

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

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Centre  
Number

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Candidate  
Number

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**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.

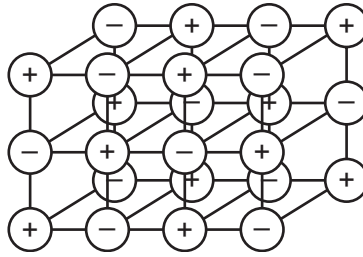
A copy of the Periodic Table is printed on page 16.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
<b>Total</b>	

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



- 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]

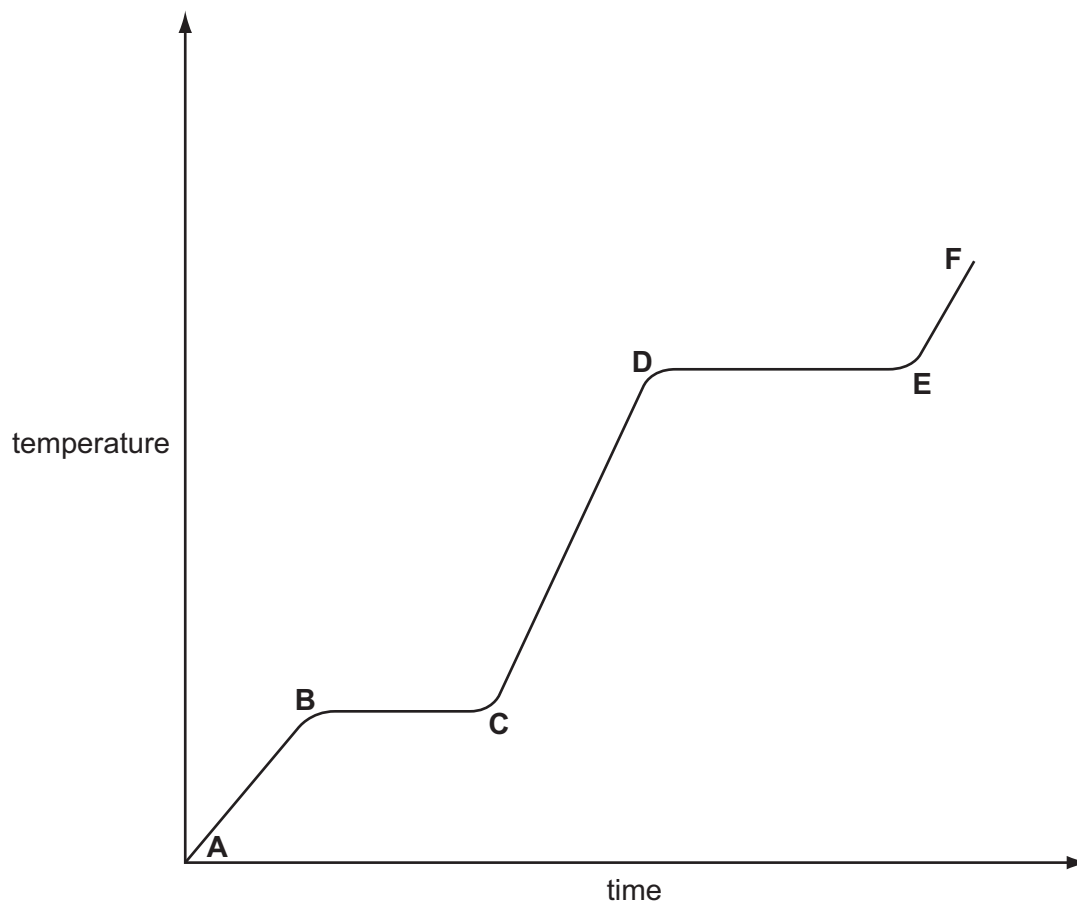
- (iv) In this compound there is an ionic bond. Why are the two ions attracted to each other?

..... [1]

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

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- (a) A pure sample of ethanoic acid is slowly heated from  $0^{\circ}\text{C}$  to  $150^{\circ}\text{C}$  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]

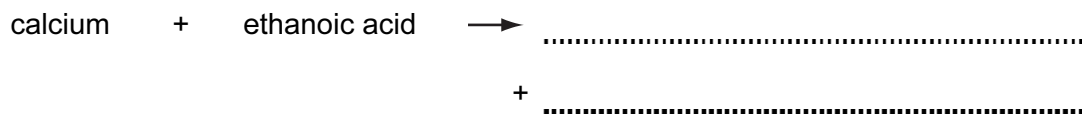
- (iv) Complete the following table that compares the separation and movement of the molecules in regions **C** to **D** with those in **E** to **F**.

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Use

	<b>C to D</b>	<b>E to F</b>
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.



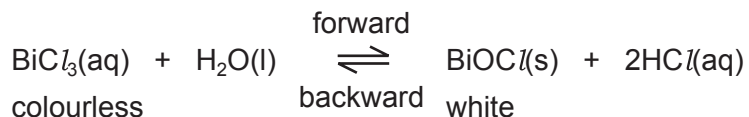
- (c) Write the symbol equation for the reaction between ethanoic acid and sodium hydroxide.

