Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Chemistry CHEM1

Unit 1 Foundation Chemistry

Thursday 23 May 2013 9.00 am to 10.15 am

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a calculator.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.
- The Periodic Table/Data Sheet is provided as an insert.
- Your answers to the questions in **Section B** should be written in continuous prose, where appropriate.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

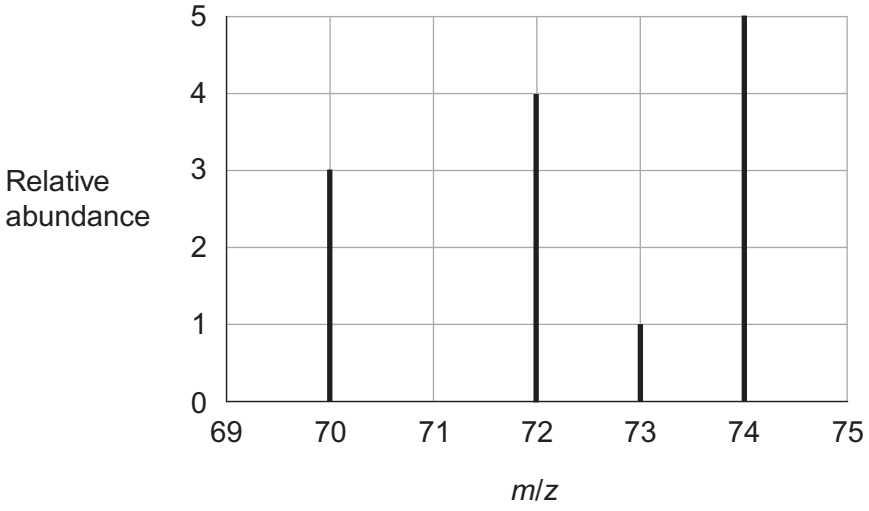
Advice
- You are advised to spend about 50 minutes on **Section A** and about 25 minutes on **Section B**.

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Section A

Answer **all** questions in the spaces provided.

1 The mass spectrum of the isotopes of element **X** is shown in the diagram.



1 (a) Define the term *relative atomic mass*.

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(2 marks)

1 (b) Use data from the diagram to calculate the relative atomic mass of **X**.

Give your answer to one decimal place.

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(3 marks)

Do not write outside the box

1 (c) Identify the ion responsible for the peak at 72

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(1 mark)

1 (d) Identify which **one** of the isotopes of **X** is deflected the most in the magnetic field of a mass spectrometer. Give a reason for your answer.

Isotope .....

Reason .....

(2 marks)

1 (e) In a mass spectrometer, the relative abundance of each isotope is proportional to the current generated by that isotope at the detector.

Explain how this current is generated.

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(2 marks)

1 (f) **X** and **Zn** are different elements.

Explain why the chemical properties of ^{70}**X** and ^{70}**Zn** are different.

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(1 mark)

11

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2 (a) The hydrocarbon but-1-ene (C_4H_8) is a member of the homologous series of alkenes. But-1-ene has structural isomers.

2 (a) (i) State the meaning of the term *structural isomers*.

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(2 marks)

2 (a) (ii) Give the IUPAC name of the **position** isomer of but-1-ene.

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(1 mark)

2 (a) (iii) Give the IUPAC name of the **chain** isomer of but-1-ene.

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(1 mark)

2 (a) (iv) Draw the displayed formula of a **functional group** isomer of but-1-ene.

(1 mark)

Do not write outside the box

2 (b) But-1-ene burns in a limited supply of air to produce a solid and water only.

2 (b) (i) Write an equation for this reaction.

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(1 mark)

2 (b) (ii) State **one** hazard associated with the solid product in part **(b) (i)**.

.....

(1 mark)

2 (c) One mole of compound **Y** is cracked to produce two moles of ethene, one mole of but-1-ene and one mole of octane (C_8H_{18}) only.

