

2007 Senior External Examination

Chemistry



Paper One — Question and response book

Wednesday 24 October 2007

9:00 am to 11:40 am

Directions

- Perusal time: **10 minutes**.
Do not write in this book during perusal time.
- Working time: **2 hours 30 minutes**.
- Materials provided:
 - Multiple-choice response sheet
 - Paper One — Resource book.
- Equipment allowed:
 - 2B pencils and eraser (only for completing the multiple-choice response sheet and for graphing)
 - pens (blue or black ink)
 - ruler
 - normal writing implements
 - any hand-held, solar- or battery-operated non-programmable calculator
 - other QSA-approved equipment.
- Paper One has **two** parts:
 - Part A: Knowledge and simple application
Questions 1–10 Multiple choice
Questions 11–18 Short response
 - Part B: Scientific processes
Questions 1–4 Short response.Attempt **all** questions.

Do not take this book, used or unused, from the examination room. Do not tear out any part of this book. The supervisor will collect this book when you leave the examination room.

Notes

Suggested time allocation:

Part A: 1 hour 50 minutes

Part B: 40 minutes.

Assessment:

Paper One assesses the following criteria published in the 1998 senior external syllabus for Chemistry:

- Knowledge of subject matter
- Scientific processes.

Standards for assessment are at the end of this book.

Candidate use

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Number of books used

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Supervisor use only

Supervisor's initials

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Planning space

Part A — Knowledge and simple application

Part A assesses knowledge of subject matter and the simple application of that knowledge based on the eight topics in the 1998 senior external syllabus for Chemistry.

Part A is worth 70 marks.

Suggested time allocation: 1 hour 50 minutes.

Multiple choice

This part has 10 questions of equal value. Attempt all questions.

Each question contains four options, **one** of which is correct or is the best option. Respond to each question by selecting one of the four possible options and blackening the appropriate circle on the multiple-choice response sheet provided. Use a 2B pencil to blacken the circles.

No credit for your response will be given if more than one circle is blackened.

Question 1

Only one of the following contains no covalent bonds. Which one?

- A diamond
- B sodium chloride
- C polyvinyl chloride
- D copper (II) sulfate

Question 2

The shape of the molecule nitrogen trichloride, NCl_3 , is best described as

- A planar trigonal.
- B bent triatomic.
- C tetrahedral.
- D pyramidal.

Question 3

The mass of one molecule of ethane gas C_2H_6 would be

- A 30 g.
- B $\frac{30}{22.4}$ g.
- C $\frac{30}{6.02 \times 10^{23}}$ g.
- D $30 \times 6.02 \times 10^{23}$ g.

Question 4

Which of the following is **not** an oxidation-reduction reaction?

- A $\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)}$
- B $\text{Ag}^+_{(aq)} + \text{Cl}^-_{(aq)} \rightarrow \text{AgCl}_{(s)}$
- C $\text{Mg}_{(s)} + 2\text{H}^+_{(aq)} \rightarrow \text{Mg}^{2+}_{(aq)} + \text{H}_{2(g)}$
- D $\text{Cu}_{(s)} + 2\text{Ag}^+_{(aq)} \rightarrow \text{Cu}^{2+}_{(aq)} + 2\text{Ag}_{(s)}$

Question 5

Which compound is an unsaturated hydrocarbon?

- A C_3H_6
- B C_4H_{10}
- C C_5H_{12}
- D C_6H_{14}

Question 6

An element was classified as belonging to Group II of the Periodic Table. The element would be expected to

- A form diatomic molecules.
- B be a liquid at room temperature.
- C react with water to form an acid.
- D conduct electricity in the solid state.

Question 7

Which of the following reactions would be least useful in producing considerable quantities of hydrogen gas in the laboratory?

- A $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
- B $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$
- C $\text{Fe} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2$
- D $\text{Pb} + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + \text{H}_2$

Question 8

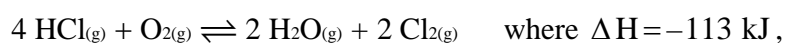
Many salts absorb energy from their surroundings when they dissolve in water. When they do so, the resulting solution becomes cold.

Why do these systems proceed spontaneously?

- A The higher entropy of the products drives the endothermic process.
- B The reaction is highly exothermic.
- C Energy is released in the process and so the system goes to a lower energy state.
- D The products achieve a lower entropy.

Question 9

For the reaction



the quantity of chlorine present at equilibrium could be increased by

- A adding a catalyst to the system.
- B increasing the total pressure of the system.
- C increasing the temperature of the system.
- D removing oxygen from the system.

