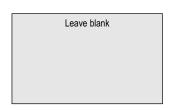
Surname		Other	Names			
Centre Number			Candida	ate Number		
Candidate Signature						



General Certificate of Education January 2005 Advanced Subsidiary Examination



CHEMISTRY CHM2 Unit 2 Foundation Physical and Inorganic Chemistry

Tuesday 11 January 2005 Morning Session

In addition to this paper you will require:	
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 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 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.
- Mark allocations are shown in brackets.
- This paper carries 30 per cent of the total marks for AS. For Advanced Level this paper carries 15 per cent of the total marks.
- You are expected to use a calculator where appropriate.
- The following data may be required. Gas constant $R = 8.31 \,\mathrm{J \, K^{-1} \, mol^{-1}}$
- Your answers to the question 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							
Number	Mark	Number	Mark				
1							
2							
3							
4							
5							
Total (Column	1)	\rightarrow					
Total (Column	2)	\rightarrow					
TOTAL							
Examine	r's Initials						

SECTION A

Answer all questions in the spaces provided.

1	(a)		e the trend in the boiling points of the halogens from fluorine to iodine and explain trend.
		Tren	d
		Expl	anation
		•••••	(4 marks)
	(b)		of the following reactions may be used to identify bromide ions. For each reaction, what you would observe and, where indicated, write an appropriate equation.
		(i)	The reaction of aqueous bromide ions with chlorine gas
			Observation
			Equation
		(ii)	The reaction of aqueous bromide ions with aqueous silver nitrate followed by the addition of concentrated aqueous ammonia
			Observation with aqueous silver nitrate
			Equation
			Observation with concentrated aqueous ammonia
		(iii)	The reaction of solid potassium bromide with concentrated sulphuric acid
			Observation 1
			Observation 2
	(c)		e an equation for the redox reaction that occurs when potassium bromide reacts concentrated sulphuric acid.
		•••••	(2 marks)



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.

Xe Xenon Helium Helium Radon Argon Bromine 35 Chlorine 17 Astatine 85 Fluorine <u>|35.5</u> |79.9 **Br** lodine ₹ Sulphur 16 Oxygen Selenium Polonium Tellurium 0 0 5 Phosphorus 74.9 **As** Arsenic Nitrogen Antimony Bismuth 121.8 **Sb** > Germanium 32 Carbon . **Ge Sn** Tin <u>S8.1</u> Silicon ≥ Aluminium Thallium Gallium 10.8 **B** Boron Indium 114.8 **n** ≡ **5.4 Zn** Zinc Cadmium Mercury 112.4 Cd 63.5 Copper **Ag** Silver **Au** Gold Platinum 78 Palladium Nickel 106.4 **Pd Cobalt** Rhodium Iridium Technetium Ruthenium Osmium Chromium Manganese 24 25 Rhenium |75 Lithium ニ Molybdenum Tungsten 74 95.9 **Mo** 183.9 **▼** relative atomic mass Vanadium 23 Tantalum Niobium 92.9 **Nb** 180.9 **Ta** atomic number Zirconium 40 Titanium Lanthanum Hafnium 57 * 72 178.5 **Hf** Key Scandium Yttrium Actinium 138.9 **La** Strontium 38 **Mg** Magnesium Calcium Beryllium 9.0 **Be** Barinm Radium 88 Potassium Francium Rubidium Caesium Hydrogen Sodium Lithium

	140.1 Ce	140.9 Pr	144.2 Nd	144.9 Pm	150.4 Sm	152.0 Eu	157.3 Gd	158.9 Tb	162.5 Dy	164.9 Ho	167.3 Er	8.9 Tm	173.0 Yb	175.0 Lu
. 36 – 71 Lantnanides	Cerium 58	Praseodymium 59	Neodymium 50	Promethium 61	Samarium Europium 62 63	Europium 63	3adolinii 34	Terbium 65	Dysprosium 66	Lam Terbium Dysprosium Holmium Erbium 1 65 66 67 68 69	Erbium 68	-hulium	Ytterbium 70	Lutetium 71
	232.0 Th	231.0 238.0 h Pa U	238.0 U	237.0 Np	239.1 Pu	243.1 Am	Cm	247.1 Bk	252.1 Cf	(252) Es	(257) Fm	9 9	(259) No	(260) Lr
T 90 – 103 Actinides	Thorium 90	Protactinium 91	Uranium 92	Neptunium 93	m Plutonium Americium 94 95 5	Americium 95	Curiun 36	Berkelium 97	Californium 98	Einsteinium 99	Fermium 100	ndelevium 1	Nobelium 102	Lawrencium 103

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_3 CH	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

