



date

Centre Number

Candidate Name _____

**International General Certificate of Secondary Education
CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**CHEMISTRY
PAPER 3**

0620/3

OCTOBER/NOVEMBER SESSION 2002

1 hour 15 minutes

Candidates answer on the question paper.
No additional materials are required.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

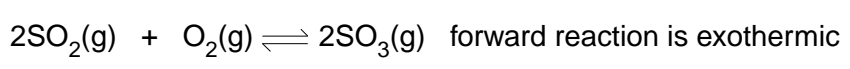
INFORMATION FOR CANDIDATES

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 12.

| FOR EXAMINER'S USE | |
|--------------------|--|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| TOTAL | |

1 (a) Sulphuric acid is made by the Contact Process.



(i) What are the reaction conditions for the Contact Process?

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

(ii) Would the yield of sulphur trioxide increase, decrease or stay the same when the temperature is increased? Explain your answer.

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

(iii) Describe how sulphur trioxide is changed into concentrated sulphuric acid.

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

(b) There are three ways of making salts from sulphuric acid.
titration using a burette and indicator
precipitation by mixing the solutions and filtering
neutralisation of sulphuric acid using an excess of an insoluble base

Complete the following table of salt preparations.

| method | reactant 1 | reactant 2 | salt |
|----------------|----------------|------------------|---------------------|
| titration | sulphuric acid | | sodium sulphate |
| neutralisation | sulphuric acid | | zinc sulphate |
| precipitation | sulphuric acid | | barium sulphate |
| | sulphuric acid | copper(II) oxide | copper(II) sulphate |

[4]

(c) The results of an investigation into the action of heat on copper(II) sulphate-5-water blue crystalline solid, are given below.

The formula is $CuSO_4 \cdot 5H_2O$ and the mass of one mole is 250 g

A 5.0g sample of the blue crystals is heated to form 3.2g of a white powder. With further heating this decomposes into a black powder and sulphur trioxide.

(i) Name the white powder.
.....[1]

(ii) What is observed when water is added to the white powder?
.....[1]

(iii) Name the black powder.
.....[1]

(iv) Calculate the mass of the black powder. Show your working.
.....
.....
.....[3]

2 Manganese is a transition element. It has more than one valency and the metal and its compounds are catalysts.

(a) (i) Predict **three** other properties of manganese that are typical of transition elements.
.....
.....[3]

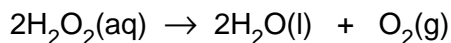
(ii) Complete the electron distribution of manganese by inserting one number.
 $2 + 8 + \dots + 2$ [1]

(b) It has several oxides, three of which are shown below.
Manganese(II) oxide, which is basic.
Manganese(III) oxide, which is amphoteric.
Manganese(IV) oxide, which is acidic.

(i) Complete the word equation.
manganese(II) oxide + hydrochloric acid \rightarrow +
..... [2]

(ii) Which, if any, of these oxides will react with sodium hydroxide?
.....[1]