2 (c) (i) Deduce the molecular formula of **Y**.

.....

(1 mark)

2 (c) (ii) Other than cracking, give **one** common use of **Y**.

.....

(1 mark)

2 (d) In cars fitted with catalytic converters, unburned octane reacts with nitrogen monoxide to form carbon dioxide, water and nitrogen only.

2 (d) (i) Write an equation for this reaction.

.....

(1 mark)

2 (d) (ii) Identify a catalyst used in a catalytic converter.

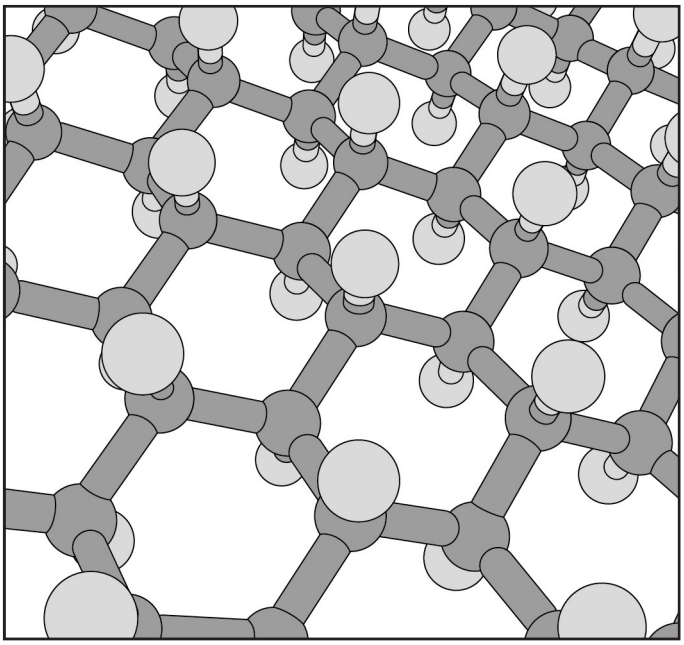
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(1 mark)

11

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3 In 2009 a new material called graphane was discovered. The diagram shows part of a model of the structure of graphane. Each carbon atom is bonded to three other carbon atoms and to one hydrogen atom.



3 (a) Deduce the type of crystal structure shown by graphane.

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(1 mark)

3 (b) State how two carbon atoms form a carbon–carbon bond in graphane.

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(1 mark)

3 (c) Suggest why graphane does **not** conduct electricity.

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(1 mark)

3 (d) Deduce the empirical formula of graphane.

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(1 mark)

4

Do not write outside the box

4 Fritz Haber, a German chemist, first manufactured ammonia in 1909.
Ammonia is very soluble in water.

4 (a) State the strongest type of intermolecular force between one molecule of ammonia and one molecule of water.

.....

(1 mark)

4 (b) Draw a diagram to show how one molecule of ammonia is attracted to one molecule of water. Include all partial charges and all lone pairs of electrons in your diagram.

(3 marks)

4 (c) Phosphine (PH_3) has a structure similar to ammonia.

In terms of intermolecular forces, suggest the main reason why phosphine is almost insoluble in water.

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(1 mark)

5

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5 Aluminium and thallium are elements in Group 3 of the Periodic Table.
Both elements form compounds and ions containing chlorine and bromine.

5 (a) Write an equation for the formation of aluminium chloride from its elements.

.....

(1 mark)

5 (b) An aluminium chloride molecule reacts with a chloride ion to form the $AlCl_4^-$ ion.

Name the type of bond formed in this reaction. Explain how this type of bond is formed in the $AlCl_4^-$ ion.

Type of bond .....

Explanation .....

.....

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(2 marks)

5 (c) Aluminium chloride has a relative molecular mass of 267 in the gas phase.

Deduce the formula of the aluminium compound that has a relative molecular mass of 267

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(1 mark)

5 (d) Deduce the name or formula of a compound that has the same number of atoms, the same number of electrons and the same shape as the $AlCl_4^-$ ion.

