Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
January 2009
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Friday 9 January 2009 1.30 pm to 2.30 pm

For this paper you must have
- a calculator.

Time allowed: 1 hour

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in **Section A** and **Section B** in the spaces provided.
- Your answers to the parts of **Section B** should be on the pages indicated. **Answers written in margins or on blank pages will not be marked**.
- Show all your working.
- 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 as an insert.

Information
- The maximum mark for this paper is 60.
- The marks for each question 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 good English, to organise relevant information clearly, 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			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

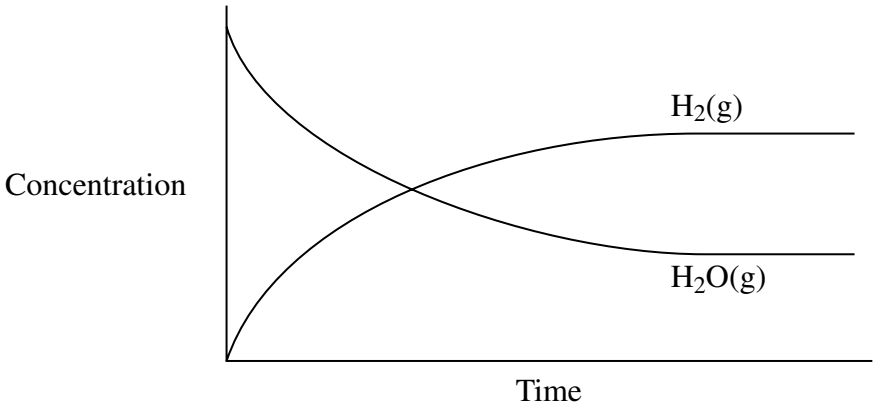
SECTION A

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

1 Hydrogen gas can be made from carbon monoxide and steam as shown by the following equation.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

The diagram below shows how the concentrations of $H_2O(g)$ and $H_2(g)$ change with time as equilibrium is established.



1 (a) On the time axis mark with an **X** the time at which equilibrium is first established.

(1 mark)

1 (b) State Le Chatelier's principle.

.....

.....

(1 mark)

1 (c) State and explain the effect on the equilibrium yield of hydrogen when the overall pressure is increased.

Effect on yield .....

Explanation .....

.....

(2 marks)

1 (d) This reaction is usually carried out at 450 °C in the presence of a catalyst.

1 (d) (i) State and explain the effect on the rate of production of hydrogen gas if this reaction is carried out at a temperature above 450 °C.

Effect on rate .....

Explanation .....

.....

(2 marks)

1 (d) (ii) State and explain the effect of a catalyst on the rate of a reaction.

Effect on rate .....

Explanation .....

.....

.....

(3 marks)

1 (d) (iii) If the temperature is higher than 450 °C the equilibrium yield of hydrogen is lower. State what can be deduced about the enthalpy change for this reaction.

.....

(1 mark)

1 (e) State and explain the effect on the equilibrium yield of hydrogen if some carbon dioxide is removed from the original equilibrium mixture.

Effect on yield .....

Explanation .....

.....

.....

(3 marks)

13

2 Aluminium is extracted by electrolysis. The electrolyte for this process is made by dissolving purified bauxite in molten cryolite.

2 (a) (i) Give the formula of the aluminium compound in bauxite.

.....

.....

(1 mark)

2 (a) (ii) State why the electrolysis can only be carried out using a molten electrolyte.

.....

.....

(1 mark)

2 (a) (iii) Give **one** reason why molten bauxite alone is not used in this electrolysis.

.....

.....

(1 mark)

2 (a) (iv) Write half-equations for the reactions occurring at the electrodes in the electrolysis of bauxite.

Half-equation 1 .....

Half-equation 2 .....

(2 marks)

2 (b) State **two** reasons why aluminium is recycled even though bauxite is in plentiful supply.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

2 (c) Iron is extracted in the Blast Furnace by reaction of iron(III) oxide with carbon monoxide or carbon.

2 (c) (i) Write an equation for the reaction of iron(III) oxide with carbon monoxide. State **one** condition needed for this reaction to occur in the Blast Furnace.

Equation

.....

Condition .....

(2 marks)

2 (c) (ii) State the role of carbon monoxide in this reaction.

.....

.....

(1 mark)

2 (c) (iii) Suggest **one** reason why the iron(III) oxide is more likely to react with carbon monoxide than with carbon.

.....

.....

(1 mark)

11

Turn over for the next question

3 (a) Explain the meaning of the term *enthalpy change* of a reaction.

