Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
January 2008
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Thursday 10 January 2008 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 **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.
- Write your answers to the question in **Section B** 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			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

SECTION A

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

1 Aqueous bromide ions can be detected by using either aqueous silver nitrate or chlorine.

(a) (i) State what is observed when aqueous silver nitrate is added to an aqueous solution containing bromide ions. Write an ionic equation for the reaction which occurs.

Observation .....

.....

Ionic equation .....

(ii) State what is observed when an excess of concentrated aqueous ammonia is added to the products formed in part (a)(i).

.....

(3 marks)

(b) (i) State what is observed when chlorine is added to an aqueous solution containing bromide ions. Write an ionic equation for the reaction which occurs.

Observation .....

.....

Ionic equation

.....

(ii) Identify one halide ion, other than chloride, which will not react with chlorine and explain why a reaction does not take place.

Halide ion .....

Explanation .....

.....

(4 marks)

(c) Bromine reacts with cold aqueous sodium hydroxide. The reaction is similar to the reaction of chlorine with cold aqueous sodium hydroxide.

Write an equation for the reaction of bromine with cold aqueous sodium hydroxide.

.....

(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.

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

* **58 – 71** Lanthanides	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
† **90 – 103** Actinides	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

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/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 When hydrogen and iodine gases are allowed to react, an equilibrium is established according to the following equation.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H^{\ominus} = -10\,kJ\,mol^{-1}$$

(a) State and explain the effect of decreasing the temperature on the equilibrium yield of hydrogen iodide.

Effect on yield of hydrogen iodide .....

Explanation .....

.....

.....

(3 marks)

(b) State and explain the effect of increasing the pressure on the equilibrium yield of hydrogen iodide.

Effect on yield of hydrogen iodide .....

Explanation .....

.....

(2 marks)

(c) Explain why an increase in the concentration of hydrogen gas increases the equilibrium yield of hydrogen iodide.

Explanation .....

.....

(1 mark)

(d) Explain why the addition of a catalyst does not alter the position of equilibrium.

.....

.....

(2 marks)

8

3 (a) Define the term *standard enthalpy of combustion*.

.....

.....

.....

(3 marks)

(b) Write an equation for the complete combustion of ethanol, C_2H_5OH

.....

(1 mark)

(c) The following table gives some standard enthalpies of formation.

	$C_3H_7OH(l)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	–315	0	–394	–286

Use these data to calculate a value for the enthalpy of combustion, $\Delta H_c^{\ominus}$, of propan-1-ol, C_3H_7OH

$$C_3H_7OH(l) + 4\tfrac{1}{2}O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$

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.....

(3 marks)

(d) State how you would expect the value obtained in part (c) to differ if gaseous water, rather than liquid water, is formed.

.....

(1 mark)

(e) In an experiment 0.92 g of propan-1-ol, C_3H_7OH, was burned and the heat given off used to raise the temperature of 250 g of water. The temperature rise was 16 °C. The specific heat capacity of water is 4.2 $J K^{-1} g^{-1}$.

Calculate a value for the enthalpy of combustion of one mole of propan-1-ol.

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.....

.....

.....

(4 marks)

(f) Suggest why the experimental value of the enthalpy of combustion obtained in part (e) is less reliable than the value obtained in part (c).

.....

(1 mark)

