

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CHEMISTRY



Paper 3 (Extended)

0620/03

October/November 2006

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 in the spaces provided on the Question Paper.

You may use a pencil for any diagrams, graphs or rough working.

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

DO NOT WRITE IN THE BARCODE.

DO NOT WRITE IN THE GREY AREAS BETWEEN THE PAGES.

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	
8	
Total	

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



- 1 Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

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ammonia argon carbon dioxide carbon monoxide chlorine
ethene hydrogen nitrogen oxygen

Which gas

- (i) is a noble gas,

.....

- (ii) is an acidic oxide,

.....

- (iii) can be polymerised,

.....

- (iv) is the active component of air,

.....

- (v) is used in the treatment of water,

.....

- (vi) is a product of respiration?

.....

[6]

- 2 The table shows the melting points, boiling points and electrical properties of the six substances **A** to **F**.

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substance	melting point / °C	boiling point / °C	electrical conductor at room temperature	electrical conductor of substance dissolved in water
A	961	2193	good	does not dissolve
B	113	444	does not conduct	does not dissolve
C	0	100	very poor	very poor
D	803	1465	does not conduct	good
E	-5 to -10	102 to 105	good	good
F	-85	-60	does not conduct	does not dissolve

- (i) Which **three** substances are solids at room temperature?

..... [1]

- (ii) Which **one** is an ionic compound?

..... [1]

- (iii) Which **one** is a gas at room temperature?

..... [1]

- (iv) Which **two** substances are liquids at room temperature?

..... [1]

- (v) Which substance is a metal?

..... [1]

- (vi) Which **one** is an impure substance?

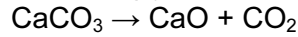
..... [1]

3 Calcium carbonate is an important raw material.

(a) Name a rock which is made up of calcium carbonate.

..... [1]

(b) When calcium carbonate is heated strongly, it decomposes.



(i) Calculate the relative formula mass of:

CaCO₃

CaO [2]

(ii) 7.00 kg of calcium oxide was formed. What mass of calcium carbonate was heated?

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

(c) Calcium carbonate is used to control soil acidity.

(i) Why is it important to control soil acidity?

..... [1]

(ii) Both calcium carbonate, insoluble in water, and calcium oxide, slightly soluble, are used to increase soil pH. Suggest **two** advantages of using calcium carbonate.

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

(iii) Give **one** use of calcium carbonate other than for making calcium oxide and controlling soil pH.

..... [1]

4 Minimising air pollution is essential for health and for the environment.

(a) Natural gas is methane.

(i) Write the equation for complete combustion of methane.

..... [2]

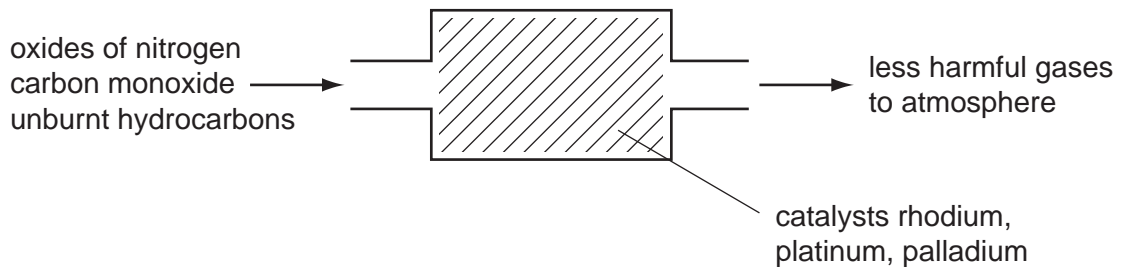
(ii) Explain why it is dangerous to use a gas fire in a poorly ventilated room.

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

(b) Low sulphur fuels are being introduced. Ordinary diesel contains 500 ppm of sulphur but low sulphur diesel contains less than 50 ppm. Why is this an advantage to the environment?

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

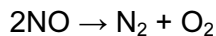
(c) Catalytic converters reduce pollution from motor vehicles, as shown in the following diagram.