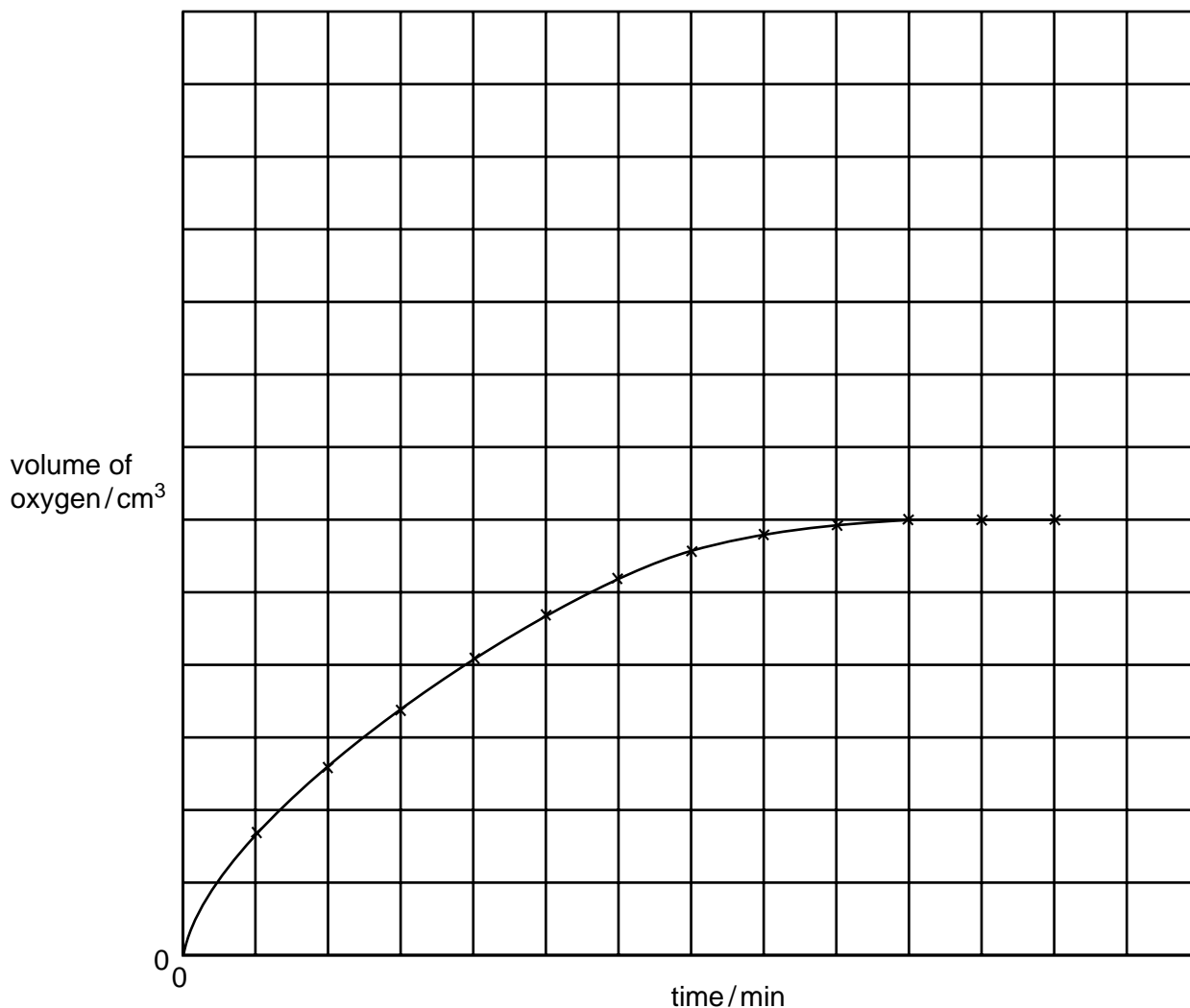
(c) Aqueous hydrogen peroxide decomposes to form water and oxygen.



This reaction is catalysed by manganese(IV) oxide

The following experiments were carried out to investigate the rate of this reaction.

A 0.1 g sample of manganese(IV) oxide was added to 20 cm³ of 0.2 M hydrogen peroxide solution. The volume of oxygen produced was measured every minute. The results of this experiment are shown on the graph.



(i) How does the rate of reaction vary with time? Explain why the rate varies.

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

(ii) The following experiment was carried out at the same temperature.

0.1 g of manganese(IV) oxide and 20 cm³ of 0.4 M hydrogen peroxide

Sketch the curve for this experiment on the same grid.

[2]

(iii) How would the shape of the graph differ if only half the mass of catalyst had been used in these experiments?

.....

.....

.....[2]

3 The elements in Period 3 and some of their common oxidation states are shown below.

| | | | | | | | | |
|-----------------|----|----|----|----|----|----|----|----|
| Element | Na | Mg | Al | Si | P | S | Cl | Ar |
| Oxidation State | +1 | +2 | +3 | +4 | -3 | -2 | -1 | 0 |

(a) (i) Why do the oxidation states increase from sodium to silicon?

.....[1]

(ii) After Group(IV) the oxidation states are negative and decrease across the period. Explain why.

.....

.....[2]

(b) The following compounds contain two elements. Predict their formulae.

aluminium sulphide

silicon phosphide [2]

(c) Choose a different element from Period 3 that matches each description.

(i) It has a similar structure to diamond.

.....[1]

(ii) It reacts violently with cold water to form a solution pH = 14.

.....[1]

(iii) It has a gaseous oxide of the type XO_2 , which is acidic.

.....[1]

(d) The only oxidation state of argon is zero. Why it is used to fill light bulbs?

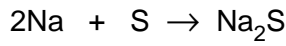
.....

.....[1]

- (e) Draw a diagram that shows the arrangement of the valency electrons in the ionic compound sodium phosphide.

Use o to represent an electron from sodium.
 Use x to represent an electron from phosphorus. [3]

- (f) Sodium reacts with sulphur to form sodium sulphide.