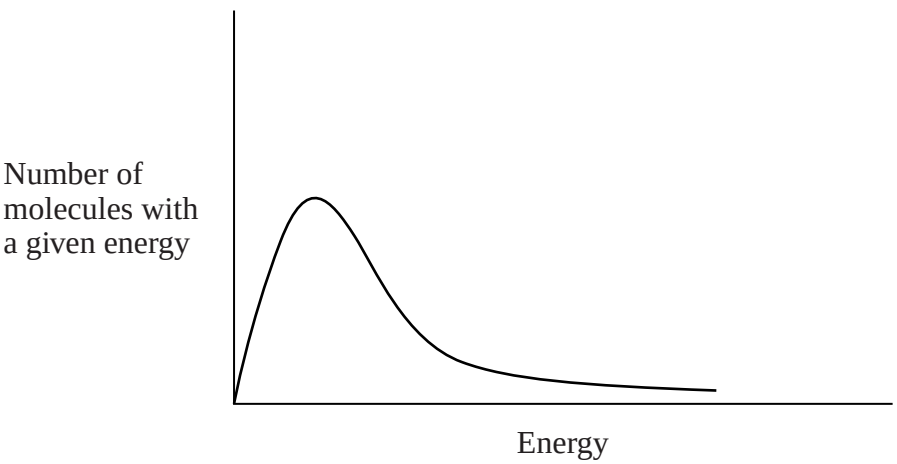
13

Turn over for the next question

4 The Figures below represent the distribution of molecular energies for one mole of gas at 300 K.

(a) On **Figure 1** below draw a curve to show the distribution of energies for one mole of gas at a higher temperature.

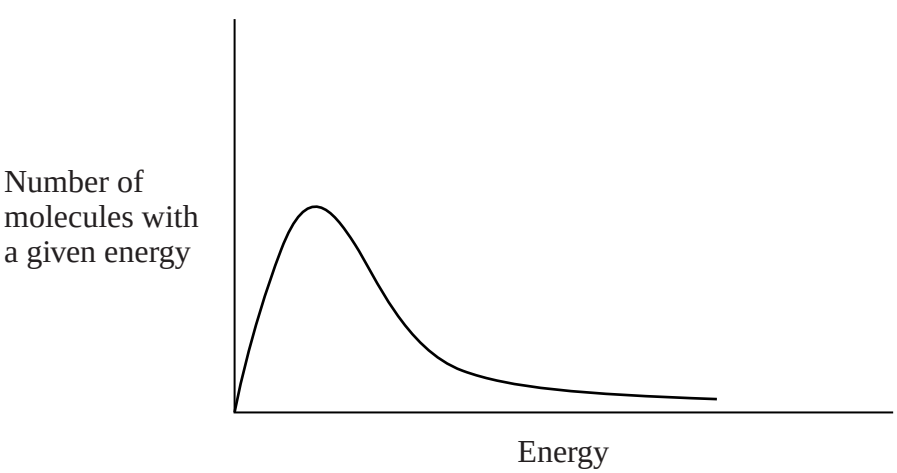
Figure 1



(2 marks)

(b) On **Figure 2** below draw a curve to show the distribution of energies for two moles of gas at 300 K.

Figure 2



(2 marks)

(c) Gases **A** and **B** react together.

(i) Explain why collisions between molecules of **A** and **B** do not always lead to a reaction.

.....

.....

(ii) Explain why increasing the temperature by a small amount has a much bigger effect on the rate of reaction than increasing the pressure by a small amount.

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(iii) Explain why adding a catalyst will increase the rate of reaction between gases **A** and **B**.

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.....

(5 marks)

9

Turn over for the next question

5 (a) Deduce the oxidation state of S in SO_3^{2-} and in SO_4^{2-}

Oxidation state of S in SO_3^{2-} .....

Oxidation state of S in SO_4^{2-} .....

(2 marks)

(b) A redox reaction occurs when Cl_2 reacts with SO_3^{2-} ions in aqueous solution.

(i) Write a half-equation for the conversion of Cl_2 into Cl^- ions.

.....

(ii) Write a half-equation for the conversion of aqueous SO_3^{2-} ions into SO_4^{2-} ions.

.....

(iii) Hence, write an overall equation for the reaction between Cl_2 and SO_3^{2-} ions.

.....

(iv) Deduce the role of SO_3^{2-} ions in this overall reaction.

.....

(4 marks)

6

SECTION B

Answer Question 6 in the space provided on pages 11–12.

6 (a) Iron can be extracted from iron(III) oxide by carbon reduction in the Blast Furnace. The iron obtained contains impurities of carbon, sulphur and phosphorus. These impurities are removed from the molten iron that is taken from the Blast Furnace.

Describe how each of the impurities is removed. Write equations for any reactions which occur.

Suggest a reason why the sulphur impurity is removed first.

(9 marks)

(b) Explain why carbon is not used as the reducing agent to extract titanium from titanium(IV) oxide.

(2 marks)

(c) State why extracting aluminium from its oxide ore is expensive and why carbon reduction is not used. Write half-equations for the reactions which occur at the electrodes when aluminium is extracted from its oxide.

(4 marks)

END OF QUESTIONS

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LEAVE MARGIN BLANK