



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

5070/21

Paper 2 Theory

October/November 2011

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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 in the spaces provided in the Question Paper.

A copy of the Periodic Table is printed on page 20.

At the end of the examination, fasten all your work securely together.

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

For Examiner's Use	
Section A	
B6	
B7	
B8	
B9	
Total	

This document consists of **17** printed pages and **3** blank pages.



Section A

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

The total mark for this section is 45.

A1 Choose from the following list of compounds to answer the questions below.

calcium hydroxide
carbon monoxide
methane
nitrogen dioxide
potassium manganate(VII)
silver nitrate
sulfur dioxide

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

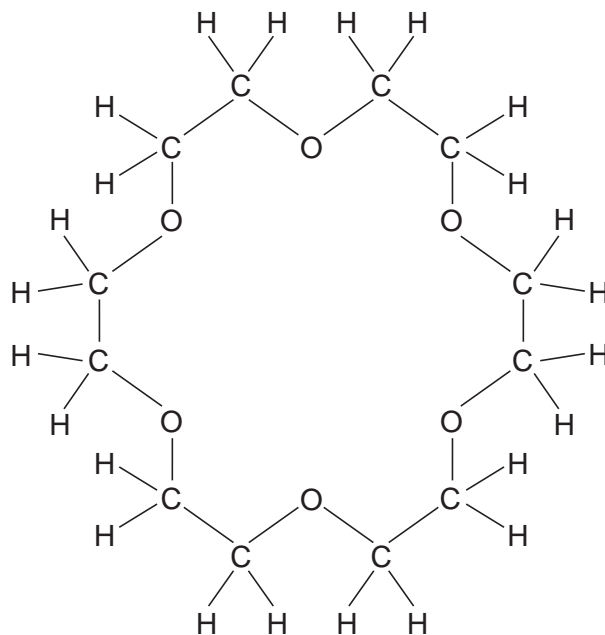
Which compound

- (a) is used as a bleach in the manufacture of paper,
..... [1]
- (b) changes from purple to colourless when its acidified solution is used to oxidise ethanol,
..... [1]
- (c) has an aqueous solution that reacts with aqueous sodium chloride to give a white precipitate,
..... [1]
- (d) can be formed by the action of lightning on gases in the atmosphere,
..... [1]
- (e) is formed by the decay of vegetable matter?
..... [1]

[Total: 5]

A2 Sodium can react with compounds called crown ethers.

(a) A typical crown ether is shown below.



Write the empirical formula for this crown ether.

..... [1]

(b) When sodium reacts with crown ethers it forms Na⁺ and Na⁻ ions.
 Draw the structure of an Na⁻ ion.
 Show all the electrons.

[1]

(c) When sodium reacts with water, hydrogen is given off and an alkaline solution is formed.

(i) Describe **two** observations that can be made when sodium reacts with water.

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

(ii) Write an equation, including state symbols, for the reaction of sodium with water.

..... [3]

(d) Sodium is an alkali metal. Iron is a transition element.
State the differences between these two metals in terms of

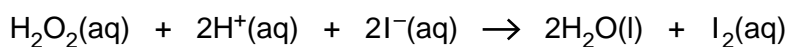
(i) melting point
..... [1]

(ii) density
..... [1]

[Total: 9]

A3 Hydrogen peroxide is a colourless liquid.

An aqueous solution of hydrogen peroxide reacts with the iodide ions in acidified potassium iodide to form water and iodine.



(a) (i) Explain why iodide ions are acting as the reducing agent in this reaction.

..... [1]

(ii) What colour change would you observe in this reaction?

..... [1]

(b) The table shows how the speed of this reaction changes when different concentrations of potassium iodide and sulfuric acid are used. The hydrogen peroxide is always in excess and the temperature remains constant.

experiment	concentration of potassium iodide in mol/dm ³	concentration of sulfuric acid in mol/dm ³	speed of reaction in mol/dm ³ /s
1	0.1	0.1	0.00017
2	0.2	0.1	0.00034
3	0.1	0.2	0.00017
4	0.3	0.1	0.00051
5	0.1	0.3	0.00017

Use the information in the table to describe how increasing the concentration of the following reagents affects the speed of reaction.

potassium iodide

..... [1]

sulfuric acid

..... [1]

(c) Explain, in terms of collisions between reacting particles, why decreasing the temperature decreases the speed of reaction between hydrogen peroxide and acidified potassium iodide.

.....

(d) Iodine-127 has the symbol ${}_{53}^{127}\text{I}$.

State the number of subatomic particles in an iodide **ion** ${}_{53}^{127}\text{I}^-$.

protons

electrons

neutrons

[2]

[Total: 8]

A4 A plant contains the coloured compounds chlorophyll and carotene.

- (a) The mixture of coloured compounds is extracted with propanone to give a brown solution.
- (i) Describe, with the aid of a labelled diagram, how you can show that there is more than one coloured compound in the brown solution.

.....

.....

.....

..... [3]

- (ii) You are given a pure sample of chlorophyll.
How can you show that the brown solution contains chlorophyll?

.....

.....

.....

..... [2]

(b) In green plants chlorophyll acts as a catalyst in photosynthesis.

