

Chemistry

Paper One

Friday, 28 October 2005

9.00 a.m. to 11.10 a.m.



Directions

- Perusal time: **10 minutes**.
Do not make notes in this booklet during perusal time.
- Working time: **2 hours**.
- Materials provided:
 - multiple-choice response sheet
 - resource booklet.
- Equipment allowed:
 - any hand-held, solar- or battery-operated non-programmable calculator
 - pens (blue or black ink)
 - 2B pencils and eraser (only for completing the multiple-choice sheet and for graphing)
 - ruler
 - normal writing implements
 - other equipment as approved by the QSA.
- This paper has **two** parts:
 - Part A: Knowledge and simple application
Questions 1–10 Multiple-choice
Questions 11–18 Short answer.
 - Part B: Scientific processes
Questions 1–5 Short answer.
 Attempt **all** questions.
- Suggested time allocation:
 - Part A: 85 minutes
 - Part B: 35 minutes.
- Do not take this booklet, used or unused, from the examination room. Do not tear out any part of this booklet.

Notes

This paper assesses:

- knowledge and simple application of subject matter
- scientific processes
- use of correct English (punctuation, spelling, clarity and conciseness of expression), legibility and general neatness.

Candidate use

Print your candidate number below								
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Number of booklets used

Supervisor use only

Supervisor's initials	
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QSA use only

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Part A—Knowledge and simple application

Part A assesses knowledge and simple application of that knowledge based on the eight syllabus topics.

Part A is worth 70 marks.

Answer **all** questions.

Multiple-choice (10 marks)

Question 1

Which one of the following correctly defines the mass number of a given atom?

- (a) the total mass of neutrons and protons in the nucleus of the atom
- (b) the total mass of neutrons, protons and electrons in the atom
- (c) the number of protons in the nucleus of the atom
- (d) the total number of neutrons and protons in the nucleus of the atom.

Question 2

The shape of the molecule boron trifluoride, BF_3 , is best described as

- (a) bent triatomic
- (b) planar trigonal
- (c) pyramidal
- (d) tetrahedral.

Question 3

Which one of the following does not change during any chemical reaction?

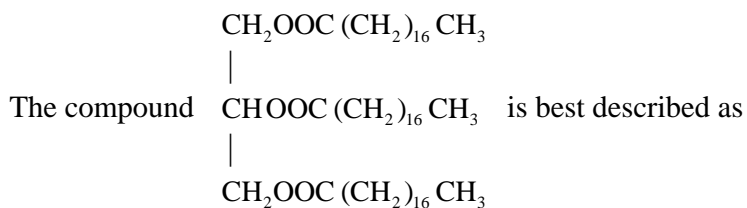
- (a) total number of molecules in the system
- (b) total volume of the system
- (c) total mass of the system
- (d) temperature of the system.

Question 4

No noticeable reaction occurred when a strip of a particular metal was added to dilute hydrochloric acid.

The metal in the strip is most likely to be

- (a) copper
- (b) iron
- (c) magnesium
- (d) zinc.

Question 5

- (a) a carbohydrate
- (b) a fat
- (c) an amino acid
- (d) a protein.

Question 6

A neutral atom has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$.

This element would be located in the Periodic Table in

- (a) group 13, period 4.
- (b) group 1, period 4.
- (c) group 14, period 1.
- (d) group 14, period 3.

Question 7

A gaseous mixture contains 1 mol of hydrogen molecules, 4 mol of nitrogen molecules and 3 mol of ammonia molecules under a total pressure of 2×10^7 Pa. What is the partial pressure of ammonia, in Pa, in the mixture?

- (a) 1.25×10^6
- (b) 3.75×10^6
- (c) 7.5×10^6
- (d) 6×10^7

Question 8

Increasing the temperature at which reactions take place

- (a) increases the value of the equilibrium constant K of all reactions
- (b) decreases the value of the equilibrium constant K of all reactions
- (c) has no effect on the value of the equilibrium constant K of all reactions
- (d) increases the rate of most reactions.

Question 9

The most soluble compound listed below is:

- (a) lead carbonate
- (b) lead chloride
- (c) lead hydroxide
- (d) lead nitrate.

Question 10

A student desired to undertake the titration of sodium hydroxide solution (in the burette) against ethanoic (acetic) acid. Which indicator should be used to obtain the correct equivalence point?

- (a) litmus paper
- (b) methyl orange
- (c) phenolphthalein
- (d) any indicator.

Short answer (60 marks)

Answer all questions (Questions 11 to 18).

You must show all working.

Answer in the spaces provided.

Marks are shown for each question.

If you need more space for a response, you may continue your answer on pages 16 and 17. Make sure you label the page used with the question number that relates to your answer.

Question 11

- (a) Explain the difference between an element and a compound. Illustrate your response with an example of each.

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(2 marks)

- (b) What is meant by the term “ion”? How is it formed? Give an example.

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(12 marks)

- (c) List the type and number of subatomic particles in the atom represented by ^{40}K .

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(12 marks)

(d) Draw the electron dot diagram for the water molecule.