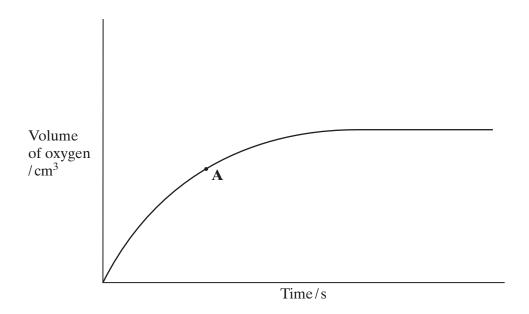
Table 2 Infra-red absorption data

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

2	(a)	By re	eferrin	g to electrons,	explain the meaning	ng of the term oxidi.	sing agent.
		•••••	•••••				(1 mark)
	(b)		the el		he ionic compoun	d MX , explain the	e meaning of the term
		•••••	•••••				(1 mark)
	(c)		-	the table belown ion or compo		xidation state of eac	h of the stated elements
						Oxidation state	
				Carbon	in CO ₃ ²⁻		
				Phosphorus	in PCl ₄		
				Nitrogen	in Mg ₃ N ₂		
							(3 marks)
	(d)		gen m	onoxide, NO, a	and copper(II) ions		copper metal forming er(II) ions.
		(ii)		e a half-equation gen monoxide.		n, in an acidified so	lution, of nitrate ions to
		(iii)			uation for this read		
			•••••				(3 marks)



3 The curve below shows how the volume of oxygen evolved varies with time when 50 cm 3 of a 2.0 mol dm $^{-3}$ solution of hydrogen peroxide, H_2O_2 , decomposes at 298 K.



(a) State how you could use the curve to find the rate of reaction at point A.

.....(1 mark)

- (b) Sketch curves, on the above axes, to illustrate how the volume of oxygen evolved would change with time if the experiment was repeated at 298 K using the following.
 - (i) $100 \text{ cm}^3 \text{ of a } 1.0 \text{ mol dm}^{-3} \text{ solution of } H_2O_2$. Label this curve **X**.
 - (ii) $25 \text{ cm}^3 \text{ of a } 2.0 \text{ mol dm}^{-3} \text{ solution of } H_2O_2 \text{ in the presence of a catalyst. Label this curve } \mathbf{Y}$.

(c) Hydrogen peroxide decomposes more rapidly in the presence of aqueous hydrogen bromide. The decomposition proceeds as shown by the following equations.

$$H_2O_2 + HBr \rightarrow HBrO + H_2O$$

 $HBrO + H_2O_2 \rightarrow H_2O + O_2 + HBr$

(i)	Write an equation for the overall reaction.
(ii)	Define the term <i>catalyst</i> .
(iii)	Give two reasons, other than an increase in the reaction rate, why these equations suggest that hydrogen bromide is behaving as a catalyst.
	Reason 1
	(5 marks)



TURN OVER FOR THE NEXT QUESTION

4	(a)		When iron(III) oxide is reduced in the Blast Furnace, both carbon and carbon monoxide act as reducing agents.															
		(i)	Write an equation to illustrate how carbon monoxide is formed in the Blast Furnace.															
		(ii)	Write an equation to illustrate how carbon monoxide reduces iron(III) oxide.															
		(iii)	Suggest in terms of collisions why, in the Blast Furnace, carbon monoxide reacts more rapidly with iron(III) oxide than does carbon.															
			(4 marks)															
	(b)	State	why carbon is not used to reduce the oxide of titanium to the metal.															
		•••••	(1 mark)															
	(c)	(i)	Name the converter that is used to remove impurities from the iron obtained from a Blast Furnace.															
		(ii)	Write an equation to illustrate how the sulphur impurity is removed from the iron.															
		(iii)	State how the phosphorus impurity is removed from iron in this converter.															
		(iv)	Explain two major benefits of using some scrap iron in this converter.															
			Benefit 1															
			Benefit 2															
			(7 marks)															
	(d)	Give	two reasons why titanium is a more expensive metal than iron.															
		Reas	on 1															
		Reas	on 2															
			(2 marks)															



SECTION B

Answer the question below in the space provided on pages 9 to 12 of this booklet.

- 5 Methanol, CH₃OH, is a convenient liquid fuel.
 - (a) An experiment was conducted to determine the enthalpy of combustion of liquid methanol. The energy obtained from burning 2.12 g of methanol was used to heat 150 g of water. The temperature of the water rose from 298 K to 362 K. (The specific heat capacity of water is 4.18 J K⁻¹ g⁻¹)
 - (i) Define the term standard enthalpy of combustion.
 - (ii) Use the data above to calculate a value for the enthalpy of combustion of one mole of liquid methanol.

(7 marks)

(b) Methanol can be synthesised from methane and steam by a process that occurs in two stages.

Stage 1
$$CH_4(g) + H_2O(g) \implies 3H_2(g) + CO(g) \quad \Delta H^{\ominus} = +206 \text{ kJ mol}^{-1}$$

Stage 2
$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$
 $\Delta H^{\Theta} = -91 \text{ kJ mol}^{-1}$

- (i) Explain why, in *Stage 1*, a higher yield of hydrogen and carbon monoxide is **not** obtained if the pressure is increased.
- (ii) Stage 2 is carried out at a compromise temperature of 500 K. By considering what would happen at higher and lower temperatures, explain why 500 K is considered to be a compromise for Stage 2.

(5 marks)

(c) The standard enthalpies of combustion of carbon monoxide and of hydrogen are -283 kJ mol⁻¹ and -286 kJ mol⁻¹, respectively. Use these data and the enthalpy change for *Stage 2* to calculate a value for the standard enthalpy of combustion of gaseous methanol.

(3 marks)

END	OF	QUESTIONS	5

•••••	•••••		•••••	•••••
		•••••		

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