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	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Chemistry CHEM1

Unit 1 Foundation Chemistry

Friday 22 May 2015 9.00 am to 10.15 am

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- 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 This question is about the elements in Period 3 of the Periodic Table.

1 (a) State the element in Period 3 that has the highest melting point.
Explain your answer.

[3 marks]

Element .....

Explanation .....

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1 (b) State the element in Period 3 that has the highest first ionisation energy.
Explain your answer.

[3 marks]

Element .....

Explanation .....

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1 (c) Suggest the element in Period 3 that has the highest electronegativity value.

[1 mark]

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Do not write outside the box

1 (d) Chlorine is a Period 3 element.
Chlorine forms the molecules ClF_3 and CCl_2

1 (d) (i) Use your understanding of electron pair repulsion to draw the shape of ClF_3 and the shape of CCl_2
Include any lone pairs of electrons that influence the shape.

[2 marks]

Shape of ClF_3

Shape of CCl_2

1 (d) (ii) Name the shape of CCl_2

[1 mark]

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1 (d) (iii) Write an equation to show the formation of one mole of ClF_3 from its elements.

[1 mark]

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Turn over for the next question

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2 Tellurium is the element with atomic number of 52

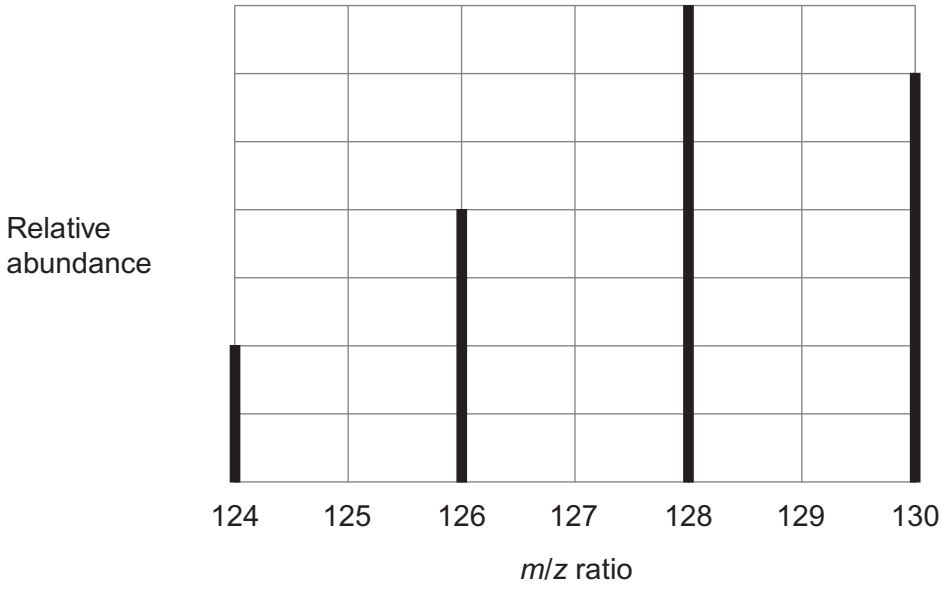
2 (a) Using information from the Periodic Table, complete the electron configuration of tellurium.

[1 mark]

[Kr] .....

2 (b) The mass spectrum of a sample of tellurium is shown in **Figure 1**.

Figure 1



2 (b) (i) Use **Figure 1** to calculate the relative atomic mass of this sample of tellurium. Give your answer to one decimal place.

[3 marks]

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2 (b) (ii) Suggest what might cause the relative atomic mass of this sample to be different from the relative atomic mass given in the Periodic Table.

[1 mark]

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Do not write outside the box

2 (c) Write an equation for the reaction that occurs when a tellurium ion hits the detector.

[1 mark]

.....

2 (d) State the *m*/*z* value of the ions that produce the biggest current at the detector when the spectrum in **Figure 1** is recorded.
Give a reason for your answer.

[2 marks]

m/*z* value .....

Reason .....

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2 (e) The mass spectrum of tellurium also has a small peak at *m*/*z* = 64

Explain the existence of this peak.

[2 marks]

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2 (f) Predict whether the atomic radius of ^{124}Te is larger than, smaller than or the same as the atomic radius of ^{130}Te
Explain your answer.

[2 marks]

Atomic radius of ^{124}Te compared to ^{130}Te .....

Explanation .....

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12

Do not write outside the box

3 Silicon dioxide (SiO_2) has a crystal structure similar to diamond.

3 (a) Give the name of the type of crystal structure shown by silicon dioxide.

[1 mark]

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3 (b) Suggest why silicon dioxide does **not** conduct electricity when molten.

[1 mark]

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3 (c) Silicon dioxide reacts with hydrofluoric acid (HF) to produce hexafluorosilicic acid (H_2SiF_6) and one other substance.

Write an equation for this reaction.

[1 mark]

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3

Do not write outside the box

4 A sample of hydrated nickel sulfate ($NiSO_4.xH_2O$) with a mass of 2.287 g was heated to remove all water of crystallisation. The solid remaining had a mass of 1.344 g.

4 (a) Calculate the value of the integer x.
Show your working.

[4 marks]

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4 (b) Suggest how a student doing this experiment could check that all the water had been removed.

[2 marks]

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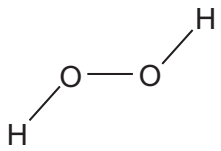
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6

Turn over for the next question

Do not write outside the box

5 A hydrogen peroxide molecule can be represented by the structure shown.



5 (a) Suggest a value for the H–O–O bond angle.

