Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM2
Unit 2 Foundation Physical and Inorganic Chemistry

Wednesday 4 June 2003 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 $R = 8.31$ 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) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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 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)

12

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.

I	II											III	IV	V	VI	VII	0
1.0 **H** Hydrogen 1																	4.0 **He** Helium 2
6.9 **Li** Lithium 3	9.0 **Be** Beryllium 4											10.8 **B** Boron 5	12.0 **C** Carbon 6	14.0 **N** Nitrogen 7	16.0 **O** Oxygen 8	19.0 **F** Fluorine 9	20.2 **Ne** Neon 10
23.0 **Na** Sodium 11	24.3 **Mg** Magnesium 12											27.0 **Al** Aluminium 13	28.1 **Si** Silicon 14	31.0 **P** Phosphorus 15	32.1 **S** Sulphur 16	35.5 **Cl** Chlorine 17	39.9 **Ar** Argon 18
39.1 **K** Potassium 19	40.1 **Ca** Calcium 20	45.0 **Sc** Scandium 21	47.9 **Ti** Titanium 22	50.9 **V** Vanadium 23	52.0 **Cr** Chromium 24	54.9 **Mn** Manganese 25	55.8 **Fe** Iron 26	58.9 **Co** Cobalt 27	58.7 **Ni** Nickel 28	63.5 **Cu** Copper 29	65.4 **Zn** Zinc 30	69.7 **Ga** Gallium 31	72.6 **Ge** Germanium 32	74.9 **As** Arsenic 33	79.0 **Se** Selenium 34	79.9 **Br** Bromine 35	83.8 **Kr** Krypton 36
85.5 **Rb** Rubidium 37	87.6 **Sr** Strontium 38	88.9 **Y** Yttrium 39	91.2 **Zr** Zirconium 40	92.9 **Nb** Niobium 41	95.9 **Mo** Molybdenum 42	98.9 **Tc** Technetium 43	101.1 **Ru** Ruthenium 44	102.9 **Rh** Rhodium 45	106.4 **Pd** Palladium 46	107.9 **Ag** Silver 47	112.4 **Cd** Cadmium 48	114.8 **In** Indium 49	118.7 **Sn** Tin 50	121.8 **Sb** Antimony 51	127.6 **Te** Tellurium 52	126.9 **I** Iodine 53	131.3 **Xe** Xenon 54
132.9 **Cs** Caesium 55	137.3 **Ba** Barium 56	138.9 **La** Lanthanum 57 *	178.5 **Hf** Hafnium 72	180.9 **Ta** Tantalum 73	183.9 **W** Tungsten 74	186.2 **Re** Rhenium 75	190.2 **Os** Osmium 76	192.2 **Ir** Iridium 77	195.1 **Pt** Platinum 78	197.0 **Au** Gold 79	200.6 **Hg** Mercury 80	204.4 **Tl** Thallium 81	207.2 **Pb** Lead 82	209.0 **Bi** Bismuth 83	210.0 **Po** Polonium 84	210.0 **At** Astatine 85	222.0 **Rn** Radon 86
223.0 **Fr** Francium 87	226.0 **Ra** Radium 88	227 **Ac** Actinium 89 †															

Key

relative atomic mass — 6.9 **Li** Lithium

atomic number — 3

140.1 **Ce** Cerium 58	140.9 **Pr** Praseodymium 59	144.2 **Nd** Neodymium 60	144.9 **Pm** Promethium 61	150.4 **Sm** Samarium 62	152.0 **Eu** Europium 63	157.3 **Gd** Gadolinium 64	158.9 **Tb** Terbium 65	162.5 **Dy** Dysprosium 66	164.9 **Ho** Holmium 67	167.3 **Er** Erbium 68	168.9 **Tm** Thulium 69	173.0 **Yb** Ytterbium 70	175.0 **Lu** Lutetium 71
232.0 **Th** Thorium 90	231.0 **Pa** Protactinium 91	238.0 **U** Uranium 92	237.0 **Np** Neptunium 93	239.1 **Pu** Plutonium 94	243.1 **Am** Americium 95	247.1 **Cm** Curium 96	247.1 **Bk** Berkelium 97	252.1 **Cf** Californium 98	(252) **Es** Einsteinium 99	(257) **Fm** Fermium 100	(258) **Md** Mendelevium 101	(259) **No** Nobelium 102	(260) **Lr** Lawrencium 103

* **58 – 71** Lanthanides

† **90 – 103** Actinides

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

.....

