

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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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.

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

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 $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
- 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**.

SECTION A

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

- 1 (a) State the trend in the boiling points of the halogens from fluorine to iodine and explain this trend.

Trend

Explanation

.....

.....

(4 marks)

- (b) Each of the following reactions may be used to identify bromide ions. For each reaction, state 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

(7 marks)

- (c) Write an equation for the redox reaction that occurs when potassium bromide reacts with concentrated sulphuric acid.

.....

(2 marks)

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

- 2 (a) By referring to electrons, explain the meaning of the term *oxidising agent*.

.....
(1 mark)

- (b) For the element **X** in the ionic compound **MX**, explain the meaning of the term *oxidation state*.

.....
(1 mark)

- (c) Complete the table below by deducing the oxidation state of each of the stated elements in the given ion or compound.

	Oxidation state
Carbon in CO_3^{2-}	
Phosphorus in PCl_4^+	
Nitrogen in Mg_3N_2	

(3 marks)

- (d) In acidified aqueous solution, nitrate ions, NO_3^- , react with copper metal forming nitrogen monoxide, NO, and copper(II) ions.

- (i) Write a half-equation for the oxidation of copper to copper(II) ions.

.....

- (ii) Write a half-equation for the reduction, in an acidified solution, of nitrate ions to nitrogen monoxide.

.....

- (iii) Write an overall equation for this reaction.

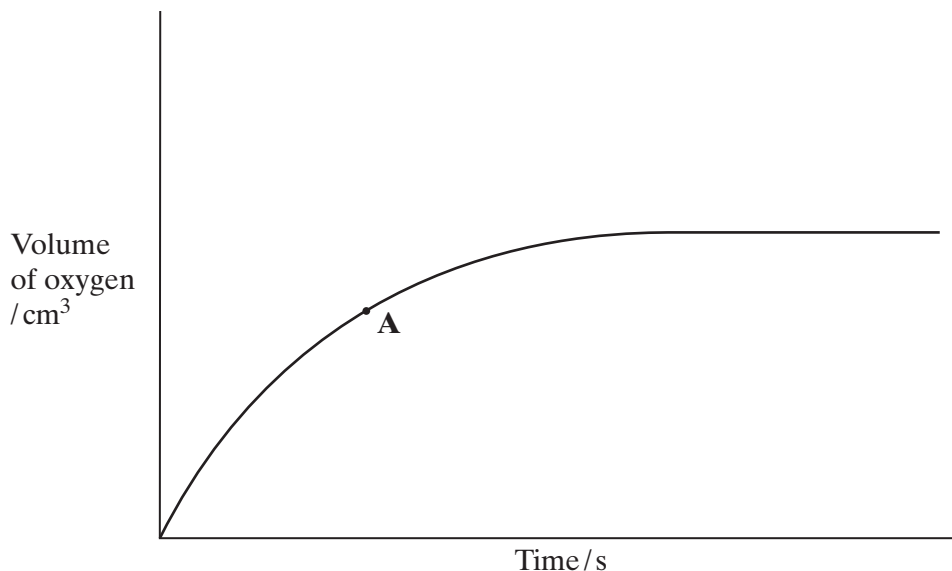
.....

(3 marks)

8

Turn over ►

- 3 The curve below shows how the volume of oxygen evolved varies with time when 50 cm³ of a 2.0 mol dm⁻³ solution of hydrogen peroxide, H₂O₂, decomposes at 298 K.

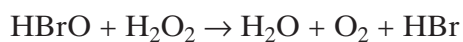
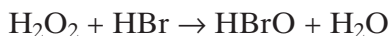


- (a) State how you could use the curve to find the rate of reaction at point **A**.

.....
(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.
- 100 cm³ of a 1.0 mol dm⁻³ solution of H₂O₂. Label this curve **X**.
 - 25 cm³ of a 2.0 mol dm⁻³ solution of H₂O₂ in the presence of a catalyst. Label this curve **Y**. (4 marks)

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



- (i) Write an equation for the overall reaction.

.....

- (ii) Define the term *catalyst*.

.....

.....

- (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

Reason 2

(5 marks)

10

TURN OVER FOR THE NEXT QUESTION

Turn over ►

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.

Reason 1

Reason 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.

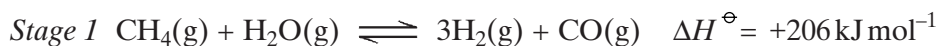
- (a) An experiment was conducted to determine the enthalpy of combustion of liquid methanol. The energy obtained from burning 2.12 g of methanol was used to heat 150 g of water. The temperature of the water rose from 298 K to 362 K. (The specific heat capacity of water is 4.18 J K⁻¹ g⁻¹)

(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.



- (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

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Turn over ►