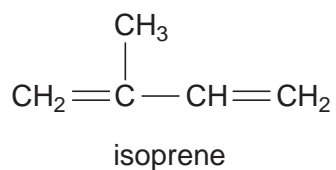
- (i) Complete the word equation which describes photosynthesis.

..... + water \rightarrow + oxygen [1]

- (ii) During one stage in photosynthesis, electrons are removed from water to produce hydrogen ions and oxygen gas.
Write an equation for this reaction.

..... [2]

- (c) Chlorophyll and carotene can be made in the laboratory from isoprene.



- (i) Isoprene is an unsaturated compound.

What do you understand by the term *unsaturated*?

..... [1]

- (ii) What would you observe when excess isoprene is added to aqueous bromine?

..... [1]

- (d) In many plants, the alkene ethene promotes the ripening of fruits.

- (i) Write the general formula for an alkene.

[1]

- (ii) Draw the structure of an alkene containing four carbon atoms.
Show all atoms and bonds.

[1]

- (iii) Describe how ethanol can be formed from ethene, stating the necessary reaction conditions.

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

[Total: 14]

A5 Three types of bonding are covalent, ionic and metallic.

(a) (i) Draw a labelled diagram to illustrate metallic bonding.

[2]

(ii) Use ideas about the structure of metals to explain why metals are

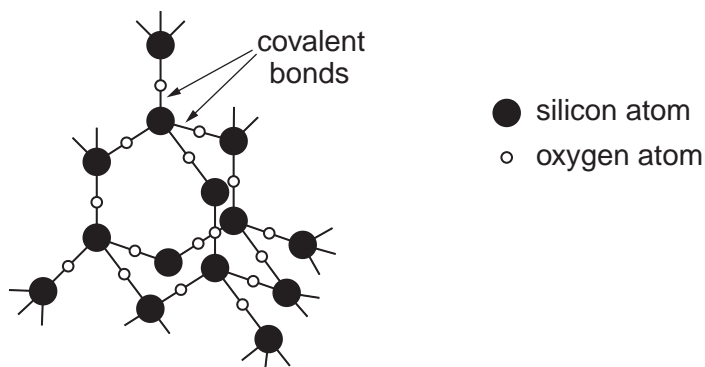
malleable,

..... [1]

good conductors of electricity.

..... [1]

(b) Silicon dioxide has a similar structure to diamond.



Suggest why silicon dioxide

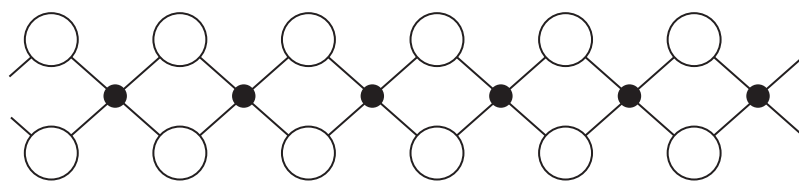
does not conduct electricity,

..... [1]

is hard.

..... [1]

(c) Part of the structure of palladium chloride is shown below.



● palladium, Pd

○ chlorine, Cl

Deduce the empirical formula for palladium chloride.

..... [1]

(d) Sodium chloride has an ionic structure.

Explain why sodium chloride conducts electricity when molten but does not conduct electricity when in the solid state.

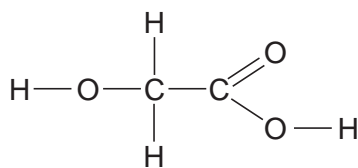
.....

.....

..... [2]

[Total: 9]

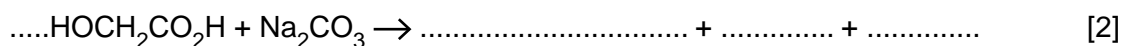
B7 The structure of glycollic acid is shown below.



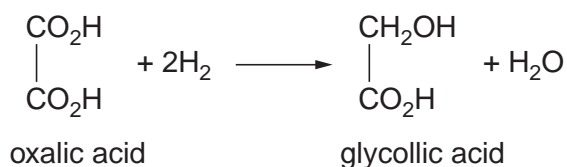
(a) Name the two functional groups present in glycollic acid.

..... and [1]

(b) Glycollic acid undergoes similar reactions to ethanoic acid. Complete the equation for the reaction of glycollic acid with sodium carbonate.



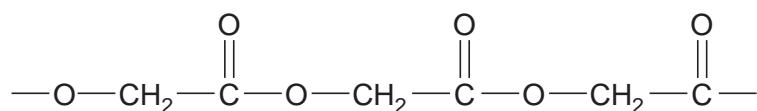
(c) Glycollic acid can be prepared from oxalic acid.



How does this equation shows that oxalic acid has been reduced?

.....
 [1]

(d) Glycollic acid polymerises to form poly(glycollic acid). The diagram shows a section of this polymer.



(i) Is poly(glycollic acid) an addition polymer or a condensation polymer? Give a reason for your answer.

.....
 [1]

(ii) Name another polymer with the same linkage as poly(glycollic acid).

..... [1]

(e) Poly(glycollic acid) is biodegradable whereas poly(ethene) is non-biodegradable.

