Surname		Initial(s)	
Signature			

London Examinations IGCSE

Chemistry

Paper 2H

Higher Tier

Tuesday 7 November 2006 – Morning

Time: 2 hours

Materials required for examination	Items included with question papers
Nil	Nil

Instructions to Candidates

In the boxes above, write your centre number and candidate number, your surname, initial(s) and signature.
The paper reference is shown at the top of this page. Check that you have the correct question paper.
Answer **ALL** the questions in the spaces provided in this question paper.
Show all the steps in any calculations and state the units.
Calculators may be used.

Information for Candidates

The total mark for this paper is 120. The marks for parts of questions are shown in round brackets:
e.g. **(2)**.
A Periodic Table is given on page 2.
This paper has 11 questions.

Advice to Candidates

Write your answers neatly and in good English.

Turn over

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THE PERIODIC TABLE

Group

1	2											3	4	5	6	7	0

Period

1

| | | | | | | | | | 1
H
Hydrogen
1 | | | | | | | | 4
He
Helium
2 |

2

| 7
Li
Lithium
3 | 9
Be
Beryllium
4 | | | | | | | | | | | 11
B
Boron
5 | 12
C
Carbon
6 | 14
N
Nitrogen
7 | 16
O
Oxygen
8 | 19
F
Fluorine
9 | 20
Ne
Neon
10 |

3

| 23
Na
Sodium
11 | 24
Mg
Magnesium
12 | | | | | | | | | | | 27
Al
Aluminium
13 | 28
Si
Silicon
14 | 31
P
Phosphorus
15 | 32
S
Sulphur
16 | 35.5
Cl
Chlorine
17 | 40
Ar
Argon
18 |

4

| 39
K
Potassium
19 | 40
Ca
Calcium
20 | 45
Sc
Scandium
21 | 48
Ti
Titanium
22 | 51
V
Vanadium
23 | 52
Cr
Chromium
24 | 55
Mn
Manganese
25 | 56
Fe
Iron
26 | 59
Co
Cobalt
27 | 59
Ni
Nickel
28 | 63.5
Cu
Copper
29 | 65
Zn
Zinc
30 | 70
Ga
Gallium
31 | 73
Ge
Germanium
32 | 75
As
Arsenic
33 | 79
Se
Selenium
34 | 80
Br
Bromine
35 | 84
Kr
Krypton
36 |

5

| 86
Rb
Rubidium
37 | 88
Sr
Strontium
38 | 89
Y
Yttrium
39 | 91
Zr
Zirconium
40 | 93
Nb
Niobium
41 | 96
Mo
Molybdenum
42 | 99
Tc
Technetium
43 | 101
Ru
Ruthenium
44 | 103
Rh
Rhodium
45 | 106
Pd
Palladium
46 | 108
Ag
Silver
47 | 112
Cd
Cadmium
48 | 115
In
Indium
49 | 119
Sn
Tin
50 | 122
Sb
Antimony
51 | 128
Te
Tellurium
52 | 127
I
Iodine
53 | 131
Xe
Xenon
54 |

6

| 133
Cs
Caesium
55 | 137
Ba
Barium
56 | 139
La
Lanthanum
57 | 179
Hf
Hafnium
72 | 181
Ta
Tantalum
73 | 184
W
Tungsten
74 | 186
Re
Rhenium
75 | 190
Os
Osmium
76 | 192
Ir
Iridium
77 | 195
Pt
Platinum
78 | 197
Au
Gold
79 | 201
Hg
Mercury
80 | 204
Tl
Thallium
81 | 207
Pb
Lead
82 | 209
Bi
Bismuth
83 | 210
Po
Polonium
84 | 210
At
Astatine
85 | 222
Rn
Radon
86 |

7

| 223
Fr
Francium
87 | 226
Ra
Radium
88 | 227
Ac
Actinium
89 | | | | | | | | | | | | | | | |

Key

| Relative atomic mass |
| Symbol |
| Name |
| Atomic number |

SECTION A

1. The starting material in the manufacture of sulphuric acid is sulphur.

    (a) Give **two** sources of sulphur.

