UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/02**

Paper 2 Theory **May/June 2008**

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do **not** use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B
Answer any **three** questions.
Write your answers on any lined pages and/or separate answer paper.

A copy of the Periodic Table is printed on page 16.
The number of marks is given in brackets [ ] at the end of each question or part question.
At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Section A	
B7	
B8	
B9	
B10	
Total	

This document consists of **16** printed pages.

UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

Section A

For Examiner's Use

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

The total mark for this section is 45.

A1 Choose from the following gases to answer the questions below.

ammonia
argon
carbon monoxide
chlorine
hydrogen
nitrogen
nitrogen dioxide
oxygen

Each gas can be used once, more than once or not at all.

Name a gas which

(a) is made during the incomplete combustion of octane,

.....[1]

(b) dissolves in water to make an alkaline solution,

.....[1]

(c) is monatomic,

.....[1]

(d) is a reducing agent in a Blast Furnace,

.....[1]

(e) is used in the Contact process.

.....[1]

[Total: 5]

A2 Iron(II) sulphate, $FeSO_4$, is easily oxidised to iron(III) sulphate.

For Examiner's Use

(a) Calculate the percentage by mass of iron in iron(II) sulphate.

..... % [2]

(b) A sample of iron(II) sulphate is dissolved in water. Describe a test to show the presence of sulphate ions in this solution.

reagents .....

observation .....[2]

(c) In the presence of aqueous hydrogen ions and dissolved oxygen, aqueous iron(II) ions are oxidised to form iron(III) ions and water.
Write an ionic equation for this reaction.

.....[2]

(d) Aqueous iron(II) ions can also be oxidised by reaction with acidified potassium dichromate(VI), $K_2Cr_2O_7$. At the same time aqueous dichromate(VI) ions are reduced.

(i) Describe the colour change of the chromium-containing species during the reaction.

.....[1]

(ii) Describe the colour change of the iron-containing species during the reaction.

.....[1]

(e) An impure sample of iron(II) sulphate was analysed by titration.

For Examiner's Use

The sample was dissolved in 25.0 cm^3 of dilute sulphuric acid and then titrated against 0.0400 mol/dm^3 potassium dichromate(VI) solution.

19.0 cm^3 of potassium dichromate(VI) solution was required to reach the end-point.

(i) Calculate the number of moles of potassium dichromate(VI) used in the titration.

..... moles [1]

(ii) One mole of potassium dichromate(VI) reacts with six moles of iron(II) ions. Calculate the mass, in grams, of iron(II) ions in the sample analysed.

mass of iron(II) ions..... g [2]

[Total: 11]

A3 A student found a copy of a Periodic Table published in the year 1930. Several elements were missing from this table because they had not yet been discovered. One of these elements was technetium, Tc.

For Examiner's Use

One isotope of technetium has the symbol $^{98}_{43}Tc$.

(a) Complete the table below to show the number of subatomic particles in one atom of this isotope.

number of protons	
number of electrons	
number of neutrons	

[2]

(b) Suggest the symbol of another isotope of technetium.

.....[1]

(c) Explain, in terms of subatomic particles and their charge, why an atom of $^{98}_{43}Tc$ is electrically neutral.

.....

.....

.....[2]

(d) From its position in the modern Periodic Table predict two properties of technetium.

1 .....

2 .....[2]

[Total: 7]

A4 Ethane, C_2H_6, and ethene, C_2H_4, are both gaseous hydrocarbons.

For Examiner's Use

(a) Describe how aqueous bromine can be used to distinguish between a sample of ethane and a sample of ethene.

.....

.....

.....[2]

(b) Draw a 'dot-and-cross' diagram for ethane.
You only need to draw the outer electrons of the carbon atoms.

[2]

(c) Ethane reacts with chlorine in the presence of ultra-violet light.
Suggest a structure for a product of this reaction.

[1]

(d) Write both the name and the molecular formula of an alkene molecule containing four carbon atoms.

name .....

molecular formula .....[2]

[Total: 7]

A5 One of the largest uses of phosphorus is in the making of safety matches. A safety match ignites when it is rubbed against the striking surface of a match box.

