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 2010

Chemistry CHEM1

Unit 1 Foundation Chemistry

Friday 21 May 2010 1.30 pm to 2.45 pm

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.
- 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 accurate scientific terminology.

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

Section A

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

1 Fluorine forms many compounds that contain covalent bonds.

1 (a) (i) State the meaning of the term *covalent bond*.

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(1 mark)

1 (a) (ii) Write an equation to show the formation of one molecule of ClF_3 from chlorine and fluorine molecules.

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(1 mark)

1 (b) Draw the shape of a dichlorodifluoromethane molecule (CCl_2F_2) and the shape of a chlorine trifluoride molecule (ClF_3). Include any lone pairs of electrons that influence the shape.

Shape of CCl_2F_2 Shape of ClF_3

(2 marks)

1 (c) Suggest the strongest type of intermolecular force between CCl_2F_2 molecules.

.....

(1 mark)

1 (d) BF_3 is a covalent molecule that reacts with an F^- ion to form a BF_4^- ion.

1 (d) (i) Name the type of bond formed when a molecule of BF_3 reacts with an F^- ion. Explain how this bond is formed.

Type of bond .....

Explanation .....

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(3 marks)

(Extra space) .....

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1 (d) (ii) State the bond angle in the BF_4^- ion.

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(1 mark)

1 (e) An ultrasound imaging agent has the formula C_4F_{10}
It can be made by the reaction of butane and fluorine as shown in the following equation.

$$C_4H_{10} + 10F_2 \longrightarrow C_4F_{10} + 10HF$$

Calculate the percentage atom economy for the formation of C_4F_{10} in this reaction. Give your answer to three significant figures.

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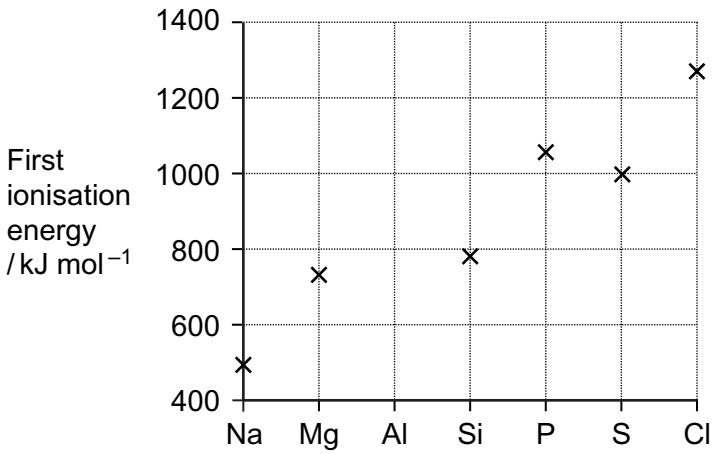
(2 marks)

11

2 The following diagram shows the first ionisation energies of some Period 3 elements.



2 (a) Draw a cross on the diagram to show the first ionisation energy of aluminium.

(1 mark)

2 (b) Write an equation to show the process that occurs when the first ionisation energy of aluminium is measured.

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(2 marks)

2 (c) State which of the first, second or third ionisations of aluminium would produce an ion with the electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^1$

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(1 mark)

2 (d) Explain why the value of the first ionisation energy of sulfur is less than the value of the first ionisation energy of phosphorus.

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(2 marks)

(Extra space) .....

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2 (e) Identify the element in Period 2 that has the highest first ionisation energy and give its electron configuration.

Element .....

Electron configuration .....

(2 marks)

2 (f) State the trend in first ionisation energies in Group 2 from beryllium to barium. Explain your answer in terms of a suitable model of atomic structure.

Trend.....

Explanation .....

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.....

(3 marks)

(Extra space) .....

.....

11

Turn over for the next question

3 In this question give all your answers to three significant figures.

Magnesium nitrate decomposes on heating to form magnesium oxide, nitrogen dioxide and oxygen as shown in the following equation.

$$2Mg(NO_3)_2(s) \longrightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

3 (a) Thermal decomposition of a sample of magnesium nitrate produced 0.741 g of magnesium oxide.

3 (a) (i) Calculate the amount, in moles, of MgO in 0.741 g of magnesium oxide.

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(2 marks)

3 (a) (ii) Calculate the total amount, in moles, of gas produced from this sample of magnesium nitrate.

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(1 mark)

3 (b) In another experiment, a different sample of magnesium nitrate decomposed to produce 0.402 mol of gas. Calculate the volume, in dm^3, that this gas would occupy at 333 K and 1.00×10^5 Pa.
(The gas constant $R = 8.31\,J\,K^{-1}\,mol^{-1}$)

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(3 marks)

(Extra space) .....