(i) What type of elements are the metals rhodium, platinum and palladium?

..... [1]

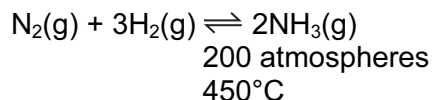
(ii) Rhodium catalyses the decomposition of the oxides of nitrogen.



Two other pollutants are carbon monoxide and unburnt hydrocarbons. How are they made into less harmful substances?

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

5 Ammonia is manufactured by the Haber Process.



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The forward reaction is exothermic.

(a) (i) What is the catalyst for this reaction?

..... [1]

(ii) Newer catalysts have been discovered for this process. Using these catalysts, the operating temperature is lowered from 450°C to 400°C. What is the advantage of using a lower temperature?
Explain your answer.

advantage

explanation

..... [2]

(b) After passing over the catalyst, the mixture contains 15% of ammonia. It is cooled and the ammonia liquefies and is separated from the unreacted nitrogen and hydrogen. They are recycled.

(i) How are the gases recycled?

..... [1]

(ii) Only ammonia gas liquefies. Suggest an explanation for this.

..... [1]

(c) Urea, $\text{CO}(\text{NH}_2)_2$, is one of the fertilisers manufactured from ammonia. Ammonia is heated with carbon dioxide.

(i) Write an equation for the manufacture of urea.

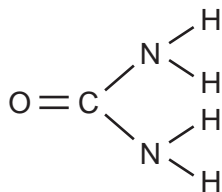
..... [2]

(ii) Explain why urea on its own might not be very effective in promoting crop growth.

..... [1]

- (d) Give a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound urea. Its structural formula is given below.

For
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Use



Use \circ to represent an electron from a carbon atom.
Use \times to represent an electron from a hydrogen atom.
Use \bullet to represent an electron from a nitrogen atom.

[3]

6 An ore of copper is the mineral, chalcopyrite. This is a mixed sulphide of iron and copper.

(a) Analysis of a sample of this ore shows that 13.80 g of the ore contained 4.80 g of copper, 4.20 g of iron and the rest sulphur.

Complete the table and calculate the empirical formula of chalcopyrite.

	copper	iron	sulphur
composition by mass /g	4.80	4.20	
number of moles of atoms			
simplest mole ratio of atoms			

The empirical formula is

[3]

..... [1]

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(i) Name;
the material used for the positive electrode (anode),

.....

the material used for the negative electrode (cathode),

.....

a suitable electrolyte.

..... [3]

(ii) Write an ionic equation for the reaction at the negative electrode.

..... [1]

(iii) One use of this pure copper is electrical conductors, another is to make alloys. Name the metal that is alloyed with copper to make brass.

..... [1]

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Use

(c) Two of the elements in chalcopyrite are the metal, copper, and the non-metal, sulphur. These have different properties. Copper is an excellent conductor of electricity and is malleable. Sulphur is a poor conductor and is not malleable, it is brittle. Explain, in terms of their structures, why this is so.

*For
Examiner's
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difference in electrical conductivity