.....

.....

.....

(2 marks)

3 (b) Write an equation, including state symbols, for the reaction that represents the standard enthalpy of formation, $\Delta H_f^{\ominus}$, of liquid carbon disulphide (CS_2).

.....

(2 marks)

3 (c) Carbon disulphide is flammable and burns in air according to the following equation.

$$CS_2(l) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g) \qquad \Delta H^{\ominus} = -1076\,kJ\,mol^{-1}$$

Using this equation and the data below, calculate a value for the standard enthalpy of formation of carbon disulphide.

	$CO_2(g)$	$SO_2(g)$	$O_2(g)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	– 394	–297	0

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(3 marks)

3 (d) (i) A 0.45 g sample of carbon disulphide was burned and the heat produced was used to raise the temperature of 75 cm^3 water from 22 °C to 30 °C. Calculate the heat produced in this reaction and hence calculate the enthalpy change, in kJ, for the combustion of one mole of carbon disulphide.
The specific heat capacity of water is 4.2 $J K^{-1} g^{-1}$.

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(4 marks)

3 (d) (ii) Explain why the answer you calculated in part (d) (i) is very low compared to the value you were given in part (c).

.....

.....

(1 mark)

12

Turn over for the next question

4 (a) In terms of electrons, state the meaning of each of the terms *reduction* and *reducing agent*.

Reduction .....

Reducing agent .....

(2 marks)

4 (b) Deduce the oxidation state of nitrogen in each of the following.

$NaNO_3$ .....

NO_2 .....

Mg_3N_2 .....

(3 marks)

4 (c) Concentrated nitric acid (HNO_3) reacts with sulphur to form nitrogen dioxide, sulphuric acid and water.

4 (c) (i) Write a half-equation to show how sulphur, in the presence of water, is converted into sulphuric acid.

.....

(1 mark)

4 (c) (ii) Write a half-equation to show how nitric acid is converted into nitrogen dioxide and water.

.....

(1 mark)

4 (c) (iii) Hence write an overall equation for the reaction between concentrated nitric acid and sulphur.

.....

.....

.....

(1 mark)

4 (c) (iv) State the role of sulphur in the reaction.

.....

(1 mark)

9

SECTION B

Answer the question below in the space provided on pages 10 to 13 of this booklet.
You should answer each part of the question on the separate page indicated.
Each part of the question is reprinted at the top of the page.

5 (a) When chlorine is dissolved in water, a pale green solution called 'chlorine water' is formed. Some of the chlorine reacts with water.

Write an equation for this reaction and state which substance causes the green colour in chlorine water.

State and explain what you would observe when chlorine water is tested with Universal Indicator paper.

(6 marks)

5 (b) State what you would observe when chlorine water is added to an aqueous solution of potassium iodide.

Write an equation for the reaction between chlorine and potassium iodide.

(2 marks)

5 (c) Identify a reagent which could be used, in a test tube reaction, to distinguish between separate aqueous solutions of potassium chloride and potassium fluoride.

In each case state any observations you would make.

Write an equation for the reaction of your chosen reagent with potassium chloride.

(4 marks)

5 (d) State the reduction product obtained when solid potassium bromide reacts with concentrated sulphuric acid.

Write an equation for the reaction which occurs.

(3 marks)

END OF QUESTIONS

5 (a) When chlorine is dissolved in water, a pale green solution called 'chlorine water' is formed. Some of the chlorine reacts with water.

Write an equation for this reaction and state which substance causes the green colour in chlorine water.

State and explain what you would observe when chlorine water is tested with Universal Indicator paper. *(6 marks)*

Write your answer to Question 5(a) on this page.

5 (b) State what you would observe when chlorine water is added to an aqueous solution of potassium iodide.

Write an equation for the reaction between chlorine and potassium iodide. *(2 marks)*

Write your answer to Question 5(b) on this page.

5 (c) Identify a reagent which could be used, in a test tube reaction, to distinguish between separate aqueous solutions of potassium chloride and potassium fluoride.

In each case state any observations you would make.

Write an equation for the reaction of your chosen reagent with potassium chloride.

(4 marks)

Write your answer to Question 5(c) on this page.

5 (d) State the reduction product obtained when solid potassium bromide reacts with concentrated sulphuric acid.

Write an equation for the reaction which occurs. *(3 marks)*

Write your answer to Question 5(d) on this page.

There are no questions printed on this page

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CHEMISTRY **CHM2**
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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

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