A and B only
 - (B) A and C only
 - (C) B and C only
 - (D) A, B and C
- 12 Which would be the best indicator to use for this titration?
- (A) bromophenol blue (pH 3.0 - 4.6)
 - (B) azolitmin (litmus) (pH 5.0 - 8.0)
 - (C) bromothymol blue (pH 6.0 - 7.6)
 - (D) phenolphthalein (pH 8.3 - 10.0)

- 13 Which of the following best describes the positive result of a standard qualitative determination of Cu^{2+} ions?
- (A) Addition of OH^- precipitates a blue solid which redissolves in $\text{NH}_3(\text{aq})$ to give a deep blue solution.
- (B) Addition of OH^- gives a green precipitate which quickly turns brown in air.
- (C) Addition of SCN^- gives a deep red solution.
- (D) Addition of SO_4^{2-} gives a white precipitate, but addition of F^- or OH^- does not.
- 14 Compound A, shown below, is a haloalkane. What is the correct name for A?



- (A) 3-methyl-3-chloro-2-fluorohexane
- (B) 2-fluoro-3-chloro-3-methylhexane
- (C) 3-chloro-2-fluoro-3-methylhexane
- (D) 3-chloro-3-methyl-2-fluorohexane
- 15 Data obtained from various combustion experiments is given in the table below.

Fuel	CH_3OH	$\text{C}_2\text{H}_5\text{OH}$	$\text{C}_3\text{H}_7\text{OH}$	$\text{C}_4\text{H}_9\text{OH}$
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
$\Delta T_{(\text{water})}$ ($^\circ\text{C}$)	+17.4	+18.9	+17.7	+21
$Q_{(\text{water})}$ (kJ)	+21.4	+23.7	+22.2	+26.3

According to this set of experimental data the heat of combustion of ethanol is:

- (A) 394 kJ/mol.
- (B) 595 kJ/mol.
- (C) 2487 kJ/mol.
- (D) 515 kJ/mol.

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Section I

Part B

Total marks (76)

Attempt Questions 16 - 30

Allow about 112 minutes for this Part

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations

Question 16 (3 marks)

Marks

(a) Name a radioisotope used in medicine.

1

(b) Describe the way in which this radioisotope is used and relate this to its properties.

2

Question 17 (3 marks)

Describe a chemical test you could use to distinguish between hexane and 1-hexene.

3

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Question 18 (4 marks)

Marks

- (a) Identify a substance which contributes to acid rain. Give both a natural and an industrial source of this substance. **1**

- (b) Explain the formation and effects of acid rain. **3**

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Question 19 (3 marks)

Marks

Three samples, P, Q and R, were tested by a pupil and the following results were obtained. The samples were collected from river water, sewage water, and sea water, but not necessarily in that order.

	Sample P	Sample Q	Sample R
pH	6.5	8.5	8.2
biological oxygen demand (ppm)	3.4	100	3.6
chloride ion concentration	low	low	high
microorganisms	low	high	low

- (a) Identify the source of samples P and Q. 2

Sample P: _____

Sample Q: _____

- (b) One test not conducted by the student was the test for water hardness. 1
Complete the following table which summarises this test.

Name of Technique used	Reagent used in the named technique

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Question 20 (4 marks)

Marks

Many chemical reactions require the use of a catalyst to improve energy efficiency. Describe the use of a catalyst to increase the efficiency of the Haber process, identifying the catalyst used.

4

Question 21 (3 marks)

Describe the production of ethene from petrochemical feedstocks.

3

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Question 22 (5 marks)

Marks

Discuss the methods used to purify and sanitise mass water supplies.

5

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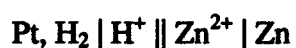
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Question 23 (9 marks)

Marks

The following galvanic cell was constructed using two half - cells under standard conditions.



- (a) Draw a labelled diagram of the galvanic cell. **3**

- (b) Calculate the theoretical voltage of this cell. **2**

- (c) Explain the purpose of the platinum electrode. **1**

Question 23 continued on page 14

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Question 23 (continued)

Marks

(d) Explain the purpose of the salt bridge.

1

(e) Electrolysis is used industrially to purify a number of metals and in electroplating. Name one metal commonly used in electroplating and explain in chemical terms why the process is used.

2

Question 24 (7 marks)

In your practical work this year you have quantitatively analysed a range of common household substances for particular cations and/or anions. Choose one such analysis and answer the following questions.

(a) What was the substance? For which ion were you testing?

1

Question 24 continued on page 15

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Question 24 (continued)

Marks

(b) Explain why it is important to monitor this cation or anion quantitatively.

1

(c) Describe the method you used in your quantitative analysis.

3

(d) Evaluate the reliability of your results.

2

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Question 25 (6 marks)

Marks

At the turn of the century (19th / 20th) Arrhenius established the existence of ions in solution, and this advance in scientific understanding was used by him to change the way chemists thought about acids and bases. Later Bronsted and Lowry independently suggested a new definition of acids and bases.