For Examiner's Use

The match head contains the following substances.

- phosphorus, P_4
- potassium chlorate(V), $KClO_3$
- sulphur, S
- a hydrocarbon wax

(a) The friction between the match head and the striking surface generates enough heat for the phosphorus to burn.
Phosphorus burns to form phosphorus(V) oxide. This oxide is covalently bonded with a molecular structure.

(i) What is the molecular formula of phosphorus(V) oxide?

.....[1]

(ii) Suggest **one** physical and **one** chemical property of phosphorus(V) oxide.

physical property .....

.....

chemical property .....

.....[2]

(b) The heat from the combustion of phosphorus provides enough energy for the decomposition of potassium chlorate(V) to oxygen and potassium chloride.
Construct the equation for the decomposition of potassium chlorate(V).

.....[2]

(c) The sulphur on the match head ignites.
Write an equation to show the combustion of sulphur.

.....[1]

(d) Finally the wax on the match head begins to combust.
One compound in the wax has the formula $C_{18}H_{38}$.
To which class of hydrocarbons does this compound belong? Explain your answer.

.....

.....[1]

[Total: 7]

A6 Sulphur dioxide, SO_2, and nitrogen dioxide, NO_2, are both atmospheric pollutants formed during the combustion of coal at a power station.

For Examiner's Use

(a) (i) State another source of sulphur dioxide as an atmospheric pollutant.

.....[1]

(ii) State another source of nitrogen dioxide as an atmospheric pollutant.

.....[1]

(b) Nitrogen dioxide and sulphur dioxide both cause acid rain. They are removed from the flue gases released from the power station by reaction with moist calcium carbonate in a process called flue gas desulphurisation.
Calcium carbonate reacts with sulphur dioxide to make a solid called calcium sulphite and a gas.

(i) What is the name of this gas?

.....[1]

(ii) Nitrogen dioxide reacts with calcium carbonate to make a solid. Suggest the name of this solid.

.....[1]

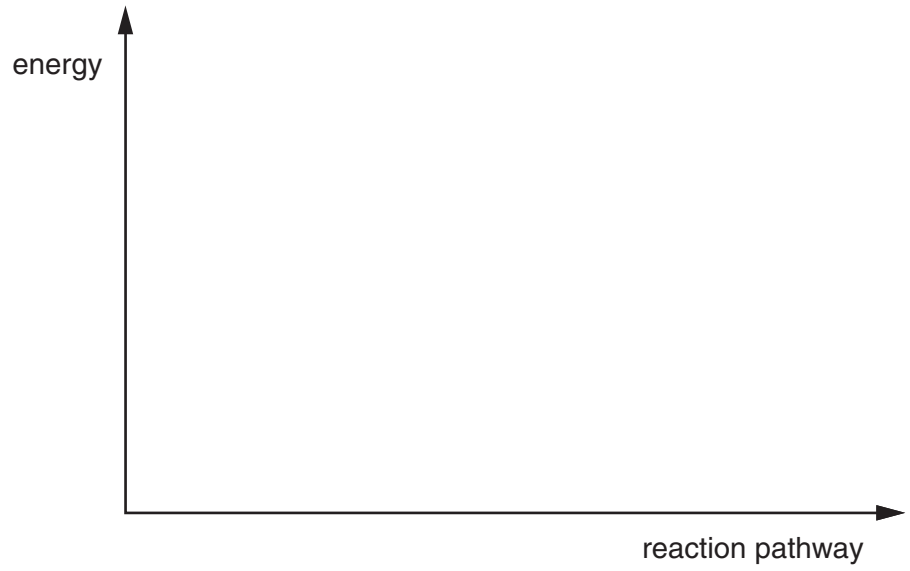
(iii) Describe one environmental effect of acid rain.

.....[1]

(c) Sulphur dioxide and nitrogen dioxide react together as shown in the equation.

$$SO_2 + NO_2 \longrightarrow SO_3 + NO \qquad \Delta H = +43 \text{ kJ/mol}$$

Draw an energy profile diagram for this reaction.
Indicate both the enthalpy change and the activation energy on your diagram.



[3]

[Total: 8]

Section B

For Examiner's Use

Answer **three** questions from this section.

