

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**.



J U N 1 5 C H E M 1 0 1

WMP/Jun15/CHEM1/E5

# CHEM1

**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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**1 (d)** Chlorine is a Period 3 element.  
Chlorine forms the molecules  $\text{ClF}_3$  and  $\text{CCl}_2$

**1 (d) (i)** Use your understanding of electron pair repulsion to draw the shape of  $\text{ClF}_3$  and the shape of  $\text{CCl}_2$   
Include any lone pairs of electrons that influence the shape.

**[2 marks]**

Shape of  $\text{ClF}_3$

Shape of  $\text{CCl}_2$

**1 (d) (ii)** Name the shape of  $\text{CCl}_2$

**[1 mark]**

.....

**1 (d) (iii)** Write an equation to show the formation of one mole of  $\text{ClF}_3$  from its elements.

**[1 mark]**

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11

**Turn over for the next question**

**Turn over ►**



2 Tellurium is the element with atomic number of 52

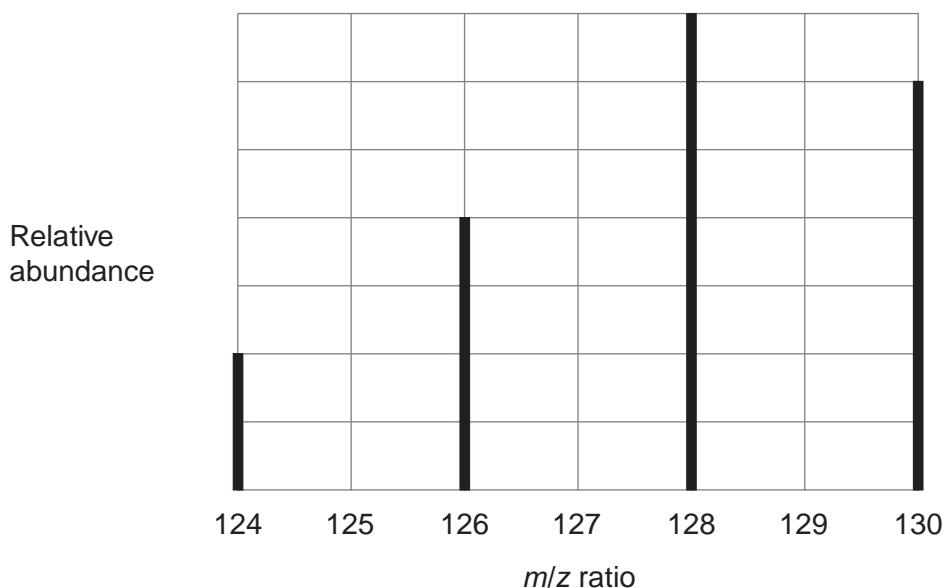
2 (a) Using information from the Periodic Table, complete the electron configuration of tellurium.

[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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**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  $^{124}\text{Te}$  is larger than, smaller than or the same as the atomic radius of  $^{130}\text{Te}$   
Explain your answer.  
[2 marks]

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

Explanation .....

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3 Silicon dioxide ( $\text{SiO}_2$ ) 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 ( $\text{H}_2\text{SiF}_6$ ) and one other substance.

Write an equation for this reaction.

[1 mark]

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**4** A sample of hydrated nickel sulfate ( $\text{NiSO}_4 \cdot x\text{H}_2\text{O}$ ) 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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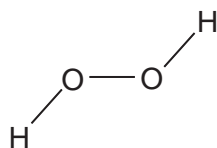
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**Turn over for the next question**

**Turn over ►**



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]





**5 (c)** Explain, in terms of electronegativity, why the boiling point of  $\text{H}_2\text{S}_2$  is lower than  $\text{H}_2\text{O}_2$ .  
**[2 marks]**

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7

**Turn over for the next question**

**Turn over ►**



**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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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

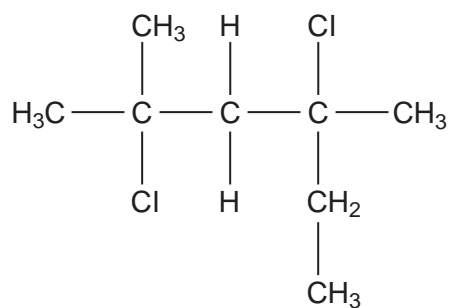
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6 (f) A compound  $C_8H_{18}$  reacts with chlorine to give several haloalkanes.

Give the IUPAC name of the following haloalkane.

[1 mark]



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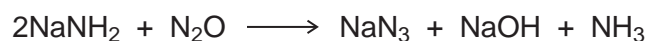


**Section B**

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

**7** Some airbags in cars contain sodium azide ( $\text{NaN}_3$ ).

**7 (a)** Sodium azide is made by reacting dinitrogen monoxide gas with sodium amide ( $\text{NaNH}_2$ ) as shown by the equation.



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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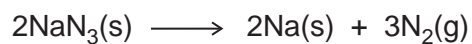
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**Question 7 continues on the next page**

**Turn over ►**



- 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.



The nitrogen produced then inflates the airbag to a volume of  $7.50 \times 10^{-2} \text{ m}^3$  at a pressure of 150 kPa and temperature of 35 °C.

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

**[6 marks]**

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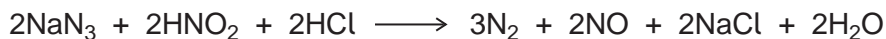
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- 7 (c)** Sodium azide is toxic. It can be destroyed by reaction with an acidified solution of nitrous acid ( $\text{HNO}_2$ ) as shown in the equation.



- 7 (c) (i)** A  $500 \text{ cm}^3$  volume of the nitrous acid solution was used to destroy completely 150 g of the sodium azide.

Calculate the concentration, in  $\text{mol dm}^{-3}$ , 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]**



- 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**

**Turn over ►**



7 (e) The azide ion has the formula  $\text{N}_3^-$

7 (e) (i) The azide ion can be represented as  $\text{N} \equiv \text{N} - \text{N}^-$   
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.

$\text{Mg}_3\text{N}$

$\text{MgN}$

$\text{MgN}_6$

$\text{Mg}_3\text{N}_2$

21

**END OF QUESTIONS**