..... [2]

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

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



(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]

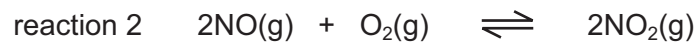
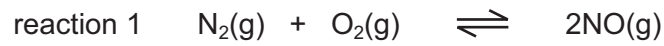
(iii) After some time why does the appearance of the mixture remain unchanged?

.....  
 ..... [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]

(b) Both of the following reactions are reversible.



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Use

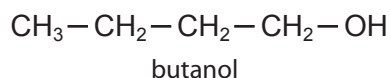
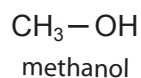
- (i) Suggest a reason why an increase in pressure does not affect the position of equilibrium for reaction 1.

..... [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.



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Use

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

.....  
 .....  
 ..... [2]

- (ii) Calculate the mass of one mole of the C<sub>8</sub> alcohol.

.....  
 ..... [2]

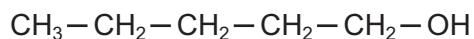
- (b) Give the name and structural formula of the third member of this series.

name ..... [1]

structural formula

[1]

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



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

[1]

(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]

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- 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.

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

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

[3]

- (ii) Explain why  $^{88}\text{Sr}$  and  $^{90}\text{Sr}$  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,  $\text{ZnS}$ .

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

.....  
 .....  
 ..... [2]

- (ii) Give a use of zinc.

..... [1]

(c) The major ore of strontium is its carbonate,  $\text{SrCO}_3$ . 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]

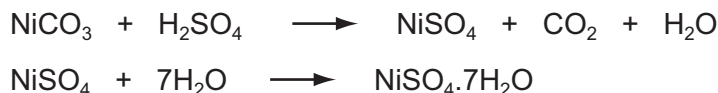
(ii) Write an equation for the reaction of strontium with water and give the reaction condition.

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<sup>3</sup> of sulphuric acid, 2.0 mol/dm<sup>3</sup>. The unreacted nickel carbonate was filtered off and the filtrate evaporated to obtain the crystals.



Mass of one mole of NiSO<sub>4</sub>·7H<sub>2</sub>O = 281 g

Mass of one mole of NiCO<sub>3</sub> = 119 g

- (i) Calculate the mass of unreacted nickel carbonate.

Number of moles of H<sub>2</sub>SO<sub>4</sub> in 40 cm<sup>3</sup> of 2.0 mol/dm<sup>3</sup> acid = 0.08

Number of moles of NiCO<sub>3</sub> 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<sub>4</sub>·7H<sub>2</sub>O that could be formed =

.....

The maximum mass of NiSO<sub>4</sub>·7H<sub>2</sub>O 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]

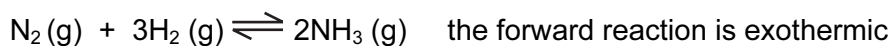
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(ii) Suggest a method of making the insoluble salt, calcium fluoride.

.....  
.....  
.....  
..... [3]

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Use*

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



catalyst platinum  
temperature 600 °C  
pressure 200 atm

For  
Examiner's  
Use

- (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	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII																													
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td>1 <b>H</b> Hydrogen 1</td> <td colspan="11"></td> </tr> </table>										1 <b>H</b> Hydrogen 1												2 <b>He</b> Helium 2																						
1 <b>H</b> Hydrogen 1																																														
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10	27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulphur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18	39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36															
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	222 <b>Rn</b> Radon 86																
87 <b>Fr</b> Francium	226 <b>Ra</b> Radium	227 <b>Ac</b> Actinium	<p>*58-71 Lanthanoid series 90-103 Actinoid series</p>										175 <b>Lu</b> Lutetium																																	
		<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td>a</td> <td><b>X</b></td> </tr> <tr> <td>b</td> <td></td> </tr> </table>		a	<b>X</b>	b		<p>Key</p> <p>a = relative atomic mass X = atomic symbol b = proton (atomic) number</p>														173 <b>Yb</b> Ytterbium	169 <b>Tm</b> Thulium	167 <b>Er</b> Erbium	165 <b>Ho</b> Holmium	162 <b>Dy</b> Dysprosium	159 <b>Tb</b> Terbium	157 <b>Gd</b> Gadolinium	152 <b>Eu</b> Europium	150 <b>Sm</b> Samarium	144 <b>Nd</b> Neodymium	141 <b>Pr</b> Praseodymium	140 <b>Ce</b> Cerium	238 <b>U</b> Uranium	232 <b>Th</b> Thorium	238 <b>Np</b> Neptunium	232 <b>Pu</b> Plutonium	232 <b>Am</b> Americium	232 <b>Cm</b> Curium	232 <b>Bk</b> Berkelium	232 <b>Cf</b> Californium	232 <b>Es</b> Einsteinium	232 <b>Fm</b> Fermium	232 <b>Md</b> Mendelevium	232 <b>No</b> Nobelium	232 <b>Lr</b> Lawrencium
a	<b>X</b>																																													
b																																														

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