Surname	Other							
Centre Number Candidate Number								
Candidate Signature	Э							

For Examiner's Use

General Certificate of Education June 2007 Advanced Subsidiary Examination ASSESSMENT and QUALIFICATIONS
ALLIANCE

CHEMISTRY CHM1 Unit 1 Atomic Structure, Bonding and Periodicity

Wednesday 6 June 2007 9.00 am to 10.00 am

For this paper you must have

· a calculator.

Time allowed: 1 hour

Instructions

- Use blue or black ink or 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.
- 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**.

F	or Exam	iner's Us	e
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
Total (Co	olumn 1)	→	
Total (Co	olumn 2) _	\rightarrow	
TOTAL			
Examine	r's Initials		

SECTION A

Answer all questions in the spaces provided.

	Tron	d			
	Ехрі	anation	•••••	•••••	•••••
	•••••				
	•••••				(3 marks
(b)	The	table below gives the valu	ies of the first three	e ionisation energies	of magnesium.
			First ionisation energy	Second ionisation energy	Third ionisation energy
	Ioni	sation energy/kJ mol ⁻¹	738	1451	7733
					•••••
					•••••
	(ii)	Explain why the third io the second ionisation end	onisation energy of	magnesium is very n	
	(ii)		onisation energy of	magnesium is very n	
	(ii)		onisation energy of	magnesium is very n	
	(ii)		onisation energy of	magnesium is very n	
	(ii)		enisation energy of a ergy of magnesium	magnesium is very n	nuch larger than
		the second ionisation end	nisation energy of ergy of magnesium	magnesium is very n	nuch larger than
		State and explain the tre in Group II.	nisation energy of ergy of magnesium	magnesium is very n	nuch larger than
		State and explain the tre in Group II. Trend	nisation energy of ergy of magnesium	magnesium is very n	elements Mg to B

The Periodic Table of the Elements

■ 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.

				Ι		Ι		Ι				
0	4.0 He Helium 2									222.0 Rn	Radon 86	
=		19.0 म	Fluorine 9	32.5 2	Chlorine 17	79.9 Br	Bromine 35	126.9 –	lodine 53	210.0 At	Astatine 85	
5		16.0 O	Oxygen 8	32.1 S	Sulphur 16	79.0 Se	Selenium 34	127.6 Te	Tellurium 52	210.0 Po	Polonium 84	
>		14.0 Z	Nitrogen Oxygen 9	31.0 P	Phosphorus 15	74.9 As	Arsenic 33	121.8 Sb	Antimony 51	209.0 Bi	Bismuth 83	
≥		12.0 C	Boron Carbon 7	28.1 Si	Silicon 14	72.6 Ge	Germanium 32	118.7 Sn	Tin 50	207.2 Pb	Lead 82	
≡		10.8 B	Boron 5	27.0 AI	Aluminium 13	69.7 Ga	Gallium 31	114.8 In	Indium 49	204.4 T	Thallium 81	
						65.4 Zn	Zinc 30	112.4 Cd	Cadmium 48	200.6 Hg	Mercury 80	
							Copper 29			197.0 Au		
							Nickel 28			195.1		
						6.83 6.83	Cobalt 27	102.9 Rh	Rhodium 45	192.2 	lridium 77	
						55.8 Fe	lron 26	101.1 Bu	Ruthenium 44	190.2 Os	Osmium 76	
		6.9 Li	Lithium 3			54.9 Mn	Manganese Iron Cobalt 25 27	98.9 Tc	Technetium 43	186.2 Re	Rhenium 75	
				I		52.0 C	Chromium 24	95.9 Mo	Molybdenum 42	183.9 W	Tungsten 74	
		tomic ma	ımber —			2 0.9		92.9 Nb		180.9 Ta	п	
	Key	relative atomic mass -	atomic number			47.9		91.2 Zr	Zirconium 40	178.5 H	Hafnium 72	
	_	- -				45.0 Sc		8 8.9		138.9 La	_	227 Ac Actinium 89 †
=		9.0 Be	Beryllium 4	24.3 Mg		40.1 Ca		87.6 SQ	_	137.3 Ba	_	226.0 7 Ra Radium 88
-	1.0 H Hydrogen	6.9 Li	Lithium 3		Sodium 11	39.1 K		85.5 8	_	132.9 Cs		223.0 Fr Francium 87

- * * * * * * * * * * * * * * * * * * *	140.1 Ce	140.9 Pr	144.2 Nd	144.9 Pm	_{0.4} Sm	152.0 Eu	157.3 Gd	158.9 Tb	162.5 Dy		167.3 Er	168.9 Tm	173.0 Yb	175.0 Lu
36 - 71 Laninanides	Cerium 58	Cerium Praseodymium Neodymium Promethium Sa 58 59 60 61 62	Neodymium 60	Promethium 61	ımarium	Europium 63	_	Terbium 65	Dysprosium 66	Holmium 67	Erbium 68	Thulium 69	Ytterbium 70	Lutetium 71
00 T	232.0 Th	232.0 231.0 238.0 237.0 Th Pa U N	238.0 U	_ م	239.1 Pu	- E	247.1 Cm	_×		(252) Es	(257) Fm	(258) Md	(259) No	(260) Lr
T 90 - 103 Actinides	Thorium 90	Protactinium 91	Uranium 92	Neptunium 93	Plutonium 94	Americiun 95			Californium 98	Einsteinium 99	Fermium 100	Mendelevium 101		Lawrencium 103