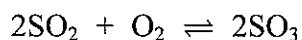   1 ....

    2 ....

    (2)

    (b) Give **two** other raw materials used in the process.

    1 ....

    2 ....

    (2)

    (c) The equation for one of the reactions involved in the contact process is

    $$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

    (i) What is the name of the product of this reaction?

    ....

    (1)

    (ii) State **two** conditions used in this reaction.

    1 ....

    2 ....

    (2)

    (Total 7 marks)

N 2 4 3 1 0 A 0 3 2 0

2. The diagram shows the apparatus used to prepare chlorine gas in the laboratory.

concentrated hydrochloric acid
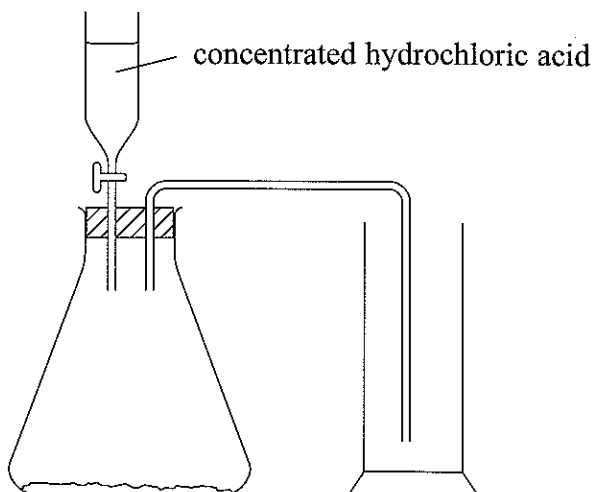
(a) At the start of the experiment the conical flask contains a manganese compound. Identify this compound and give its colour.

Compound ....

Colour ....

(2)

(b) The diagram shows the gas being collected by downward delivery. On what property of chlorine does this method depend?

....

(1)

(c) What colour is seen in the gas jar as it fills with chlorine?

....

(1)

(d) Describe a test for chlorine gas.

Test ....

Result ....

(2)

(e) In industry, chlorine is manufactured from brine.

   (i) Name the compound in brine that is the source of chlorine.

     ....

                           (1)

   (ii) What method is used to obtain chlorine from brine?

     ....

                           (1)

   (iii) State **one** large-scale use of chlorine.

     ....

     ....

                           (1)   **Q2**

(Total 9 marks)

3. The formulae CH_4 and C_4H_{10} represent two organic compounds.

(a) State why these compounds are described as

(i) saturated..

....

(1)

(ii) hydrocarbons ....

....

(1)

(b) CH_4 and C_4H_{10} are members of the same homologous series. All members of the same homologous series can be represented by a general formula.

(i) What is the general formula of this homologous series?

....

(1)

(ii) To which homologous series do CH_4 and C_4H_{10} belong?

....

(1)

(iii) Give **two** other features of members of the same homologous series.

1 ....

2 ....

(2)

(c) The compound C_4H_{10} exists as isomers. What is meant by the term **isomers**?

....

....

(2)

Q3

(Total 8 marks)

4. The Periodic Table on page 2 may be useful in answering parts of this question. The symbols of some atoms and ions are shown below.

Al   Cl⁻   Mg Mg^{2+} Na^+ O^{2-}

(a) Which **one** of these is formed by the loss of one electron from an atom?

....

(1)

(b) Which **one** of these is formed by the gain of two electrons by an atom?

....

(1)

(c) Which **one** of these has the same electronic configuration as an atom of argon?

....

(1)

(d) Which **one** of these has an electronic configuration of 2.8.2?

....

(1)

(e) Which **three** of these have the same electronic configuration?

....

(1)

(f) Compounds containing the ions listed include MgO and NaCl. Which of these compounds has the higher melting point? Give a reason.

Compound with higher melting point ....

Reason ....

....