Question 10

The mass of sodium chloride needed to make 100 mL of 4.0 M solution would be

- A 5.85 g.
- B 23.4 g.
- C 58.5 g.
- D 234.0 g.

Short response (60 marks)

Attempt all questions.

You must show all working.

Respond in the spaces provided.

Marks are shown for each question.

If you need more space for a response, you may continue on pages 20 and 21.
Make sure you label the page used with the question number that relates to your response.

Question 11

- (a) Naturally occurring copper was found to have 70% ${}^{63}_{29}\text{Cu}$ and 30% ${}^{65}_{29}\text{Cu}$. What would be the atomic mass of this sample?

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(3 marks)

- (b) An atom has in its nucleus 15 protons and 16 neutrons. What would be the electron configuration of the neutral atom of this element? Explain your reasoning.

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(2 marks)

- (c) Which element would you expect to have the higher first ionisation energy — sodium Na or chlorine Cl? Explain your reasoning.

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(2 marks)

- (d) Explain why potassium atoms readily form K^+ ions in chemical reactions, while chlorine atoms readily form Cl^- ions.

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(2 marks)

Question 12

- (a) What is the mass of one mole of hydrated sodium carbonate crystals, $Na_2CO_3 \cdot 10 H_2O$?

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(2 marks)

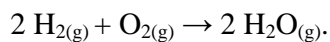
- (b) A compound was analysed and found to have the following composition by mass:
carbon 23.5%; hydrogen 1.9%; fluorine 74.5%.

What is the empirical formula of this compound?

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(3 marks)

(c) Hydrogen burns in oxygen to form water vapour:



If a mixture of 400 mL hydrogen and 400 mL oxygen is ignited, what would be the volume of the final product **and** what would be its composition? Assume all volumes are measured at 100°C and one atmosphere pressure.

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(3 marks)

(d) Explain the meaning of the term “molarity of a solution”.

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(2 marks)

Question 13

(a) A salt bridge is used in an electrical cell. Explain two purposes for the salt bridge.

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(3 marks)

(b) What are the oxidation numbers for the following named atoms:

(i) chlorine in NaClO_4

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(ii) phosphorus in H_3PO_4

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(iii) mercury in Hg_2Cl_2 ?

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(3 marks)

Question 14

(a) What is meant by the terms **saturated** and **unsaturated** as applied to hydrocarbons?

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(2 marks)

(b) Describe the reaction of a bromine solution on cyclohexene. Include the colour change, and an equation.

Description:

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Equation:

(2 marks)

(c) How can a large quantity of ethanol be prepared?

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(2 marks)

Question 15

(a) Name a group of elements for which the outermost energy level contains only *s* electrons.

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(1 mark)

(b) Name a period of elements for which the outermost energy level contains only *s* and *p* electrons.

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(1 mark)

(c) Name a period of elements for which the outermost energy level contains only *s*, *p* and *d* electrons.

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(1 mark)

(d) Name one example of an acidic oxide.

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(1 mark)

(e) What is meant by the term **amphoteric**?

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(1 mark)

Question 16

(a) List the major gases in the earth's atmosphere. Disregard pollutants.

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(2 marks)

(b) Explain why the presence of ozone in the upper atmosphere is important to humans.

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(1 mark)

(c) Explain how the amount of ozone in the atmosphere changes.

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(2 marks)

Question 17

(a) State the Law of Conservation of Energy.

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(1 mark)

(b) What is meant by the term **enthalpy**?

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(1 mark)

(c) What is meant by the term **entropy**?

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(1 mark)

(d) A reaction has a ΔH° value of -200 kJ mol^{-1} . Is the reaction exothermic or endothermic? Explain.

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(1 mark)

(e) Draw a labelled diagram to show how potential energy–reaction coordinate diagrams change when a catalyst is added to the reaction.

(2 marks)

(f) Give an example of a reaction where a negative catalyst (inhibitor) is used.

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(1 mark)

Question 18

(a) What is meant by a reversible chemical reaction?

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(1 mark)

(b) Describe the characteristics of a reaction which has reached equilibrium.

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(2 marks)

(c) Give examples of the following equilibrium systems. Include states.

(i) A phase change:

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(ii) Making a saturated solution:

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(iii) A precipitation reaction:

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(3 marks, 1 each)

(d) Name **one** of each:

(i) a strong electrolyte:

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(ii) a weak electrolyte:

.....

(iii) a non-electrolyte:

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(1½ marks, ½ each)

(e) For each of the following, name one material with the given pH value.