(1 mark)

(e) What is the main difference between a covalent bond and an ionic bond?

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(2 marks)

(f) Name a polar molecule other than water.

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(1 mark)

Question 12

(a) A cylinder holds 0.130g of ethane C_2H_6 .

(i) How many moles of ethane are there in the cylinder?

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(12 marks)

(ii) How many molecules of ethane are there in the cylinder?

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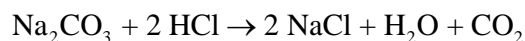
(12 marks)

(iii) The ethane gas empties into the atmosphere at $25^\circ C$ and standard pressure. What volume of gas would there be?

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(2 marks)

- (b) What mass of pure anhydrous sodium carbonate would be needed to react with 0.124 mol of pure hydrochloric acid according to the equation



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(2 marks)

- (c) An organic chemical was found to have the following percentage composition by mass: carbon 40%, hydrogen 6.7% and oxygen 53.3%. Its approximate molar mass was 182. Calculate its molecular formula and exact molar mass. Show all working clearly.

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(2 marks)

Question 13

- (a) What are the oxidation states (or oxidation numbers) of chlorine in the following:

(i) Cl atom in chlorine gas

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(ii) Cl atom in hydrogen chloride gas

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(iii) Cl ion in sodium chloride

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(iv) Cl atom in potassium chlorate KClO_3 .

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(2 marks)

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- (b) Using half-reactions, write and balance the net equation between tin (II) ions and solid manganese (IV) oxide in acid solution forming tin (IV) ions and manganese (II) ions respectively.

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(2 marks)

- (c) A current of 0.100 amperes flows through a solution of copper (II) sulfate CuSO_4 for 100 minutes. How many grams of copper will be deposited at the cathode?

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(2 marks)

Question 14

Draw the full structural formula for each of the following named substances. Use the space provided. There is no need to draw electron dot diagrams.

- (a) ethene (ethylene)

- (b) 1-butanol

- (c) propanal

(d) propanone

(e) ethyl ethanoate (ethyl acetate)

(f) sodium methanoate (sodium formate)

(g) poly (vinyl chloride)

(h) cis-butene

(i) 2,3 – dibromopentane

(9 marks, 1 each)

Question 15

Answer the following questions concerning the Periodic Table and its elements.

- (a) In which period of the Periodic Table is sulfur located?

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(1 mark)

- (b) In which group of the Periodic Table is germanium located?

.....
(1 mark)

- (c) What is the electron configuration of the third element in Period 3?

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(1 mark)

- (d) Use the Periodic Table to determine the number of valence electrons in chlorine.

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(1 mark)

- (e) What will be the formula of the simplest oxide of silicon?

.....
(1 mark)

- (f) Would the oxide of aluminium, Al_2O_3 , be acidic, basic or amphoteric?

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(1 mark)

Question 16

- (a) Describe how a small sample of carbon dioxide gas could be prepared and collected in the laboratory. Give the reaction and how the gas is collected. No diagrams are needed.

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(2 marks)

- (b) Describe how you could tell that the container was full of gas.

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(1 mark)

(c) Describe how you could prove the collected gas was carbon dioxide.

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(1 mark)

(d) Identify two ways in which carbon dioxide is important for human welfare.

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(1 mark)

Question 17

(a) Explain why some chemical reactions are very fast and why others are quite slow.

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(2 marks)

(b) What is meant by an endothermic reaction? Give one example.

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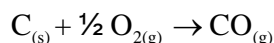
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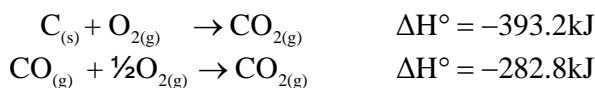
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(2 marks)

- (c) Calculate ΔH° for the following reaction at 25°C :



given the following reactions at 25°C :



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(2 marks)

Question 18

- (a) Write the ionic dissociation equation for sodium hydroxide in water.

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(1 mark)

- (b) 8.0 g of sodium hydroxide were dissolved in 750 mL of aqueous solution. Calculate the molarity of the solution.

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(2 marks)

- (c) Calculate the concentration of the ions causing the alkalinity.

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(1 mark)

- (d) What is the pH of the solution?

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(2 marks)

- (e) Are there any hydrogen ions (H^+ or H_3O^+) present in the solution? Explain.

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(2 marks)

- (f) An aqueous solution of ammonia can be classified as a Bronsted-Lowry base. Show this by means of a suitable equation, clearly showing the conjugate pairs.

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(2 marks)

End of Part A

Part B—Scientific processes

Section B assesses scientific processes, reasoning based on the eight syllabus topics and practical work.

Section B is worth 30 marks.

Answer **all** questions.

Short-answer questions (30 marks)

Question 1 – Separating minerals

A mineral called gay-lussite, named after the French 19th century chemist Gay-Lussac, is a mixture composed of calcium carbonate (limestone) and sodium carbonate (soda ash) and water.

