UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CHEMISTRY

Paper 3 (Extended) **0620/03**

October/November 2005

1 hour 15 minutes

Candidates answer on the Question Paper.
No Additional Materials required.

Candidate Name

Centre Number

Candidate Number

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 pencil for any diagrams, graphs or rough working.

WRITE IN THE BOXES PROVIDED ON THE QUESTION PAPER

DO **NOT** WRITE IN THE BARCODE.

DO **NOT** WRITE IN THE GREY AREAS BETWEEN THE PAGES.

Do not use staples, paper clips, highlighters, glue or correction fluid.

You may use a calculator.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 16.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

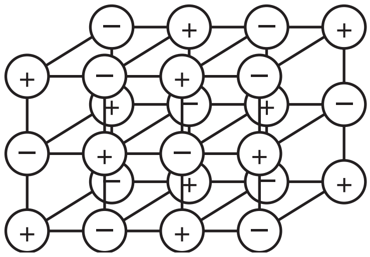
This document consists of **14** printed pages and **2** blank page.

IB05 11_0620_03/5RP

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 **(a)** The structure of a typical ionic compound is a regular arrangement of positive and negative ions.



(i) What is the name of this regular arrangement of particles?

.... [1]

(ii) Give **two** physical properties of ionic compounds.

....

.... [2]

(b) Ions are formed by electron loss or gain. The electron distribution of a magnesium atom is 2 + 8 + 2 and of a nitrogen atom is 2 + 5.

(i) Give the formula of the magnesium ion.

.... [1]

(ii) Give the formula of the nitride ion.

.... [1]

(iii) What is the formula of the ionic compound, magnesium nitride?

.... [1]

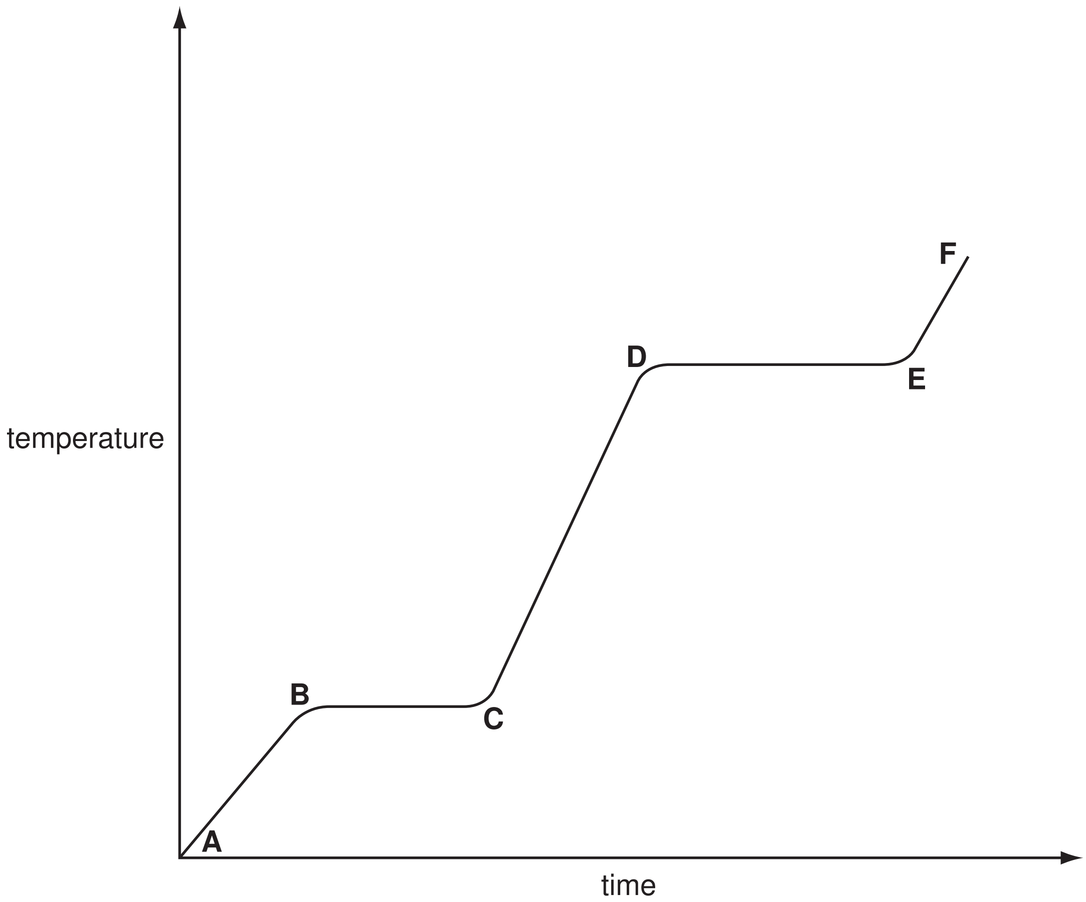
(iv) In this compound there is an ionic bond. Why are the two ions attracted to each other?