(2)

(Total 7 marks)

Q4

5. The equation shows the formation of hydrogen chloride.

$$H_2 + Cl_2 \rightarrow 2HCl \qquad \Delta H = -184 \, kJ$$

(a) (i) What does the symbol ΔH represent?

....

(1)

(ii) ΔH is negative for this reaction. What does this indicate?

....

(1)

(b) Each substance in the equation contains the same type of bonding. Name this type of bonding and describe how it forms.

Name ....

Description ....

....

(3)

(c) Draw a dot and cross diagram to show the bonding in H_2.

(1)

(d) H_2 molecules contain strong bonds. Explain why the boiling point of H_2 is low.

....

....

(2)

(e) Hydrogen chloride is soluble in both water and methylbenzene.
What colour is phenolphthalein in each of these solutions?

Hydrogen chloride dissolved in water ....

Hydrogen chloride dissolved in methylbenzene ....

(2)

(f) A student carries out a test to show that a solution of hydrogen chloride contains chloride ions. First she adds dilute nitric acid.

(i) Name the other solution she adds.

....

(1)

(ii) Describe what she observes.

....

(1)

(iii) Complete the equation to show the reaction that occurs.

.... + HCl → .... + ...

(2)

Q5

(Total 14 marks)

TOTAL FOR SECTION A: 45 MARKS

Turn over

SECTION B

6. The table gives some information about the elements in Group 7 of the Periodic Table.

Name of element	Melting point (°C)	Boiling point (°C)
fluorine	−220	−188
chlorine	−101	−35
bromine	−7	
iodine	+114	+184
astatine		+337

(a) (i) Use the information in the table to predict the physical state of astatine at room temperature.

....

(1)

(ii) Use the information in the table to predict a value for the boiling point of bromine.

....

(1)

(b) All atoms of elements in Group 7 have seven electrons in their outer shell. When they react they can form ions.

(i) What is the charge on the ions formed?

....

(1)

(ii) Explain why the atoms form ions with this charge.

....

....

(2)

(c) Which element in Group 7 is the **most** reactive?

....

(1)

N 2 4 3 1 0 A 0 1 0 2 0

(d) When chlorine gas is bubbled through potassium bromide solution a reaction takes place.

(i) Write the chemical equation for the reaction.

....

(2)

(ii) What is **seen** during the reaction?

....

(1)

(e) A compound contains 16.4% potassium, 30.0% chlorine and 53.6% iodine by mass. Calculate the empirical formula of the compound.

(3)

(Total 12 marks)

Q6

N 2 4 3 1 0 A 0 1 1 2 0

7. Aluminium is extracted from aluminium oxide by electrolysis.
The diagram shows a cross-section through an electrolysis cell.

positive electrode

aluminium oxide in cryolite

negative electrode
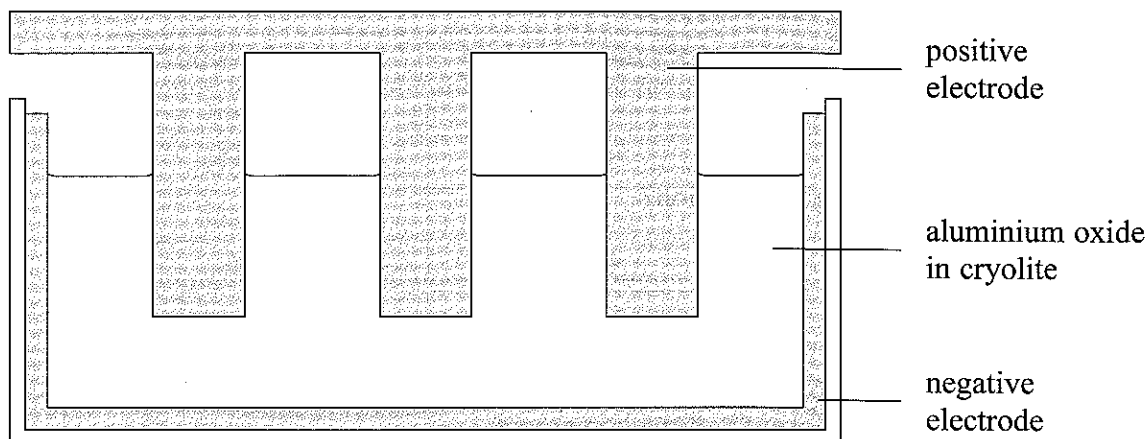
(a) Aluminium oxide has a melting point of over 2000°C.