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/ррт
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
С—Н	2850–3300
С—С	750–1100
C=C	1620–1680
C=O	1680–1750
С—О	1000-1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000

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(c)	There is a trend in the reactivity of the Group II metals with H ₂ O. State the conditions needed for Mg and Ca to react rapidly with H ₂ O. Write an equation for each of these reactions.
	Conditions for Mg
	Equation
	Conditions for Ca
	Equation
	(4 marks)

Turn over for the next question

Turn over ▶

2	(a)		nonium carbamate contains 15.38 % of carbon, 7.69 % of hydrogen, 35.90 % of gen and 41.03 % of oxygen by mass.
			these data to confirm that the empirical formula of ammonium carbamate is N_2O_2
		•••••	
		•••••	
			(2 marks)
	(b)	Whe	n heated, ammonium carbamate, H ₂ NCOONH ₄ , decomposes as shown below.
			$H_2NCOONH_4(s) \longrightarrow 2NH_3(g) + CO_2(g)$
			closed container, a 7.50 g sample of ammonium carbamate was heated. The solid mposed completely into ammonia and carbon dioxide at 473 K and 98.7 kPa.
		(i)	Calculate the number of moles of ammonium carbamate used and the total number of moles of gas produced.
			Moles of ammonium carbamate used
			Total moles of gas produced
		(ii)	State the ideal gas equation and use it, together with your answer from part (b)(i), to calculate the total volume of gas produced at 473 K and 98.7 kPa. Include units in your final answer. (The gas constant $R = 8.31 \mathrm{JK^{-1}mol^{-1}}$)
			(If you have been unable to obtain an answer to part (b)(i), you should assume that the total number of moles of gas produced is 0.253 mol. This is not the correct answer.)
			Ideal gas equation
			Calculation
			(7 marks)

	dinitrogen tetroxide and	water.		

$$....N_2O_4 +H_2O \longrightarrowHNO_3 +NO$$
 (1 mark)

(b) A 150 cm³ sample of 1.65 mol dm⁻³ aqueous nitric acid was completely reacted with copper. The equation for the reaction which occurred is shown below.

$$3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

- (i) Calculate the number of moles of nitric acid in 150 cm³ of 1.65 mol dm⁻³ aqueous nitric acid.
- (ii) Calculate the number of moles, and hence the mass, of copper that would react completely with this amount of nitric acid.

(If you have been unable to obtain an answer to part (b)(i), you should assume that the total number of moles of nitric acid is 0.172. This is not the correct answer.)

Moles of copper
Mass of copper

(5 marks)

Turn over for the next question

pola		of NH ₃ , H ₂ O and HF contain covalent bonds. The bonds in these molecules are
(a)	State	what is meant by a covalent bond and by a polar bond.
	Cova	alent bond
	•••••	
	Pola	r bond
		(2 marks)
(b)	(i)	Explain why the H–F bond is polar.
	(ii)	State which one of the molecules NH ₃ , H ₂ O or HF contains the least polar bond.
	(iii)	Explain why the bond in your chosen molecule from part (b)(ii) is less polar than the bonds found in the other two molecules.
		(4 marks)
(c)		boiling points of NH ₃ , H ₂ O and HF are all high for molecules of their size. This e to the type of intermolecular force present in each case.
	(i)	Identify the type of intermolecular force responsible.
	(ii)	Draw a diagram to show how two molecules of ammonia are attracted to each other by this type of intermolecular force. Include partial charges and all lone pairs of electrons in your diagram.

Whe	en an H ⁺ ion reacts with an NH ₃ molecu	le, an NH ₄ ion is formed.	
(i)	Give the name of the type of bond formed when an H ⁺ ion reacts with an NH ₃ molecule. Describe how this bond is formed in the NH ₄ ⁺ ion.		
	Type of bond		
	Description		
(ii)	Draw the shape, including any lone pairs of electrons, of an NH ₃ molecule and an NH ₄ ion.		
	NH_3	NH_4^+	
(iii)	Name the shape produced by the arran	gement of the atoms in the NH ₃ molecule.	
(iv)	Give the bond angle in the NH ₄ ⁺ ion.		
		(7 marks)	

(d)

SECTION B

Answer questions 5 and 6 in the space provided on pages 11 and 12.

5 (a) The two isotopes normally found in a sample of nitrogen are ¹⁴N and ¹⁵N. Compare these two isotopes in terms of their fundamental particles. State and explain the difference, if any, in the chemical properties of these two isotopes.

(4 marks)

(b) State the block in the Periodic Table to which nitrogen belongs and explain your answer.

Give the electron arrangement of the N^{3-} ion.

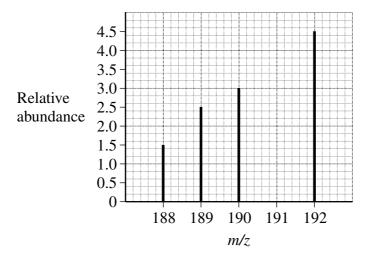
(3 marks)

6 (a) Acceleration and detection are two processes involved in obtaining the mass spectrum of a vaporised sample of a metal.

Name the other two main processes involved. In each case, identify the part of the mass spectrometer responsible for that process.

(4 marks)

(b) The diagram below shows the mass spectrum of a gaseous sample of a metal **Z**.



Use the spectrum to calculate the relative atomic mass of **Z**. Give your answer to one decimal place.

Deduce the identity of **Z**.

(4 marks)

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