

Surname						Other Names					
Centre Number						Candidate Number					
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For Examiner's Use

General Certificate of Education
June 2008
Advanced Subsidiary Examination



CHEMISTRY
Unit 1 Atomic Structure, Bonding and Periodicity

CHM1

Wednesday 4 June 2008 9.00 am to 10.00 am

For this paper you must have

- a calculator.

Time allowed: 1 hour

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in **Section A** and **Section B** in the spaces provided. Answers written in margins or blank pages will not be marked.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The Periodic Table/Data Sheet is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information

- The maximum mark for this paper is 60.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- Your answers to the questions in **Section B** should be written in continuous prose, where appropriate.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

Advice

- You are advised to spend about 45 minutes on **Section A** and about 15 minutes on **Section B**.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			



SECTION A

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

- 1** (a) State, in terms of protons and neutrons, the meaning of the term *isotopes*.

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(1 mark)

- 1** (b) The table below gives the relative abundance of each isotope in a mass spectrum of a sample of lead, Pb

m/z	204	206	207	208
Relative abundance (%)	1.5	23.6	21.4	53.5

Use these data to calculate the relative atomic mass of this sample of lead. Give your answer to **one** decimal place.

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(2 marks)



■ The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

† 90 – 103 Actinides

Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Table 1
Proton n.m.r chemical shift data

Type of proton	δ/ppm
RCH_3	0.7–1.2
R_2CH_2	1.2–1.4
R_3CH	1.4–1.6
RCOCH_3	2.1–2.6
ROCH_3	3.1–3.9
RCOOCH_3	3.7–4.1
ROH	0.5–5.0

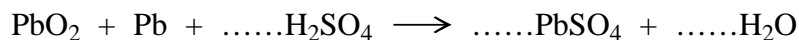
Table 2
Infra-red absorption data

Bond	Wavenumber/ cm^{-1}
C—H	2850–3300
C—C	750–1100
C=C	1620–1680
C=O	1680–1750
C—O	1000–1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000



1 (c) Lead is used in lead-acid car batteries.

1 (c) (i) Balance the equation, given below, for the overall reaction which occurs when a lead-acid battery produces a current.



1 (c) (ii) State what chemical difference there will be, if any, if the lead used in the above reaction is ^{204}Pb rather than ^{206}Pb . Explain your answer.

Chemical difference

Explanation

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(3 marks)

1 (d) An atom has four times the number of protons, and three times the number of neutrons, as there are in the ^7Li atom.

Deduce the symbol, including the mass number, of this atom.

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(2 marks)

1 (e) Before deflection or detection can occur in a mass spectrometer, a sample of gaseous atoms must first be ionised.

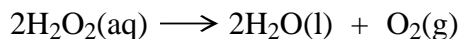
1 (e) (i) Explain how gaseous atoms are ionised in a mass spectrometer.

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1 (e) (ii) Identify another process in a mass spectrometer, apart from deflection and detection, which depends on the sample being ionised.

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(3 marks)

- 2 (a) Oxygen may be prepared by the decomposition of hydrogen peroxide, H_2O_2 , as shown in the equation below.



A 150 cm^3 sample of 2.72 mol dm^{-3} aqueous hydrogen peroxide was decomposed completely.

Calculate the number of moles of hydrogen peroxide in the 150 cm^3 sample and hence deduce the number of moles of oxygen gas produced.

Moles of H_2O_2 in sample

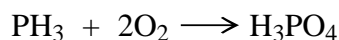
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Moles of O_2 produced

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(3 marks)

- 2 (b) Phosphine, PH_3 , and oxygen can react to form phosphoric acid, H_3PO_4 , as shown in the equation below.



An excess of oxygen was mixed with 1.43 g of phosphine in a sealed container and allowed to react.

- 2 (b) (i) Calculate the number of moles of PH_3 in 1.43 g of phosphine.

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- 2 (b) (ii) Calculate the number of moles of oxygen which reacted with this amount of phosphine.

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- 2 (b) (iii) Calculate the mass of phosphoric acid formed in this reaction.

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(4 marks)



- 2 (c) After the reaction in part (b) was complete, 0.166 mol of oxygen was left unreacted. The final temperature was 300 K. The volume of the sealed container was 1725 cm³.

State the ideal gas equation and use it to calculate the pressure of the oxygen in the container after the reaction was complete.

(The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$)

Ideal gas equation

Pressure

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(4 marks)

Turn over for the next question



- 3 (a) State the meaning of the term *first ionisation energy* of an atom.

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(2 marks)

- 3 (b) Explain why there is a general increase in the first ionisation energies of the Period 3 elements Na to Ar

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(2 marks)

- 3 (c) State how the first ionisation energy of sulphur deviates from the general trend in part (b). Explain your answer.

Deviation of sulphur from the general trend

Explanation

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(3 marks)

- 3 (d) (i) Draw the shape of a BF_3 molecule and the shape of a H_2S molecule. In each case show any lone pairs of electrons.



- 3 (d) (ii) Explain why a BF_3 molecule has the shape you have drawn.

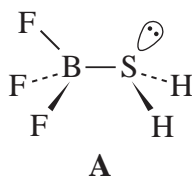
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(4 marks)

- 3 (e) Hydrogen sulphide, H_2S , reacts with boron trifluoride, BF_3 , to form compound **A**.



Predict the value of the H-S-H bond angle in compound **A**.

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(1 mark)

- 4 (a) State which has the larger atomic radius, a sodium atom or a chlorine atom. Explain your answer.

Atom with larger atomic radius

Explanation

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(4 marks)

- 4 (b) (i) Give the electron arrangement of the sodium atom.

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- 4 (b) (ii) State which has the larger radius, a sodium atom or a sodium ion (Na^+). Explain your answer.

Larger radius

Explanation

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- 4 (b) (iii) Suggest why a chloride ion (Cl^-) has a larger radius than a chlorine atom.

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(5 marks)

- 4 (c) Consider the sulphates and the hydroxides of the Group II elements Mg to Ba

- 4 (c) (i) Give the formula of the **least** soluble sulphate

- 4 (c) (ii) Give the formula of the **most** soluble hydroxide

(2 marks)

SECTION B

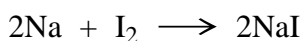
Answer **both** questions in the space provided on pages 11-16.

- 5** Diamond and graphite are both giant covalent (macromolecular) forms of carbon.

State how the structures of diamond and graphite are different. Briefly explain why diamond is very hard, and why graphite is able to act as a lubricant and as an electrical conductor.

(7 marks)

- 6** On heating, a mixture of sodium and iodine react to form sodium iodide as shown by the equation below.



The melting points of iodine and sodium iodide are 114 °C and 662 °C respectively.

For each of the substances sodium, iodine and sodium iodide, state the type of bonding present and explain the nature of the attractive forces holding each solid together.

Briefly explain why the melting point of iodine is much lower than that of sodium iodide.

Explain, in terms of electrons, how the reaction between sodium and iodine occurs.

(8 marks)

END OF QUESTIONS

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Turn over ►



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Turn over ►



[illegible]

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Turn over ►



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