An 11.5 g sample of sodium is reacted with 10 g of sulphur. All of the sodium reacted but there was an excess of sulphur.
 Calculate the mass of sulphur left unreacted.

- (i) Number of moles of sodium atoms reacted =
 [2 moles of Na react with 1 mole of S]
- (ii) Number of moles of sulphur atoms that reacted =
- (iii) Mass of sulphur reacted =g
- (iv) Mass of sulphur left unreacted =g [4]

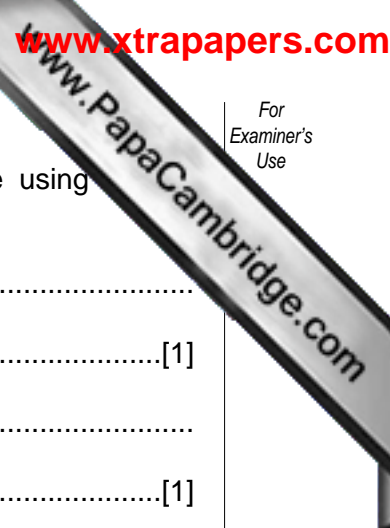
- 4 For over 5000 years copper has been obtained by the reduction of its ores. More recently the metal has been purified by electrolysis.

- (a) Copper is used to make alloys.

- (i) Give **two** other uses of copper.
[2]

- (ii) Alloys have similar structures to pure metals. Give a labelled diagram that shows the structure of a typical alloy, such as brass.

[3]



(b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper)
.....[1]

(ii) anode (impure copper)
.....[1]

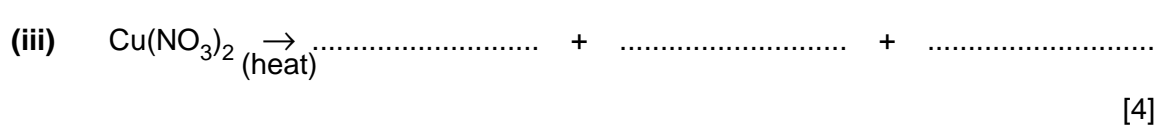
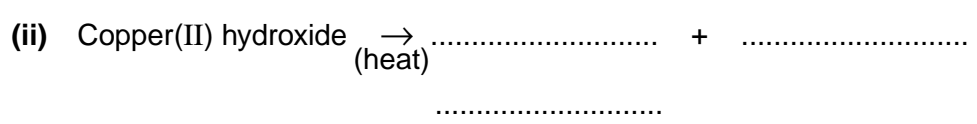
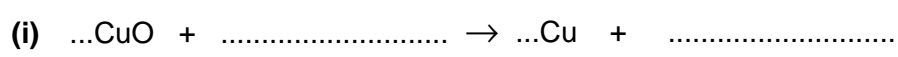
(iii) Write an ionic equation for the reaction at the cathode.
.....[1]

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.
The colourless gas is
The solution changes into [2]

(c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?
.....
.....[2]

(d) Copper is an unreactive metal. Its compounds are easily reduced to the metal or decomposed to simpler compounds. Complete the following equations.



5 Alkenes are unsaturated hydrocarbons. They show structural isomerism. Alkenes take part in addition reactions and form polymers.

(a) Structural isomers have the same molecular formula but different structural formulae. Give an example of structural isomerism.

molecular formula

two structural formulae

[3]

(b) Ethene reacts with each of the following. Give the name and structural formula of each product.

(i) steam

name of product

structure of product

[2]

(ii) hydrogen

name of product

structure of product

[2]

(c) Alkenes polymerise by addition.

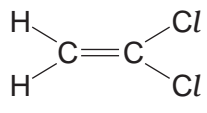
(i) Explain the term *polymerise*.

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

(ii) What is the difference between addition polymerisation and condensation polymerisation?

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

(iii) Poly(dichloroethene) is used extensively to package food. Draw its structure. The structural formula of dichloroethene is drawn below.



[2]

(d) Steel may be coated with another metal, eg zinc or chromium, or with a polymer, eg poly(chloroethene), to prevent rusting.

(i) Suggest a property of poly(chloroethene) that makes it suitable for this purpose.

.....[1]

(ii) Explain why the steel will rust when the protective coating of chromium or polymer is broken.

.....[1]

(iii) When the protective layer of zinc is broken, the steel still does not rust. Suggest an explanation.