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

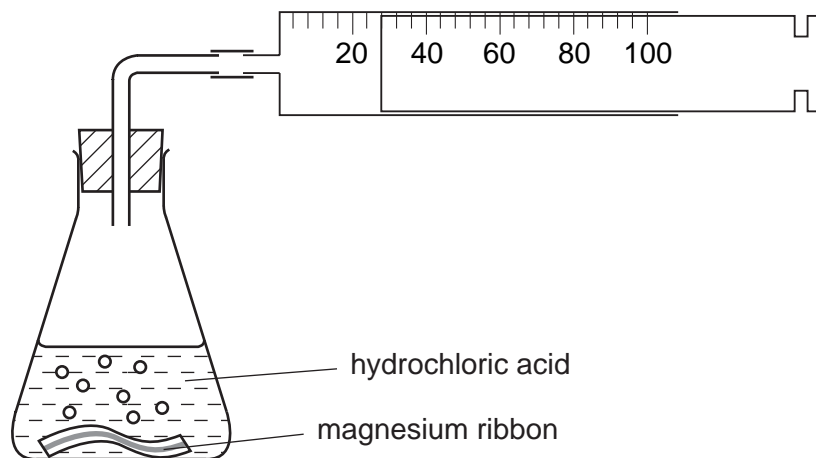
difference in malleability

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

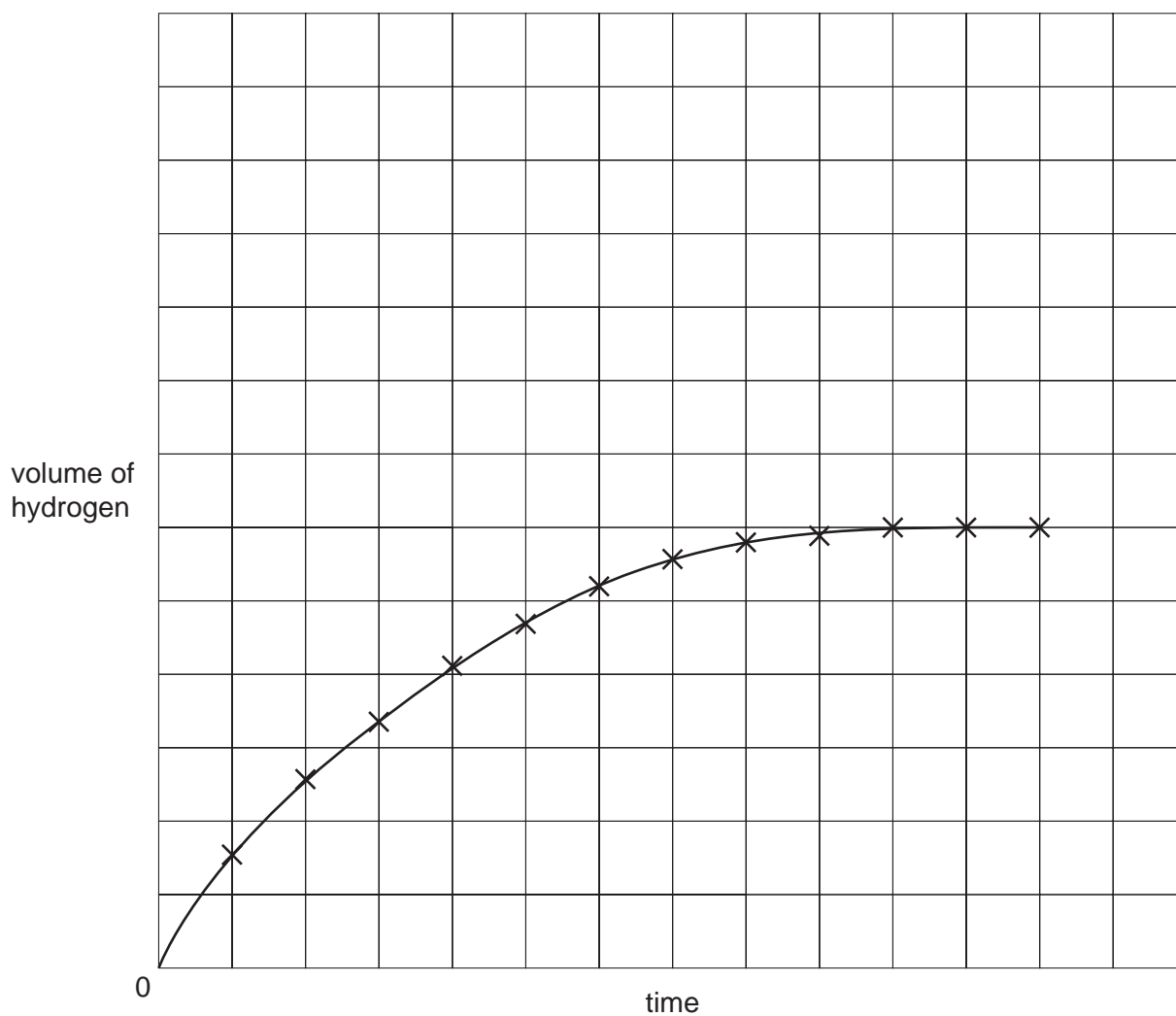
- 7 The rate of a reaction depends on concentration of reactants, temperature and possibly a catalyst or light.