(i) pH = 1:

(ii) pH = 3:

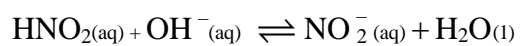
(iii) pH = 7:

(iv) pH = 10:

(v) pH = 13:

(2½ marks, ½ each)

- (f) Use the Lowry-Bronsted concept of acids and bases to label the conjugate pairs in the equation



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(2 marks)

End of Part A

Part B — Scientific processes

Part B assesses scientific processes based on the eight topics in the 1998 senior external syllabus for Chemistry and practical work undertaken during your study of the subject.

Attempt all questions. All questions are of equal value.

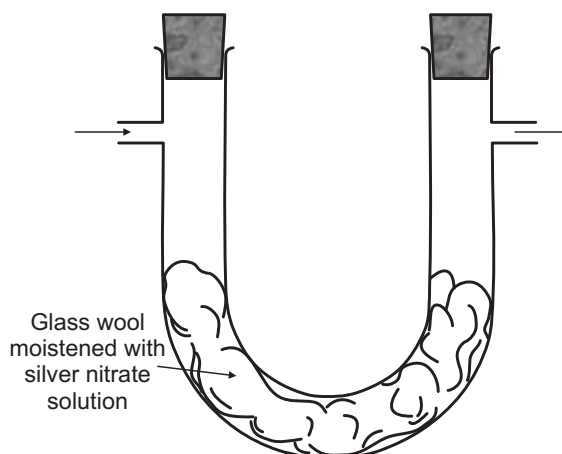
Your responses will be assessed using the assessment criteria listed at the end of each question.

Suggested time allocation: 40 minutes.

Short response

Question 1 — Purifying a gas mixture

A chemist has a sample of sulfur dioxide gas which contains traces of hydrogen chloride gas. In order to remove the traces of hydrogen chloride, the gases were passed through the apparatus drawn below.



Respond to the following questions:

- (a) Give a scientific explanation of how the hydrogen chloride is removed.

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(b) The silver nitrate solution was spread over the glass wool. What is the advantage of doing this?

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(c) Why is it an advantage to use a small volume of silver nitrate solution rather than a large volume of silver nitrate solution?

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ASSESSMENT CRITERIA

The candidate:

A	B	C	D	E
<ul style="list-style-type: none">• responds correctly to all three sections• fully explains the reasons for the responses.	<ul style="list-style-type: none">• responds correctly to all three sections but some incorrect or incomplete explanations <p style="text-align: center;">OR</p> <ul style="list-style-type: none">• responds correctly to two of the three sections, and• fully explains reasons for the responses.	<ul style="list-style-type: none">• responds correctly to one or two of the three sections• explains the reasoning with some success.	<ul style="list-style-type: none">• responds correctly to one section• attempts a reasoned explanation without success.	<ul style="list-style-type: none">• makes little or no attempt at the question with no success.

Question 2 — Volumetric experiment

A student was asked to determine the concentration of a quantity of hydrochloric acid solution.

In the first instance, a quantity of sodium hydroxide solution was available, and it was labelled as 0.100 M.

- (a) Describe briefly the procedure whereby the student could determine the concentration of the hydrochloric acid solution using the available sodium hydroxide. Clearly list the steps in order and number them.

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- (b) What are the main possible errors that could affect the determination of the concentration?

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(c) How could the student check that the sodium hydroxide was indeed 0.100 M as claimed?

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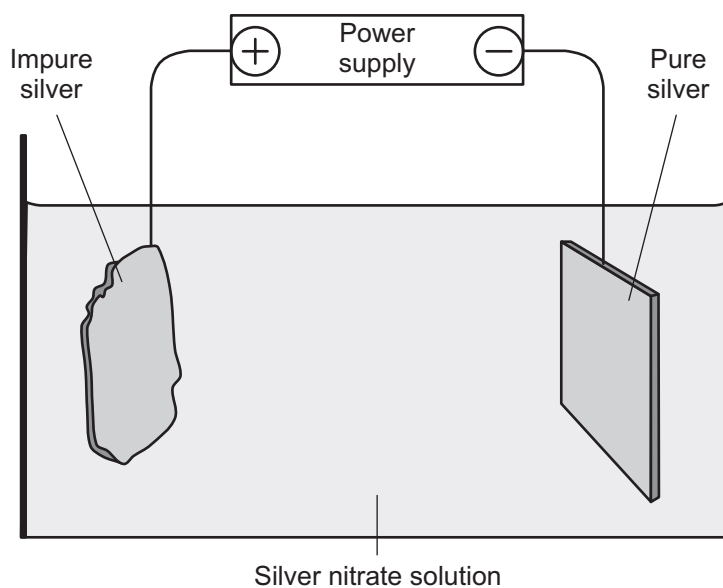
ASSESSMENT CRITERIA

The candidate:

A	B	C	D	E
<ul style="list-style-type: none">describes a suitable ordered procedureaccounts for the main possible errorsis able to give a suitable procedure to check the sodium hydroxide.	<ul style="list-style-type: none">is able to respond correctly as in A but with minor errors or omissions. <p style="text-align: center;">OR</p> <ul style="list-style-type: none">is able to respond correctly as in A for two of the three items fully.	<ul style="list-style-type: none">is able to respond to two of the three sections correctly but with minor errors or omissions.	<ul style="list-style-type: none">is able to respond to one of the three sections correctly.	<ul style="list-style-type: none">is unable to respond to any of the three sections.