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

11
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DATA SHEET
The Periodic Table of the Elements

| | | Group | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------------|--|--|-------------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|-------------------------------------|--|-------------------------------------|--|-------------------------------------|------------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|------------------------------------|----------------------------------|-----------------------------------|-------------------------------------|------------------------------------|-----------------------------------|----------------------------------|--|-------------------------------------|-------------------------------------|-------------------------------------|----------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|
| I | II | III | IV | V | VI | VII | 0 | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 Li Lithium 4 | 9 Be Beryllium | <table border="1"> <tr> <td>1 H Hydrogen 1</td> <td colspan="10"></td> </tr> </table> | | | | | | | | | | 1 H Hydrogen 1 | | | | | | | | | | | 4 He Helium 2 | | | | | | | | | | | | | |
| 1 H Hydrogen 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 Na Sodium 12 | 24 Mg Magnesium | 11 B Boron 5 | 12 C Carbon 6 | 14 N Nitrogen 7 | 16 O Oxygen 8 | 19 F Fluorine 9 | 20 Ne Neon 10 | 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 | 40 Ca Calcium 20 | 65 Zn Zinc 30 | 70 Ga Gallium 31 | 75 As Arsenic 33 | 79 Se Selenium 34 | 80 Br Bromine 35 | 84 Kr Krypton 36 | 85 Rb Rubidium 38 | 88 Sr Strontium 38 | 89 Y Yttrium 39 | 91 Ti Titanium 22 | 91 Zr Zirconium 40 | 93 Nb Niobium 41 | 95 Mn Manganese 25 | 96 Cr Chromium 24 | 99 Mo Molybdenum 42 | 101 Ru Ruthenium 44 | 106 Pd Palladium 46 | 112 Cd Cadmium 48 | 115 In Indium 49 | 119 Sn Tin 50 | 122 Sb Antimony 51 | 127 I Iodine 53 | 131 Xe Xenon 54 | | | | | | | | | | | | |
| 133 Cs Caesium 56 | 137 Ba Barium 57 | 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 | 210 Po Polonium 84 | 210 At Astatine 85 | 222 Rn Radon 86 | 226 Ra Radium 88 | 227 Ac Actinium 89 | | | | 227 Fr Francium 87 | | | | | | | | | | | | | |
| | | <table border="1"> <tr> <td>140 Ce Cerium 58</td> <td>141 Pr Praseodymium 59</td> <td>144 Nd Neodymium 60</td> <td>150 Sm Samarium 62</td> <td>152 Eu Europium 63</td> <td>157 Gd Gadolinium 64</td> <td>162 Dy Dysprosium 66</td> <td>165 Ho Holmium 67</td> <td>167 Er Erbium 68</td> <td>169 Tm Thulium 69</td> <td>173 Yb Ytterbium 70</td> <td>175 Lu Lutetium 71</td> </tr> <tr> <td>232 Th Thorium 90</td> <td>238 U Uranium 92</td> <td>238 Pa Protactinium 91</td> <td>238 Np Neptunium 93</td> <td>238 Pu Plutonium 94</td> <td>238 Am Americium 95</td> <td>238 Cm Curium 96</td> <td>238 Bk Berkelium 97</td> <td>238 Cf Californium 98</td> <td>238 Es Einsteinium 99</td> <td>238 Fm Fermium 100</td> <td>238 Md Mendelevium 101</td> <td>238 No Nobelium 102</td> </tr> </table> | | | | | | | | | | 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 | 167 Er Erbium 68 | 169 Tm Thulium 69 | 173 Yb Ytterbium 70 | 175 Lu Lutetium 71 | 232 Th Thorium 90 | 238 U Uranium 92 | 238 Pa Protactinium 91 | 238 Np Neptunium 93 | 238 Pu Plutonium 94 | 238 Am Americium 95 | 238 Cm Curium 96 | 238 Bk Berkelium 97 | 238 Cf Californium 98 | 238 Es Einsteinium 99 | 238 Fm Fermium 100 | 238 Md Mendelevium 101 | 238 No Nobelium 102 |
| 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 | 167 Er Erbium 68 | 169 Tm Thulium 69 | 173 Yb Ytterbium 70 | 175 Lu Lutetium 71 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 232 Th Thorium 90 | 238 U Uranium 92 | 238 Pa Protactinium 91 | 238 Np Neptunium 93 | 238 Pu Plutonium 94 | 238 Am Americium 95 | 238 Cm Curium 96 | 238 Bk Berkelium 97 | 238 Cf Californium 98 | 238 Es Einsteinium 99 | 238 Fm Fermium 100 | 238 Md Mendelevium 101 | 238 No Nobelium 102 | | | | | | | | | | | | | | | | | | | | | | | | |

71-79 Lanthanoid series
81-103 Actinoid series

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.).