The total mark for this section is 30.

B7 This question is about the chemistry of chlorine and some of its compounds.

(a) Describe, with the aid of an ionic equation, the reaction of chlorine with aqueous potassium bromide. Explain why this reaction involves the reduction of chlorine. [3]

(b) Magnesium reacts with chlorine to form magnesium chloride.
Draw diagrams to show the electronic structures and charges of both ions present in magnesium chloride. [2]

(c) Silver chloride is an insoluble salt.
Outline the preparation of pure, dry silver chloride, starting from solid silver nitrate. [4]

(d) State **one** environmental problem associated with the molecule $C_2F_3Cl_3$. [1]

[Total: 10]

[Turn over

B8 Crude oil is a raw material which is processed in an oil refinery.
Two of the processes used are fractional distillation and cracking.

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The table shows the percentage by mass of some different fractions in crude oil. The table also shows the demand for each fraction expressed as a percentage.

fraction	number of carbon atoms per molecule	percentage in crude oil	percentage needed by the oil refinery to supply demand
petroleum gases	1 - 4	4%	11%
gasoline	5 - 9	11%	22%
kerosene	10 - 14	12%	20%
gas oil	14 - 20	18%	15%
waxes and bitumen	over 20	23%	4%

(a) The variation in which physical property is used to separate crude oil by fractional distillation? [1]

(b) **(i)** Define the term *cracking*. [2]

(ii) Use information from the table to explain how cracking helps an oil refinery match the supply of gasoline with the demand for gasoline. [2]

(c) The hydrocarbon $C_{15}H_{32}$ can be cracked to make propene and one other hydrocarbon.

(i) Draw the structure of propene. [1]

(ii) Write an equation for this reaction. [1]

(d) Propene is used to make alcohols and poly(propene).

(i) Describe how propene can be converted into an alcohol and draw the structure of this alcohol. [2]

(ii) Draw the structure of poly(propene) showing at least two repeat units. [1]

[Total: 10]

B9 Dilute ethanoic acid and dilute hydrochloric acid both react with magnesium ribbon to form hydrogen.

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(a) Give the formula of one ion found in both of these dilute acids. [1]

(b) Magnesium ribbon reacts with hydrochloric acid as shown in the equation.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

A 0.24 g sample of magnesium ribbon is added to 5.0 cm^3 of 2.0 mol/dm^3 hydrochloric acid.

(i) Which reactant, magnesium or hydrochloric acid, is in excess? Use calculations to explain your answer. [2]

(ii) Calculate the maximum mass of magnesium chloride that can be formed in this reaction. [2]

(iii) A 0.24 g sample of magnesium ribbon is added to 5.0 cm^3 of 2.0 mol/dm^3 ethanoic acid.
Explain why this reaction forms the same volume of hydrogen but takes place much more slowly than the reaction of the same mass of magnesium with 5.0 cm^3 of 2.0 mol/dm^3 hydrochloric acid. [3]

(c) (i) Write an equation for the reaction between dilute ethanoic acid and sodium carbonate. [1]

(ii) What observations would be made during this reaction? [1]

[Total: 10]

B10 Brass is an alloy of zinc and copper.

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(a) Describe, with the aid of a labelled diagram, the structure of a metal such as copper. [2]

(b) Explain, in terms of their structures, why both zinc and copper are good conductors of electricity. [1]

(c) A 1.2 g sample of powdered brass was analysed by reaction with excess dilute sulphuric acid.
The zinc reacts as shown in the equation to form 0.072 dm^3 of hydrogen measured at room temperature and pressure.

$$Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$$

(i) Suggest why brass was used in a powdered rather than lump form. [1]

(ii) Calculate the mass of zinc in the sample of brass. [2]

(iii) Calculate the percentage of zinc in the sample of brass. [1]

(d) Describe how aqueous ammonia can be used to show that only the zinc in the sample reacted with the acid. [3]

[Total: 10]

If you use these lined pages to complete an answer to any question, the question number **must** be clearly shown.

For Examiner's Use

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 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
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
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	64 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
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	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
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 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 Lanthanoid series
† 90–103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).