Some properties of calcium carbonate and sodium carbonate are given in the table below:

Property	Calcium carbonate	Sodium carbonate
Melting point	Decomposes at 825°C	Melts at 851°C
Solubility in water	Insoluble	7g/100mL at 0°C 45g/100 mL at 100°C
Solubility in alcohol	Insoluble	Insoluble
Solubility in hydrochloric acid	Soluble (reacts)	Soluble (reacts)

Describe how you would separate the two substances from the mineral gay-lussite. Give details of the procedures, and make sure that you recover the two mineral samples.

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(6 marks)

Question 2 – Predicting chemical reactions

Predict whether chemical reactions would occur in each of the following. Where a reaction (or reactions) could occur, write a balanced equation for each reaction, and give a reason. Where no reaction could occur, write no reaction **and** give a reason.

- (a) zinc is added to an aqueous solution of silver nitrate (AgNO_3).

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- (b) zinc is added to an aqueous solution of iron (II) sulfate (FeSO_4).

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- (c) excess zinc is added to an aqueous solution of iron (III) sulfate ($\text{Fe}_2(\text{SO}_4)_3$).

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- (d) chlorine is added to an aqueous solution of sodium bromide (NaBr).

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- (e) bromine is added to an aqueous solution of sodium chloride (NaCl).

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(6 marks)

Question 3 – Distinguishing organic substances

Distinguish between the following pairs of organic substances using any knowledge, reasoning or suitable tests.

- (a) cyclohexane and hexanol

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(3 marks)

- (b) benzoic acid and ethyl benzoate

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(3 marks)

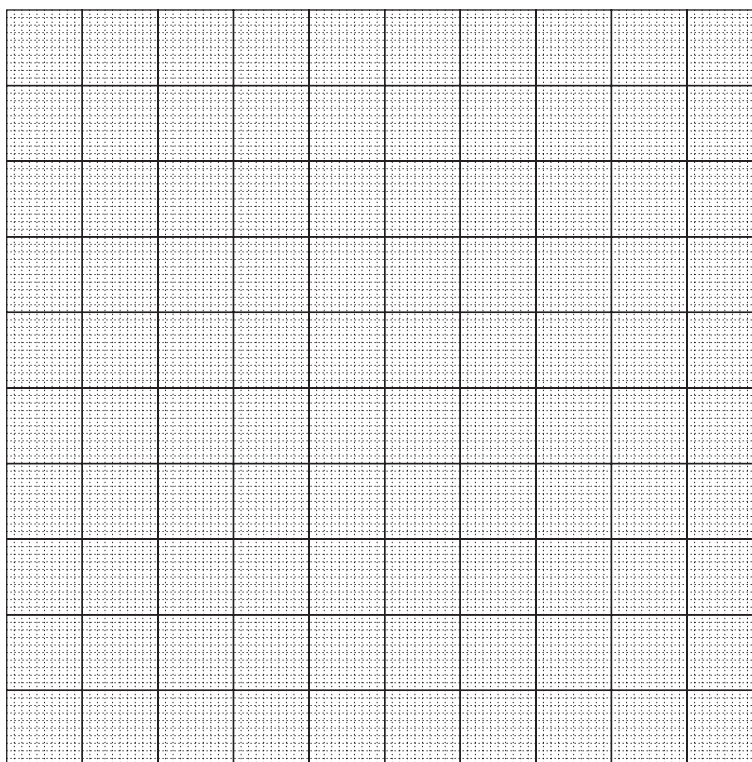
Question 4 – Reaction progress

A 25.0 g sample of powdered iron was heated in a crucible with a Bunsen burner for 10 minutes. After the crucible was allowed to cool, it was weighed to determine the increase in mass of the iron. Then the sample was heated again for another 10 minutes, allowed to cool and weighed again. The process was repeated a further six times until 80 minutes heating had been done.

The following masses were recorded at the corresponding time intervals:

Time (min)	0	10	20	30	40	50	60	70	80
Mass gained by sample (g)	0	6.5	8.0	8.8	9.2	9.3	9.4	9.4	9.4

- (a) Plot the increase in mass in the iron against time elapsed on the graph paper below. Make sure you draw a tidy, fully labelled graph in pencil.



(2 marks)

From your graph, answer the following questions.

- (b) When was the reaction complete?

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(1 mark)

- (c) What is the final ratio of the mass of the original iron to the mass of the **product**? Show your working.

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(2 marks)

(d) What ratio would you get if you stopped heating the sample at the end of 20 minutes?

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(1 mark)

Question 5 — Changing equilibria

The Haber Process for producing ammonia may operate at 200 atm and 500°C with an iron catalyst or with a mixture of metal oxides as the catalyst.



What effect, if any, would each of the following have on the equilibrium – that is, on the amount of ammonia present when equilibrium was restored? Justify your answers.

(a) Increasing the pressure to 400 atm.

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(b) Lowering the temperature to 300°C without changing the pressure.

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(c) Adding water to the system.

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(6 marks, 2 each)

Acknowledgments

Pearson Prentice Hall, USA, for a table and adapted text from *Introductory Physical Science* edited by Uri Haber-Schaim, published by Prentice-Hall, Inc., New Jersey, USA, 1967.

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