- (a) What was the Lowry-Bronsted definition? 2

- (b) What was one advantage of the new definition for scientific chemical thinking? 1

- (c) Name an example of an amphiprotic ion and explain using chemical equations what is meant by "amphiprotic". 3

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Question 26 (4 marks)

Marks

Biopolymers are the "plastics" of the future. Discuss.

4

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Question 27 (4 marks)

Marks

Is a Lewis acid / base reaction also a redox reaction? Discuss.

4

Question 28 (8 marks)

The atmosphere can be described as the layer of gases extending from the Earth's surface to an altitude of about 300 km. It consists of distinct layers defined by changes in the relationship between temperature and altitude.

(a) Ozone can be thought of as a pollutant or as a necessary component of the atmosphere. Discuss.

4

Question 28 continued on page 19

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Question 28 (continued)

Marks

- (b) Draw an electron dot diagram of oxygen gas and ozone, and explain why ozone (bp = $-111\text{ }^{\circ}\text{C}$) has a higher boiling point than O_2 (bp = $-183\text{ }^{\circ}\text{C}$).

4

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Question 29 (7 marks)

Marks

2.0 L of concentrated (10M) hydrochloric acid was spilled in a laboratory accident.

Three substances were considered for use to minimise the damage, solid sodium hydrogencarbonate, powdered limestone (calcium carbonate) and 2M sodium hydroxide solution.

- (a) Calculate the minimum mass of calcium carbonate needed to neutralise the acid. Show numerical working. **3**

- (b) Assess each of the three for use in the neutralisation of the spilt acid. **4**

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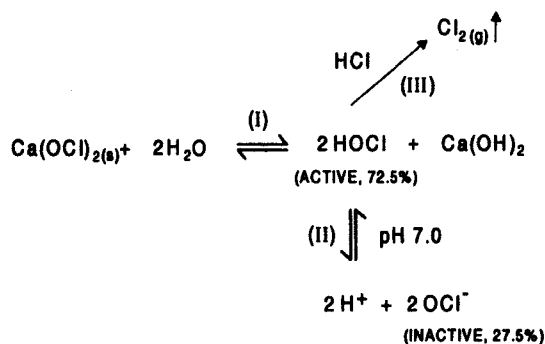
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Student Number

Question 30 (6 marks)

Marks

The use of chlorine as an algaecide in the sanitisation of swimming pools can be explained by the following chemical reactions.



Solid calcium hypochlorite reacts with water to produce hypochlorous acid which is the active constituent.

At a pH of 7.0, 27.5% of the acid ionises to give inactive hypochlorite ion. The remaining hypochlorous acid results in chlorine available for sanitisation.

- (a) What is meant by "pH of 7.0"? 1

- (b) Comment on the strength of hypochlorous acid. 2

Question 30 continued on page 22

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Student Number

Question 30 (continued)

Marks

- (c) Explain in terms of Le Chatelier's principle the effect of adding HCl on the solubility of calcium hypochlorite. **3**

Section II

Total marks (30)

Attempt ONE question from Questions 31 - 35

Allow about 45 minutes for this Part

Answer the question in a writing booklet. Extra writing booklets are available.
Show all relevant working in questions involving calculations.

	Pages
Question 31	Industrial Chemistry
Question 32	Shipwrecks and Salvage
Question 33	Biochemistry of Movement
Question 34	Chemistry of Art 24
Question 35	Forensic Chemistry

Question 34 - Chemistry of Art (30 marks)

- (a) (i) Cinnabar was used from earliest times by people to decorate themselves. What is the major reason why cinnabar poses a health risk as a cosmetic? 2
- (ii) What is paint? 3
- (iii) Name and give the chemical formula and colour of two pigments used in paints. 2
- (iv) Describe the use of a separation process in extracting a named pigment from its source. 2
- (b) The "New Year" fireworks are a spectacular annual display. Salts of strontium and barium are added to create various colours in such a display.
- (i) Describe an experiment that you could do in the laboratory to demonstrate the characteristic colours produced by strontium and barium ions. 4
- (ii) Discuss the theoretical background for the characteristic colours. 4
- (c) One characteristic of transition metals is their ability to form compounds with a variety of oxidation states. Copper, for example, can exist in the +1, +2, +3 and +4 states.
- (i) Write down the full (ground state) electron configuration, in terms of sub-shells (*s*, *p*, *d* notation), of a copper atom. 2
- (ii) Use this electron configuration to account for the existence of the two most common oxidation states of copper. 2
- (iii) Describe the experimental procedure that you used in your investigation to observe a colour change in a named transition metal as it changed in oxidation state. 4
- (iv) What is Hund's Rule? Illustrate your answer using an "orbital box" diagram showing the (ground state) configuration of the d-electrons of a Mn atom. 2
- (d) Explain the relationship between absorption and reflectance spectra. 3

End of Question 34