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(1 mark)

5 (e) Draw and name the shape of the $TlBr_5^{2-}$ ion.

Shape of the $TlBr_5^{2-}$ ion.

Name of shape .....

(2 marks)

Do not write outside the box

5 (f) (i) Draw the shape of the $TlCl_2^+$ ion.

(1 mark)

5 (f) (ii) Explain why the $TlCl_2^+$ ion has the shape that you have drawn in part **(f) (i)**.

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(1 mark)

5 (g) Which **one** of the first, second or third ionisations of thallium produces an ion with the electron configuration [Xe] $5d^{10}6s^1$?

Tick (✓) **one** box.

First ☐

Second ☐

Third ☐

(1 mark)

10

Do not write outside the box

6 The elements in Period 2 show periodic trends.

6 (a) Identify the Period 2 element, from carbon to fluorine, that has the largest atomic radius. Explain your answer.

Element .....

Explanation .....

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(3 marks)

6 (b) State the general trend in first ionisation energies from carbon to neon.
Deduce the element that deviates from this trend and explain why this element deviates from the trend.

Trend .....

Element that deviates .....

Explanation .....

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(4 marks)

6 (c) Write an equation, including state symbols, for the reaction that occurs when the first ionisation energy of carbon is measured.

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(1 mark)

Do not write outside the box

6 (d) Explain why the second ionisation energy of carbon is higher than the first ionisation energy of carbon.

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(1 mark)

6 (e) Deduce the element in Period 2, from lithium to neon, that has the highest second ionisation energy.

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(1 mark)

10

Turn over for the next question

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Section B

Answer **all** questions in the spaces provided.

7 Zinc forms many different salts including zinc sulfate, zinc chloride and zinc fluoride.

7 (a) People who have a zinc deficiency can take hydrated zinc sulfate ($ZnSO_4.xH_2O$) as a dietary supplement.

A student heated 4.38 g of hydrated zinc sulfate and obtained 2.46 g of anhydrous zinc sulfate.

Use these data to calculate the value of the integer x in $ZnSO_4.xH_2O$
Show your working.

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(3 marks)

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7 (b) Zinc chloride can be prepared in the laboratory by the reaction between zinc oxide and hydrochloric acid.
The equation for the reaction is

$$ZnO + 2HCl \longrightarrow ZnCl_2 + H_2O$$

A 0.0830 mol sample of pure zinc oxide was added to 100 cm^3 of 1.20 mol dm^{-3} hydrochloric acid.

Calculate the maximum mass of anhydrous zinc chloride that could be obtained from the products of this reaction.

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(4 marks)

Question 7 continues on the next page

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7 (c) Zinc chloride can also be prepared in the laboratory by the reaction between zinc and hydrogen chloride gas.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

An impure sample of zinc powder with a mass of 5.68 g was reacted with hydrogen chloride gas until the reaction was complete. The zinc chloride produced had a mass of 10.7 g.

Calculate the percentage purity of the zinc metal.
Give your answer to 3 significant figures.

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(4 marks)

7 (d) Predict the type of crystal structure in solid zinc fluoride and explain why its melting point is high.

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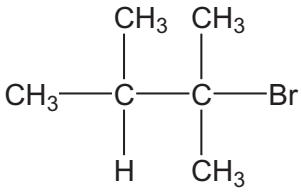
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(3 marks)

14

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8 (a) The structure of the bromoalkane **Z** is



Give the IUPAC name for **Z**.

Give the general formula of the homologous series of straight-chain bromoalkanes that contains one bromine atom per molecule.

Suggest **one** reason why 1-bromohexane has a higher boiling point than **Z**.

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(3 marks)

(Extra space) .....

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8 (b) Draw the displayed formula of 1,2-dichloro-2-methylpropane.

State its empirical formula.

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(2 marks)

END OF QUESTIONS

5

There are no questions printed on this page

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