[1 mark]

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5 (b) Hydrogen peroxide dissolves in water.

5 (b) (i) State the strongest type of interaction that occurs between molecules of hydrogen peroxide and water.

[1 mark]

.....

5 (b) (ii) Draw a diagram to show how one molecule of hydrogen peroxide interacts with one molecule of water.
Include all lone pairs and partial charges in your diagram.

[3 marks]

Do not write outside the box

5 (c) Explain, in terms of electronegativity, why the boiling point of H_2S_2 is lower than H_2O_2.

[2 marks]

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Turn over for the next question

Do not write outside the box

6 Central heating fuel, obtained by the fractional distillation of crude oil, contains saturated hydrocarbons with the molecular formula $C_{16}H_{34}$

6 (a) Give the meaning of the terms **saturated** and **hydrocarbon** as applied to saturated hydrocarbons.

[2 marks]

Saturated .....

.....

Hydrocarbon .....

.....

6 (b) If the boiler for a central heating system is faulty, a poisonous gas may be produced during the combustion of $C_{16}H_{34}$

Write an equation for the reaction that forms this poisonous gas and one other product only.

[1 mark]

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6 (c) Explain why the sulfur compounds found in crude oil should be removed from the fractions before they are used for central heating fuel.

[2 marks]

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Do not write outside the box

6 (d) A hydrocarbon $C_{16}H_{34}$ can be cracked to form C_8H_{18}, ethene and propene.

6 (d) (i) Write an equation to show this cracking reaction.

[1 mark]

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6 (d) (ii) Suggest **one** important substance manufactured on a large scale from propene.

[1 mark]

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6 (d) (iii) Draw the **displayed formula** of the functional group isomer of propene.

[1 mark]

6 (e) There are many structural isomers with the molecular formula C_8H_{18}

Draw the structure of 2,3,3-trimethylpentane.

[1 mark]

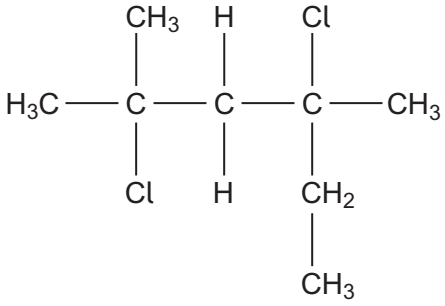
Question 6 continues on the next page

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6 (f) A compound C_8H_{18} reacts with chlorine to give several haloalkanes.

Give the IUPAC name of the following haloalkane.

[1 mark]



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10

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Section B

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

7 Some airbags in cars contain sodium azide (NaN_3).

7 (a) Sodium azide is made by reacting dinitrogen monoxide gas with sodium amide ($NaNH_2$) as shown by the equation.

$$2NaNH_2 + N_2O \longrightarrow NaN_3 + NaOH + NH_3$$

Calculate the mass of sodium amide needed to obtain 550 g of sodium azide, assuming there is a 95.0% yield of sodium azide.
Give your answer to 3 significant figures.

[5 marks]

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Question 7 continues on the next page

Do not write outside the box

7 (b) If a car is involved in a serious collision, the sodium azide decomposes to form sodium and nitrogen as shown in the equation.

$$2NaN_3(s) \longrightarrow 2Na(s) + 3N_2(g)$$

The nitrogen produced then inflates the airbag to a volume of 7.50×10^{-2} m^3 at a pressure of 150 kPa and temperature of 35 ºC.

Calculate the minimum mass of sodium azide that must decompose.
(The gas constant R = 8.31 J K^{-1} mol^{-1})

[6 marks]

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7 (c) Sodium azide is toxic. It can be destroyed by reaction with an acidified solution of nitrous acid (HNO_2) as shown in the equation.

$$2NaN_3 + 2HNO_2 + 2HCl \longrightarrow 3N_2 + 2NO + 2NaCl + 2H_2O$$

7 (c) (i) A 500 cm^3 volume of the nitrous acid solution was used to destroy completely 150 g of the sodium azide.

Calculate the concentration, in mol dm^{-3}, of the nitrous acid used.

[3 marks]

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7 (c) (ii) Nitrous acid decomposes on heating.

Balance the following equation for this reaction.

[1 mark]

$$.....HNO_2 \longrightarrow .....HNO_3 + ...NO + ...H_2O$$

7 (d) Sodium azide has a high melting point.

Predict the type of bonding in a crystal of sodium azide.
Suggest why its melting point is high.

[3 marks]

Type of bonding .....

Reason for high melting point .....

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Question 7 continues on the next page

Do not write outside the box

7 (e) The azide ion has the formula N_3^-

7 (e) (i) The azide ion can be represented as $N \equiv N - N^-$
One of these bonds is a co-ordinate bond.

On the following diagram, draw an arrowhead on one of the bonds to represent the direction of donation of the lone pair in the co-ordinate bond.

[1 mark]



7 (e) (ii) Give the formula of a molecule that has the same number of electrons as the azide ion.

[1 mark]

.....

7 (e) (iii) Which is the correct formula of magnesium azide?

[1 mark]

Tick (✓) **one** box.

Mg_3N ☐

MgN ☐

MgN_6 ☐

Mg_3N_2 ☐

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END OF QUESTIONS

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