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3 (c) A 0.0152 mol sample of magnesium oxide, produced from the decomposition of magnesium nitrate, was reacted with hydrochloric acid.

$$MgO + 2HCl \longrightarrow MgCl_2 + H_2O$$

3 (c) (i) Calculate the amount, in moles, of HCl needed to react completely with the 0.0152 mol sample of magnesium oxide.

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(1 mark)

3 (c) (ii) This 0.0152 mol sample of magnesium oxide required 32.4 cm^3 of hydrochloric acid for complete reaction. Use this information and your answer to part **(c) (i)** to calculate the concentration, in mol dm^{-3}, of the hydrochloric acid.

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(1 mark)

8

Turn over for the next question

4 There are several oxides of nitrogen.

4 (a) An oxide of nitrogen contains 25.9% by mass of nitrogen. Determine the empirical formula of this oxide.

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(3 marks)

(Extra space) .....

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4 (b) Give **one** reason why the oxide NO is a pollutant gas.

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(1 mark)

4 (c) The oxide NO reacts with oxygen to form nitrogen dioxide. Write an equation for this reaction.

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(1 mark)

4 (d) Explain how NO is produced in the engine of a motor vehicle.

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(2 marks)

4 (e) Write an equation to show how NO is removed from the exhaust gases in motor vehicles using a catalytic converter.

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(1 mark)

8

5 The alkane butane is used as a fuel.

5 (a) (i) Write an equation for the complete combustion of butane.

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(1 mark)

5 (a) (ii) State a condition which may cause carbon to be formed as a product in the combustion of butane.

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(1 mark)

5 (b) Butane obtained from crude oil may contain trace amounts of an impurity. When this impurity burns it produces a toxic gas that can be removed by reacting it with calcium oxide coated on a mesh.

5 (b) (i) Suggest the identity of the toxic gas.

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(1 mark)

5 (b) (ii) Suggest why calcium oxide reacts with the toxic gas.

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(1 mark)

5 (b) (iii) Suggest why the calcium oxide is coated on a mesh.

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(1 mark)

5

Turn over for the next question

6 Pent-1-ene is a member of the alkene homologous series.

6 (a) Pent-1-ene can be separated from other alkenes.

State the physical property of alkenes that allows them to be separated from a mixture by fractional distillation.

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(1 mark)

6 (b) (i) State the meaning of the term *structural isomerism*.

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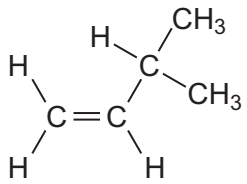
(2 marks)

6 (b) (ii) Name the branched chain isomer of pent-1-ene shown below.



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(1 mark)

6 (b) (iii) Draw the structure of a functional group isomer of pent-1-ene.

(1 mark)

6 (c) The cracking of one molecule of compound **X** produces pent-1-ene, ethene and butane in a 1:2:1 mol ratio.
Deduce the molecular formula of **X** and state a use for the ethene formed.

Molecular formula of **X** .....

.....

Use of ethene .....

(2 marks)

7

Turn over for the next question

Section B

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

7 Iodine and graphite are both solids. When iodine is heated gently a purple vapour is seen. Graphite will not melt until the temperature reaches 4000 K. Graphite conducts electricity but iodine is a very poor conductor of electricity.

7 (a) State the type of crystal structure for each of iodine and graphite.

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(2 marks)

7 (b) Describe the structure of and bonding in graphite and explain why the melting point of graphite is very high.

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(4 marks)

(Extra space) .....

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7 (c) Explain why iodine vaporises when heated gently.

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(2 marks)

7 (d) State why iodine is a very poor conductor of electricity.

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(1 mark)

9

Turn over for the next question

8 (a) Define the term *mass number* of an atom.

The mass number of an isotope of nitrogen is 15. Deduce the number of each of the fundamental particles in an atom of ^{15}N

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(3 marks)

(Extra space) .....

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8 (b) Define the term *relative atomic mass*.

An organic fertiliser was analysed using a mass spectrometer. The spectrum showed that the nitrogen in the fertiliser was made up of 95.12% ^{14}N and 4.88% ^{15}N

Calculate the relative atomic mass of the nitrogen found in this organic fertiliser. Give your answer to two decimal places.

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(4 marks)

(Extra space) .....

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8 (c) In a mass spectrometer, under the same conditions, $^{14}N^+$ and $^{15}N^+$ ions follow different paths. State the property of these ions that causes them to follow different paths.

State **one** change in the operation of the mass spectrometer that will change the path of an ion.

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(2 marks)

Question 8 continues on the next page

8 (d) Organic fertilisers contain a higher proportion of ^{15}N atoms than are found in synthetic fertilisers.

State and explain whether or not you would expect the chemical reactions of the nitrogen compounds in the synthetic fertiliser to be different from those in the organic fertiliser. Assume that the nitrogen compounds in each fertiliser are the same.

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(2 marks)

11

END OF QUESTIONS