.... [1]

2 Ethanoic acid is a colourless liquid at room temperature. It has the typical acid properties and forms compounds called ethanoates.

For Examiner's Use

(a) A pure sample of ethanoic acid is slowly heated from 0°C to 150°C and its temperature is measured every minute. The results are represented on the graph below.



(i) Name the change that occurs in the region **D** to **E**.

.... [1]

(ii) What would be the difference in the region **B** to **C** if an impure sample had been used?

.... [1]

(iii) Sketch on the graph how the line would continue if the acid was heated to a higher temperature. [1]

(iv) Complete the following table that compares the separation and movement of the molecules in regions **C** to **D** with those in **E** to **F**.

	C to **D**	**E** to **F**
separation (distance between particles)	....	....
movement of particles	random and slow	....
Can particles move apart to fill any volume?	....	....

[5]

(b) Complete the word equations for the reactions of ethanoic acid.

calcium + ethanoic acid → ....

+ ....

.... + ethanoic acid → zinc ethanoate + water [2]

(c) Write the symbol equation for the reaction between ethanoic acid and sodium hydroxide.

.... [2]

For Examiner's Use

3 Reversible reactions can come to equilibrium. They have both a forward and a backward reaction.

(a) When water is added to an acidic solution of bismuth(III) chloride, a white precipitate forms and the mixture slowly goes cloudy.

$$\underset{\text{colourless}}{BiCl_3(aq)} + H_2O(l) \underset{\text{backward}}{\overset{\text{forward}}{\rightleftharpoons}} \underset{\text{white}}{BiOCl(s)} + 2HCl(aq)$$

(i) Explain why the rate of the forward reaction decreases with time.

....

.... [2]

(ii) Why does the rate of the backward reaction increase with time?

....

.... [1]

(iii) After some time why does the appearance of the mixture remain unchanged?

....

.... [2]

(iv) When a few drops of concentrated hydrochloric acid are added to the cloudy mixture, it changes to a colourless solution. Suggest an explanation.

....

.... [2]

For Examiner's Use

(b) Both of the following reactions are reversible.

reaction 1 $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

reaction 2 $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

(i) Suggest a reason why an increase in pressure does not affect the position of equilibrium for reaction 1.

.... [1]

(ii) What effect would an increase in pressure have on the position of equilibrium for reaction 2? Give a reason for your answer.

....

.... [2]

4 The alcohols form a homologous series. The first member is methanol and the fourth is butanol.

CH_3-OH methanol $\quad\quad$ $CH_3-CH_2-CH_2-CH_2-OH$ butanol

(a) (i) Give **two** general characteristics of a homologous series.

....

....

.... [2]

(ii) Calculate the mass of one mole of the C_8 alcohol.

....

.... [2]

(b) Give the name and structural formula of the third member of this series.

name .... [1]

structural formula

[1]

(c) The structural formula of the fifth member, pentan-1-ol, is drawn below.

$$CH_3-CH_2-CH_2-CH_2-CH_2-OH$$

(i) Draw the structural formula of an isomer of this alcohol.

[1]

For Examiner's Use

(ii) Predict the names of the product(s) formed when pentan-1-ol

- reacts with an excess of oxygen,

  .... and .... [1]

- is dehydrated to form an alkene,

  .... [1]

- is oxidised by acidified potassium dichromate(VI).

  .... [1]

For Examiner's Use

5 Strontium and zinc are both metals with a valency of 2. Strontium is more reactive than zinc. Its chemistry is similar to that of calcium.