(1 mark)

(b) Consider the following redox reaction.

$$SO_2(aq) + 2H_2O(l) + 2Ag^+(aq) \rightarrow 2Ag(s) + SO_4^{2-}(aq) + 4H^+(aq)$$

(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) Fe^{2+} ions are oxidised to Fe^{3+} ions by ClO_3^- ions in acidic conditions. The ClO_3^- ions are reduced to Cl^- ions.

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

.....

(ii) Deduce the oxidation state of chlorine in ClO_3^- ions.

.....

(iii) Write a half-equation for the reduction of ClO_3^- ions to Cl^- ions in acidic conditions.

.....

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

.....

(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.

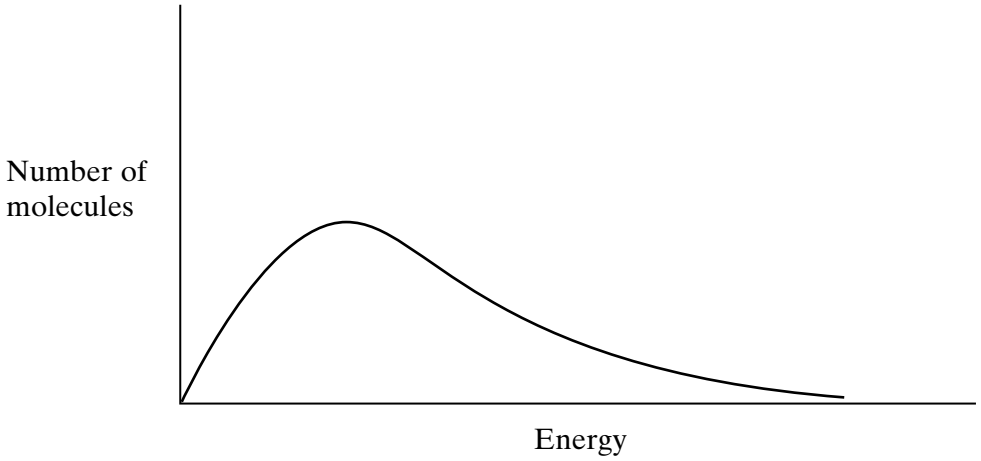
Equation .....

Oxidising agent .....

(2 marks)

10

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.

$$A(g) \rightleftharpoons B(g) + C(g) \qquad \Delta H \text{ is positive}$$

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

.....

.....

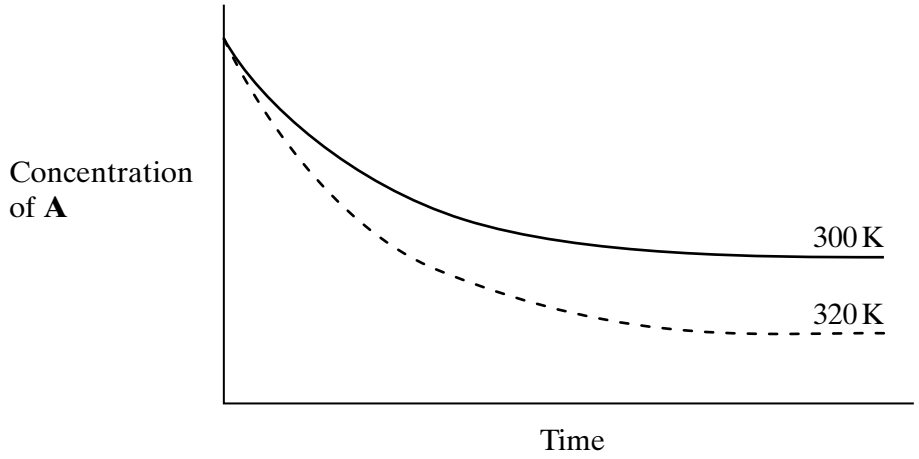
(ii) Explain why the decomposition of **A** is faster at higher temperatures.

.....

.....

(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.

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(ii) Explain why, at 320 K, the concentration of **A** falls to a lower value compared with the reaction at 300 K.

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(3 marks)

11

TURN OVER FOR THE NEXT QUESTION

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 $J\,K^{-1}\,g^{-1}$)

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(iii) Hence, calculate a value, in $kJ\,mol^{-1}$, 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 $-1290\,kJ\,mol^{-1}$. A data book value for the same reaction is $\Delta H_c^{\ominus} = -2430\,kJ\,mol^{-1}$.

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

.....

(ii) This data book value of $\Delta H_c^{\ominus}$ for butanone ($-2430\,kJ\,mol^{-1}$) 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

$$2C(s) + 3H_2(g) + S(s) \rightarrow C_2H_5SH(l)$$

.....

.....

.....

.....

(3 marks)

12

TURN OVER FOR THE NEXT QUESTION

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