For
Examiner's
Use

- (a) A piece of magnesium ribbon was added to 100 cm³ of 1.0 mol/dm³ hydrochloric acid. The hydrogen evolved was collected in a gas syringe and its volume measured every 30 seconds.



In all the experiments mentioned in this question, the acid was in excess. The results were plotted to give a graph.



- (i) The experiment was repeated. Two pieces of magnesium ribbon were added to 100 cm³ of 1.0 mol/dm³ hydrochloric acid. Sketch this graph on the same grid and label it X.

[2]

- (ii) The experiment was repeated using one piece of magnesium ribbon and 100 cm³ of 1.0 mol/dm³ ethanoic acid. Describe how the **shape** of this graph would differ from the one given on the grid.

.....
 [2]

- (b) Reaction rate increases when concentration or temperature is increased. Using the idea of reacting particles, explain why;

increasing concentration increases reaction rate,

.....
 [2]

increasing temperature increases reaction rate.

.....
 [2]

- (c) The rate of a photochemical reaction is affected by light. A reaction, in plants, between carbon dioxide and water is photochemical.

- (i) Name the **two** products of this reaction.

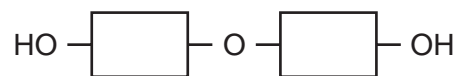
.....
 [2]

- (ii) This reaction will only occur in the presence of light and another chemical. Name this chemical.

..... [1]

8 The three types of food are carbohydrates, proteins and fats.

- (a) Aqueous starch is hydrolysed to maltose by the enzyme amylase.
The formula of maltose is:



Starch is hydrolysed by dilute sulphuric acid to glucose.



- (i) What is an enzyme?

..... [1]

- (ii) Draw the structure of starch.

[1]

- (iii) Name the technique that would show that the products of these two hydrolyses are different.

..... [1]

- (b) Proteins have the same linkage as nylon but there is more than one monomer in the macromolecule.

- (i) Draw the structure of a protein.

[2]

- (ii) What class of compound is formed by the hydrolysis of proteins?

..... [1]

(c) Fats are esters. Some fats are saturated, others are unsaturated.

(i) Write the word equation for the preparation of the ester, propyl ethanoate.

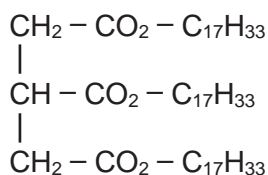
..... [2]

(ii) Deduce the structural formula of this ester showing each individual bond.

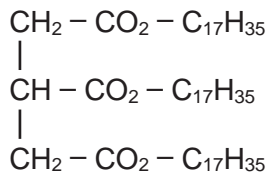
[2]

(iii) How could you distinguish between these two fats?

Fat 1 has the formula



Fat 2 has the formula



test

result with fat 1

result with fat 2 [3]

(iv) Both of these fats are hydrolysed by boiling with aqueous sodium hydroxide. What type of compounds are formed?

..... and [2]

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DATA SHEET
The Periodic Table of the Elements