(a) (i) Complete the following table that shows the number of protons, electrons and neutrons in each particle.

particle	protons	electrons	neutrons
^{88}Sr			
^{90}Sr			
$^{65}Zn^{2+}$			

[3]

(ii) Explain why ^{88}Sr and ^{90}Sr are isotopes.

.... [1]

(iii) Complete the electron distribution of an atom of strontium.

2 + 8 + 18 + ... + ... [1]

(b) The major ore of zinc is zinc blende, ZnS.

(i) Describe how zinc is extracted from zinc blende.

....

....

.... [2]

(ii) Give a use of zinc.

.... [1]

For Examiner's Use

(c) The major ore of strontium is its carbonate, $SrCO_3$. Strontium is extracted by the electrolysis of its molten chloride.

(i) Name the reagent that will react with the carbonate to form the chloride.

.... [1]

(ii) The electrolysis of molten strontium chloride produces strontium metal and chlorine. Write ionic equations for the reactions at the electrodes.

negative electrode (cathode) ....

positive electrode (anode) .... [2]

(iii) One of the products of the electrolysis of concentrated aqueous strontium chloride is chlorine. Name the other two.

.... [2]

(d) Both metals react with water.

(i) Write a word equation for the reaction of zinc and water and state the reaction conditions.

word equation .... [1]

conditions .... [2]

(ii) Write an equation for the reaction of strontium with water and give the reaction condition.

equation .... [2]

condition .... [1]

6 **(a)** The following method is used to make crystals of hydrated nickel sulphate.

An excess of nickel carbonate, 12.0 g, was added to 40 cm^3 of sulphuric acid, 2.0 mol/dm^3. The unreacted nickel carbonate was filtered off and the filtrate evaporated to obtain the crystals.

$$NiCO_3 + H_2SO_4 \longrightarrow NiSO_4 + CO_2 + H_2O$$
$$NiSO_4 + 7H_2O \longrightarrow NiSO_4.7H_2O$$

Mass of one mole of $NiSO_4.7H_2O$ = 281 g
Mass of one mole of $NiCO_3$ = 119 g

(i) Calculate the mass of unreacted nickel carbonate.

Number of moles of H_2SO_4 in 40 cm^3 of 2.0 mol/dm^3 acid = 0.08

Number of moles of $NiCO_3$ reacted = ...

Mass of nickel carbonate reacted = ... g

Mass of unreacted nickel carbonate = ... g [3]

(ii) The experiment produced 10.4 g of hydrated nickel sulphate. Calculate the percentage yield.

The maximum number of moles of $NiSO_4.7H_2O$ that could be formed =

....

The maximum mass of $NiSO_4.7H_2O$ that could be formed = ... g

The percentage yield = ... % [3]

(b) In the above method, a soluble salt was prepared by neutralising an acid with an insoluble base. Other salts have to be made by different methods.

(i) Give a brief description of how the soluble salt, rubidium sulphate could be made from the soluble base, rubidium hydroxide.

....

....

....

.... [3]

For Examiner's Use

For Examiner's Use

(ii) Suggest a method of making the insoluble salt, calcium fluoride.

....

....

....

.... [3]

For Examiner's Use

7 In 1909, Haber discovered that nitrogen and hydrogen would react to form ammonia. The yield of ammonia was 8%.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the forward reaction is exothermic

catalyst platinum
temperature 600 °C
pressure 200 atm

(a) Describe how hydrogen is obtained for the modern process.

....

.... [2]

(b) (i) What is the catalyst in the modern process?

.... [1]

(ii) Explain why the modern process, which uses a lower temperature, has a higher yield of 15%.

....

.... [2]

(c) (i) Complete the following table that describes the bond breaking and forming in the reaction between nitrogen and hydrogen to form ammonia.

bonds	energy change /kJ	exothermic or endothermic
1 mole of N ≡ N broken	+945	....
3 moles of .... broken	+1308	....
6 moles of N – H formed	-2328	....

[3]

(ii) Explain, using the above data, why the forward reaction is exothermic.

....

.... [2]

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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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89															

*58-71 Lanthanoid series
90-103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**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	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

Key

a **X** b

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

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