(i) Explain why obtaining molten aluminium oxide is difficult.

....

....

(1)

(ii) How does the use of cryolite help to overcome this difficulty?

....

....

(2)

(b) The products of the electrolysis are oxygen and aluminium.

(i) Complete the ionic half-equation for the formation of oxygen at the positive electrode.

$$O^{2-} \rightarrow \quad O_2 + \quad e^-$$

(1)

(ii) Write the ionic half-equation to show the formation of aluminium at the negative electrode.

....

(2)

(c) The electrolysis of aluminium oxide is a redox process. Use the equations in (b) to help you identify what has been oxidised. Explain your answer.

Oxidised ....

Explanation ....

(2)

(d) Explain why the positive electrodes need to be replaced regularly.

....

....

....

....

(3)

(e) Aluminium is used as the main conductor in overhead power cables.

(i) Describe the structure of aluminium metal.

....

....

(2)

(ii) Explain why it is a good conductor of electricity.

....

....

(1)

Q7

(Total 14 marks)

8. Potassium carbonate, K_2CO_3, reacts with sulphurous acid, H_2SO_3.

$$K_2CO_3(s) + H_2SO_3(aq) \rightarrow K_2SO_3(aq) + H_2O(l) + CO_2(g)$$
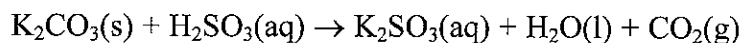
(a) Sulphurous acid is a weak acid. Give **two** differences between strong and weak acids.

1 ....

....

2 ....

....

(2)

A 2.76 g sample of solid potassium carbonate was placed in a beaker.

(b) (i) Calculate the relative formula mass, M_r, of potassium carbonate.

(1)

(ii) Calculate the amount, in moles, of potassium carbonate in 2.76 g.

(1)

(iii) Sulphurous acid of concentration $0.200 \, mol \, dm^{-3}$ was added to the beaker. Calculate the minimum volume, **in cm³**, of sulphurous acid needed to react with 2.76 g of potassium carbonate.

(2)

(iv) Calculate the relative formula mass, M_r, of carbon dioxide.

(1)

N 2 4 3 1 0 A 0 1 4 2 0

(v) Calculate the mass of carbon dioxide formed.

(1)

(vi) Calculate the volume of this mass of carbon dioxide at room temperature and pressure (rtp).
The volume of one mole of any gas at rtp is 24 dm^3.

(1)

(c) Describe simple tests that can be used to show that the solution produced in the reaction contains

(i) potassium ions

Test ....

Result ....

(2)

(ii) sulphite ions

Test ....

....

Result ....

(3)

(Total 14 marks)

Q8

9. Crude oil is a complex mixture of different hydrocarbons. It is separated into useful fractions by fractional distillation. Short-chain hydrocarbons are used as fuels.

(a) Name the fraction that contains methane.

....

(1)

(b) How does the release of methane into the atmosphere affect the environment?

....

(1)

(c) Long-chain hydrocarbons are cracked to produce hydrocarbons with shorter chains.

(i) State **one** condition needed for cracking to occur.

....

(1)

(ii) Why are long-chain hydrocarbons available for cracking?

....

....

(1)

(d) Methane is used as a fuel. The combustion of methane is shown by the equation

$$H-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-H \ + \ 2O{=}O \ \rightarrow \ O{=}C{=}O \ + \ 2H-O-H$$
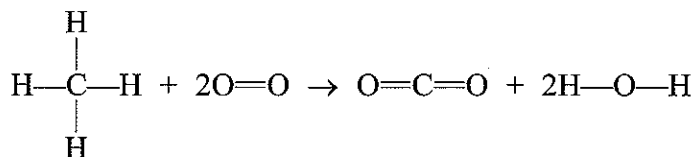
The table gives some average bond dissociation energies.