		Group																																																																						
I	II	III	IV	V	VI	VII	0						0																																																											
		1 H Hydrogen 1											2 He Helium 2																																																											
7 Li Lithium 3	9 Be Beryllium 4											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						84 Kr Krypton 36																																																											
39 K Potassium 19	40 Ca Calcium 20	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	131 Xe Xenon 54						227 Ac Actinium 89																																																											
85 Rb Rubidium 37	88 Sr Strontium 38	101 Ru Ruthenium 44	106 Pd Palladium 46	112 Cd Cadmium 48	115 In Indium 49	127 I Iodine 53	209 Pb Lead 82						86 Rn Radon 86																																																											
133 Cs Caesium 55	137 Ba Barium 56	190 Os Osmium 76	195 Pt Platinum 78	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82						226 Ra Radium 88																																																												
226 Fr Francium 87	227 Ac Actinium 89											227 Ac Actinium 89																																																												
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<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%; text-align: center;">a</td> <td style="width: 5%; text-align: center;">X</td> <td style="width: 5%; text-align: center;">b</td> <td style="width: 5%;"></td> <td style="width: 5%; text-align: center;">140 Ce Cerium 58</td> <td style="width: 5%; text-align: center;">141 Pr Praseodymium 59</td> <td style="width: 5%; text-align: center;">144 Nd Neodymium 60</td> <td style="width: 5%; text-align: center;">150 Sm Samarium 62</td> <td style="width: 5%; text-align: center;">152 Eu Europium 63</td> <td style="width: 5%; text-align: center;">157 Gd Gadolinium 64</td> <td style="width: 5%; text-align: center;">162 Dy Dysprosium 66</td> <td style="width: 5%; text-align: center;">165 Ho Holmium 67</td> <td style="width: 5%; text-align: center;">169 Tm Thulium 69</td> <td style="width: 5%; text-align: center;">173 Yb Ytterbium 70</td> <td style="width: 5%; text-align: center;">175 Lu Lutetium 71</td> </tr> <tr> <td style="text-align: center;">Key</td> <td></td> <td></td> <td></td> <td style="text-align: center;">232 Th Thorium 90</td> <td style="text-align: center;">141 Pa Protactinium 91</td> <td style="text-align: center;">238 U Uranium 92</td> <td style="text-align: center;">150 Sm Samarium 62</td> <td style="text-align: center;">152 Eu Europium 63</td> <td style="text-align: center;">157 Gd Gadolinium 64</td> <td style="text-align: center;">162 Dy Dysprosium 66</td> <td style="text-align: center;">165 Ho Holmium 67</td> <td style="text-align: center;">169 Tm Thulium 69</td> <td style="text-align: center;">173 Yb Ytterbium 70</td> <td style="text-align: center;">175 Lu Lutetium 71</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td style="text-align: center;">91 Pa Protactinium 91</td> <td style="text-align: center;">92 Th Thorium 90</td> <td style="text-align: center;">93 Np Neptunium 93</td> <td style="text-align: center;">94 Pu Plutonium 94</td> <td style="text-align: center;">95 Am Americium 95</td> <td style="text-align: center;">96 Cm Curium 96</td> <td style="text-align: center;">97 Bk Berkelium 97</td> <td style="text-align: center;">98 Cf Californium 98</td> <td style="text-align: center;">99 Es Einsteinium 99</td> <td style="text-align: center;">100 Fm Fermium 100</td> <td style="text-align: center;">102 No Nobelium 102</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td style="text-align: center;">99 Th Thorium 90</td> <td style="text-align: center;">91 Pa Protactinium 91</td> <td style="text-align: center;">92 U Uranium 92</td> <td style="text-align: center;">94 Pu Plutonium 94</td> <td style="text-align: center;">95 Am Americium 95</td> <td style="text-align: center;">96 Cm Curium 96</td> <td style="text-align: center;">97 Bk Berkelium 97</td> <td style="text-align: center;">98 Cf Californium 98</td> <td style="text-align: center;">99 Es Einsteinium 99</td> <td style="text-align: center;">100 Fm Fermium 100</td> <td style="text-align: center;">102 No Nobelium 102</td> </tr> </table>													a	X	b		140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	162 Dy Dysprosium 66	165 Ho Holmium 67	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	Key				232 Th Thorium 90	141 Pa Protactinium 91	238 U Uranium 92	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	162 Dy Dysprosium 66	165 Ho Holmium 67	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71					91 Pa Protactinium 91	92 Th Thorium 90	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	102 No Nobelium 102					99 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	102 No Nobelium 102
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a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).