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General Certificate of Education  
June 2003  
Advanced Subsidiary Examination



**CHEMISTRY** **CHM2**  
**Unit 2 Foundation Physical and Inorganic Chemistry**

Wednesday 4 June 2003 Morning Session

<b>In addition to this paper you will require:</b> a calculator.
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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**.

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**SECTION A**

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

- 1 (a) Iron is extracted in a Blast Furnace by a continuous reduction process. Identify **two** reducing agents present in the Blast Furnace. In each case, write an equation to show how the reducing agent reacts in the formation of iron.

*Reducing agent 1* .....

*Equation* .....

*Reducing agent 2* .....

*Equation* .....

(4 marks)

- (b) Titanium is extracted from  $\text{TiO}_2$  using two separate batch processes. For each of these processes, write an equation for the reaction occurring.

*Equation 1* .....

*Equation 2* .....

(4 marks)

- (c) Suggest in general terms how metals can be extracted from sulphide ores. Explain how pollution problems can arise from such extractions.

*Extraction* .....

.....

.....

*Pollution problems* .....

.....

.....

(4 marks)



**Table 1**  
Proton n.m.r chemical shift data

Type of proton	$\delta/\text{ppm}$
$\text{RCH}_3$	0.7–1.2
$\text{R}_2\text{CH}_2$	1.2–1.4
$\text{R}_3\text{CH}$	1.4–1.6
$\text{RCOCH}_3$	2.1–2.6
$\text{ROCH}_3$	3.1–3.9
$\text{RCOOCH}_3$	3.7–4.1
$\text{ROH}$	0.5–5.0

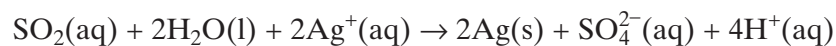
**Table 2**  
Infra-red absorption data

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

- 2 (a) In terms of electrons, what happens to an oxidising agent during a redox reaction?

.....  
(1 mark)

- (b) Consider the following redox reaction.



- (i) Identify the oxidising agent and the reducing agent in this reaction.

*Oxidising agent* .....

*Reducing agent* .....

- (ii) Write a half-equation to show how sulphur dioxide is converted into sulphate ions in aqueous solution.

.....  
(3 marks)

- (c)  $\text{Fe}^{2+}$  ions are oxidised to  $\text{Fe}^{3+}$  ions by  $\text{ClO}_3^-$  ions in acidic conditions. The  $\text{ClO}_3^-$  ions are reduced to  $\text{Cl}^-$  ions.

- (i) Write a half-equation for the oxidation of  $\text{Fe}^{2+}$  ions in this reaction.

.....

- (ii) Deduce the oxidation state of chlorine in  $\text{ClO}_3^-$  ions.

.....

- (iii) Write a half-equation for the reduction of  $\text{ClO}_3^-$  ions to  $\text{Cl}^-$  ions in acidic conditions.

.....

- (iv) Hence, write an overall equation for the reaction.

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(4 marks)

- (d) Write an equation to show how sulphur is removed from impure iron obtained from the Blast Furnace. Identify the oxidising agent in this reaction.

*Equation* .....

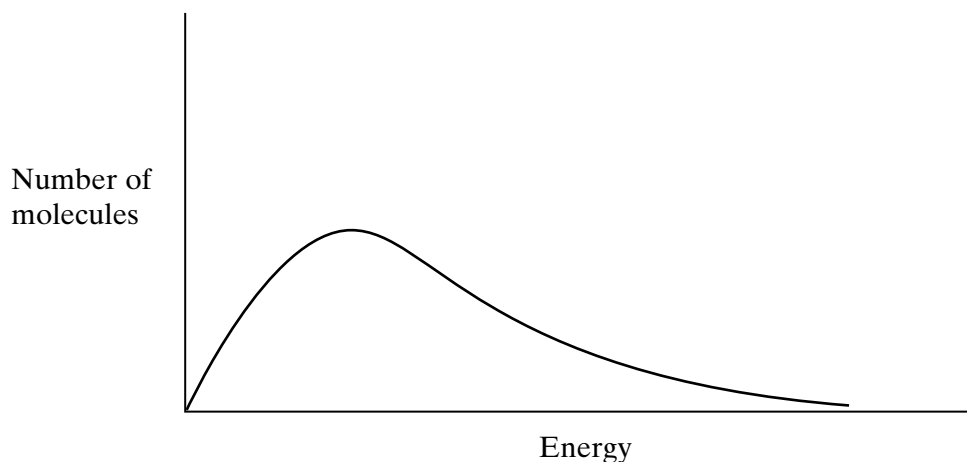
*Oxidising agent* .....

(2 marks)

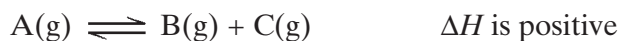
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Turn over 

- 3 (a) A sample of a gas was sealed into a flask at temperature  $T$  and pressure  $P$ . The Maxwell-Boltzmann distribution of energies for the molecules in this sample is shown below.