Question 3 — Electrolytic refining of silver

Impure silver can be refined by the electrolytic process shown in the diagram.



Each of the following questions requires you to give a scientific explanation and to justify your response.

(a) Discuss the flow of electrons in the complete process.

(i) Where do they originate?

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(ii) Where do they move to?

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(iii) Where are they consumed?

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(b) Discuss the changes that take place in:

(i) the impure silver

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(ii) the pure silver

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(iii) the silver nitrate solution.

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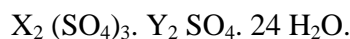
ASSESSMENT CRITERIA

The candidate:

A	B	C	D	E
<ul style="list-style-type: none">• is able to discuss the flow of electrons correctly in all three parts in (a)• is able to discuss the changes in all three parts in (b).	<ul style="list-style-type: none">• is able to discuss either the flow of electrons or the changes correctly in all three parts <p style="text-align: center;">OR</p> <ul style="list-style-type: none">• responds correctly in two of the three parts in (a), and• is able to discuss the changes in at least two of the three parts in (b).	<ul style="list-style-type: none">• is able to discuss either the flow of electrons or the changes correctly in two parts <p style="text-align: center;">OR</p> <ul style="list-style-type: none">• is able to discuss the changes in at least one of the three parts in (b).	<ul style="list-style-type: none">• is able to discuss either the flow of electrons or the changes in only one part	<ul style="list-style-type: none">• makes little or no meaningful attempt at the question.

Question 4 — Alums

Alums are double salts of the general formula



They have very spectacular shapes and are good examples for crystal growing. Aqueous solutions of alums contain the ions of X, Y and sulfate.

Respond to the following questions, giving a brief explanation as part of your response.

- (a) Deduce the charge on each ion of X.

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- (b) Deduce the charge on each ion of Y.

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- (c) Name at least two elements that X could be.

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- (d) Name at least three elements that Y could be.

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- (e) Name one polyatomic ion that Y could be.

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ASSESSMENT CRITERIA

The candidate:

A	B	C	D	E
<ul style="list-style-type: none">• responds to at least four of the five sections correctly• gives brief adequate explanations.	<ul style="list-style-type: none">• responds to at least three of the five sections correctly• gives brief adequate explanations.	<ul style="list-style-type: none">• responds to at least two of the five sections correctly• gives brief adequate explanations.	<ul style="list-style-type: none">• responds to some correctly but does not give brief adequate explanations.	<ul style="list-style-type: none">• responds to sections incorrectly and does not give adequate explanations.

Additional response page

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Additional response page

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Minimum standards associated with exit criteria

Criteria	Very High Achievement	High Achievement	Sound Achievement	Limited Achievement	Very Limited Achievement
Knowledge of subject matter	A very high ability to recall and apply knowledge of chemistry in simple situations.	A high ability to recall and apply knowledge of chemistry in simple situations.	A satisfactory ability to recall and apply knowledge of chemistry in simple situations.	Limited ability to recall and apply knowledge of chemistry in simple situations.	Very limited ability to recall and apply knowledge of chemistry in simple situations.
Scientific processes	A very high ability to succeed in simple scientific process tasks—collecting and organising data, processing information, making simple judgments, communicating information in various contexts, devising and designing simple and/or single-step investigations.	A high ability to succeed in simple scientific process tasks—collecting and organising data, processing information, making judgments, communicating information in various contexts, devising and designing simple and/or single-step investigations.	A satisfactory ability to succeed in simple scientific process tasks—collecting and organising data, processing information, making judgments, communicating information in various contexts, devising and designing simple and/or single-step investigations.	Limited ability to succeed in simple scientific process tasks.	Very limited ability to succeed in simple scientific process tasks.

Acknowledgments

Random House Group, London, for material from *Problems in Modern Chemistry* by JC Mathews, published by Hutchinson Educational, London, 1971.

Clearway Textbooks, Sydney, for a graphic from *Higher School Certificate Chemistry* by V Liondas and JS Mackay, 1978.

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