Bond	Average bond dissociation energy (kJ/mol)
O=O	496
C=O	743
C—H	412
O—H	463

Use the data in the table opposite to answer the following questions.

(i) Calculate the total energy taken in when all the bonds in the reactants are broken.

(2)

(ii) Calculate the total energy given out when all the bonds in the products are formed.

(2)

(iii) Calculate the value of ΔH for this reaction.

(1)

(e) When a hydrocarbon burns in a limited supply of oxygen, incomplete combustion occurs. One of the products is carbon monoxide.

(i) Write a chemical equation for the incomplete combustion of methane.

....

(2)

(ii) Why can incomplete combustion be dangerous?

....

....

....
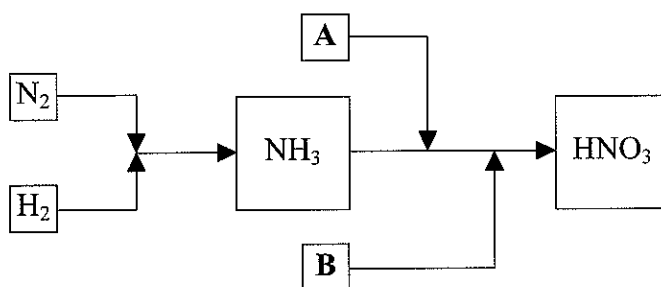
(2) | **Q9**

(Total 13 marks)

10. The flow chart shows the steps in the industrial production of ammonia, NH_3, and nitric acid, HNO_3.

(a) (i) Name the raw material from which hydrogen is obtained.

....

(1)

(ii) Write a chemical equation to show how hydrogen is obtained from this raw material.

....

(2)

(iii) Name the catalyst used in the production of ammonia.

....

(1)

(b) Substance **A** in the flow chart is an element. Substance **B** is a compound. Identify **A** and **B**.

A ....

B ....

(2)

(c) During the conversion of ammonia into nitric acid, nitrogen dioxide, NO_2, is made. Nitrogen dioxide can undergo the following reaction.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \quad \Delta H = -57 \text{ kJ/mol}$$
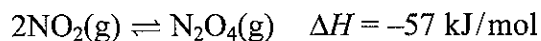
This reaction is reversible. A dynamic equilibrium is established.

(i) How can you tell from the equation that the reaction is reversible?

....

(1)

(ii) What is meant by the term **dynamic equilibrium**?

....

....

....

(2)

(iii) What happens to the amount of $N_2O_4(g)$ in the mixture at equilibrium when the pressure is increased?

....

(1)

(iv) What happens to the amount of $N_2O_4(g)$ in the mixture at equilibrium when the temperature is increased?

....

(1)

(d) (i) Why is it important that oxides of nitrogen are not allowed to escape into the atmosphere?

....

(1)

(ii) Describe **two** problems that can result.

1 ....

....

2 ....

....

(2)

Q10

(Total 14 marks)

TURN OVER FOR QUESTION 11

11. Diamond and graphite are allotropes of carbon. They both have giant molecular covalent structures.
Both diamond and graphite have high sublimation points.
Diamond can be used for cutting.
Graphite can be used as a lubricant.

(a) Describe, without drawing a diagram, the structure of diamond.
Include the number of atoms to which each carbon atom is bonded and how the atoms are arranged. Explain how this structure relates to the use of diamond in cutting.

....

....

....

....

....

....

(3)

(b) Describe, without drawing a diagram, the structure of graphite.
Include the number of atoms to which each carbon atom is bonded and how the atoms are arranged. Explain how this structure relates to the use of graphite as a lubricant.

....

....

....

....

....

....

(3)

(c) Explain why both diamond and graphite have high sublimation points.

....

....

(2)

Q11

(Total 8 marks)

TOTAL FOR SECTION B: 75 MARKS

TOTAL FOR PAPER: 120 MARKS

END

N 2 4 3 1 0 A 0 2 0 2 0