- (i) Using the axes above, sketch the curve that you would expect if this sample of gas at pressure  $P$  had been cooled. Label this curve **X**.
- (ii) Using the axes above, sketch the curve that you would expect if another sample of the same gas was sealed in the same flask at the original temperature,  $T$ , but at a higher pressure. Label this curve **Y**. (4 marks)
- (b) Gas **A** decomposes slowly to form gases **B** and **C**. An equilibrium is established as shown by the following equation.



- (i) In terms of the behaviour of molecules, state what must happen before molecules of **A** can react to form **B** and **C**.

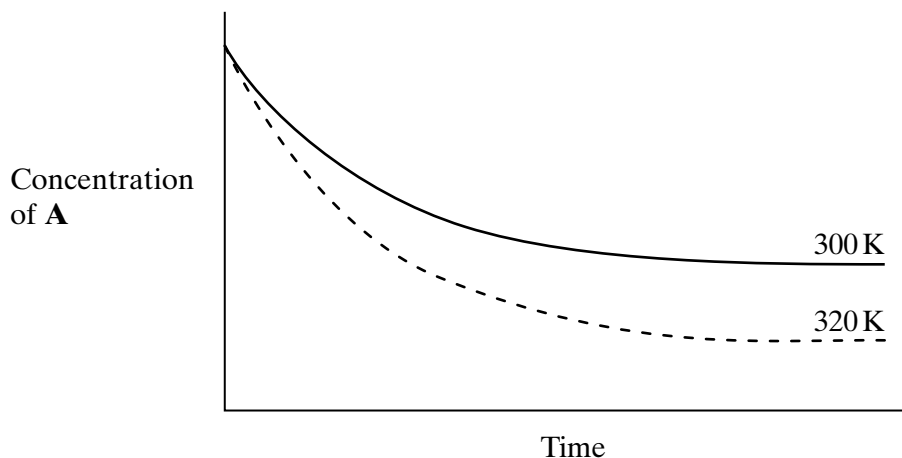
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- (ii) Explain why the decomposition of **A** is faster at higher temperatures.

.....  
 .....

(4 marks)

- (c) The graphs below show how, starting from **A** alone, the concentration of **A** varies with time at temperatures of 300 K and 320 K for the reversible reaction given in part (b).



- (i) Suggest why, as shown on the graphs, the concentration of **A** remains constant after a time.
- .....
- (ii) Explain why, at 320 K, the concentration of **A** falls to a lower value compared with the reaction at 300 K.
- .....
- .....
- .....

(3 marks)

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**TURN OVER FOR THE NEXT QUESTION**

Turn over

- 4 (a) Write an equation for the complete combustion of propanone,  $C_3H_6O$ , to form carbon dioxide and water.

.....  
(1 mark)

- (b) In a laboratory experiment, 1.45 g of propanone were burned completely in oxygen. The heat from this combustion was used to raise the temperature of 100 g of water from 293.1 K to 351.2 K.

- (i) Calculate the number of moles of propanone in the 1.45 g.

.....  
.....

- (ii) Calculate the heat energy required to raise the temperature of 100 g of water from 293.1 K to 351.2 K.  
(The specific heat capacity of water is  $4.18 \text{ JK}^{-1} \text{ g}^{-1}$ )

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- (iii) Hence, calculate a value, in  $\text{kJ mol}^{-1}$ , for the enthalpy of combustion of propanone.

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.....  
(5 marks)

- (c) In a similar experiment, the enthalpy of combustion of butanone,  $C_4H_8O$ , was found to be  $-1290 \text{ kJ mol}^{-1}$ . A data book value for the same reaction is  $\Delta H_c^\ominus = -2430 \text{ kJ mol}^{-1}$ .

- (i) Suggest one reason why the experimental value is very different from the data book value.

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- (ii) This data book value of  $\Delta H_c^\ominus$  for butanone ( $-2430 \text{ kJ mol}^{-1}$ ) refers to the formation of carbon dioxide gas and water in the gaseous state. How would this value differ if it referred to the formation of water in the liquid state? Explain your answer.

*Difference* .....

*Explanation* .....

.....  
(3 marks)



- (d) Calculate a value for the standard enthalpy of formation for liquid ethanethiol,  $C_2H_5SH$ . Use the equation given below and enthalpy of combustion data from the following table.

Substance	$C_2H_5SH(l)$	$C(s)$	$H_2(g)$	$S(s)$
$\Delta H_c^\ominus / kJ mol^{-1}$	-1170	-394	-286	-297



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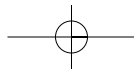
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(3 marks)

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**TURN OVER FOR THE NEXT QUESTION**

Turn over 



**SECTION B**

Answer the question below in the space provided on pages 10 to 12 of this booklet.

- 5 (a) Describe and explain the trend in the boiling points of the elements down Group VII from fluorine to iodine. *(4 marks)*
- (b) Describe what you would observe when aqueous silver nitrate, followed by dilute aqueous ammonia, is added to separate aqueous solutions of sodium chloride and sodium bromide. *(4 marks)*
- (c) State the trend in the oxidising abilities of the elements down Group VII from chlorine to iodine.  
Explain how this trend can be shown by displacement reactions between halogens and halide ions in aqueous solutions.  
Illustrate your answer with appropriate observations and equations. *(7 marks)*

**END OF QUESTIONS**

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