(i) Suggest two environmental advantages of using biodegradable polymers.

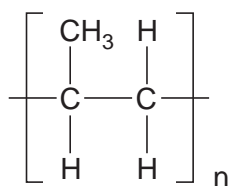
.....

 [2]

(ii) State one use of poly(ethene).

..... [1]

(iii) The diagram shows the repeat unit of poly(propene).



Draw the structure of the monomer used to make poly(propene).

[1]

[Total: 10]

B8 Aluminium is extracted from bauxite ore.

(a) One stage in purifying bauxite to obtain pure aluminium oxide involves mixing the crushed ore with concentrated aqueous sodium hydroxide. The products of the reaction are aqueous sodium aluminate, NaAlO_2 , and water.

(i) What type of oxide is aluminium oxide? Give a reason for your answer.

.....
 [1]

(ii) Write an equation for the reaction of aluminium oxide with aqueous sodium hydroxide.

..... [1]

(iii) The impurities in the ore are insoluble in water. Suggest how the impurities are separated from the aqueous sodium aluminate.

..... [1]

(b) Pure aluminium oxide is electrolysed in the presence of cryolite to produce aluminium.

(i) Aluminium forms at the cathode and oxygen at the anode. Write ionic equations for the reaction at

the cathode [1]

the anode. [2]

(ii) Explain why cryolite is added to the aluminium oxide.

..... [1]

(c) (i) Aluminium is higher in the metal reactivity series than iron. Apart from differences in malleability, explain why fizzy drinks cans are made from aluminium rather than iron.

.....
 [2]

(ii) Aluminium is often used in the form of alloys.

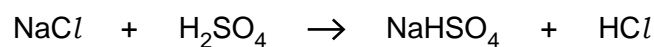
What do you understand by the term *alloy*?

.....
 [1]

[Total: 10]

B9 Hydrogen fluoride, hydrogen chloride and hydrogen iodide are all acidic gases.

- (a) A student makes hydrogen chloride by reacting sodium chloride with excess concentrated sulfuric acid at room temperature and pressure.



- (i) Calculate the maximum volume of hydrogen chloride that can be made from 0.2 moles of sodium chloride at room temperature and pressure.

[1]

- (ii) Draw a 'dot-and-cross' diagram for hydrogen chloride. Show only the outer electrons.

[1]

- (b) Hydrogen fluoride is made by heating calcium fluoride, CaF_2 , with concentrated sulfuric acid. Give an equation for this reaction.

..... [2]

- (c) Hydrogen chloride dissolves in water to form hydrochloric acid. Hydrogen fluoride dissolves in water to form hydrofluoric acid.
A 0.1 mol/dm^3 solution of hydrochloric acid is completely ionised.
A 0.1 mol/dm^3 solution of hydrofluoric acid is only 10% ionised.

Use this information to compare and explain

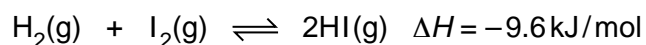
the strength of each acid,

.....

the pH of each of these solutions.

..... [2]

- (d) When hydrogen and iodine are heated in a sealed container an equilibrium is reached with the product, hydrogen iodide.



- (i) Predict the effect of the following on this equilibrium:

increasing the temperature,

..... [1]

decreasing the concentration of hydrogen iodide.

..... [1]

- (ii) At 400 °C the equilibrium mixture contains 0.4000 moles of hydrogen, 0.07560 moles of iodine and 1.344 moles of hydrogen iodide.
Calculate the percentage of iodine molecules, I_2 , by mass in this equilibrium mixture.

[2]

[Total: 10]

DATA SHEET
The Periodic Table of the Elements

		Group																																																																																											
I	II	III	IV	V	VI	VII	0																																																																																						
7 Li Lithium 4	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18	19 F Fluorine 9	20 Ne Neon 10	2 He Helium 2																																																																																
23 Na Sodium 12	24 Mg Magnesium 12	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Ca Calcium 20	41 K Potassium 19	42 V Vanadium 23	43 Cr Chromium 24	44 Mn Manganese 25	45 Fe Iron 26	46 Ru Ruthenium 44	47 Rh Rhodium 45	48 Pd Palladium 46	49 Cd Cadmium 48	50 In Indium 49	51 Tl Thallium 81	52 Hg Mercury 80	53 Au Gold 79	54 Pt Platinum 78	55 Ir Iridium 77	56 Os Osmium 76	57 Rf Rutherfordium 104	58 La Lanthanum 57	59 Ce Cerium 58	60 Pr Praseodymium 59	61 Nd Neodymium 60	62 Pm Promethium 61	63 Sm Samarium 62	64 Gd Gadolinium 64	65 Tb Terbium 65	66 Dy Dysprosium 66	67 Ho Holmium 67	68 Er Erbium 68	69 Tm Thulium 69	70 Yb Ytterbium 70	71 Lu Lutetium 71	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	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	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	104 Rf Rutherfordium 104	105 Db Dubnium 105	106 Sg Seaborgium 106	107 Bh Bohrium 107	108 Hs Hassium 108	109 Mt Meitnerium 109	110 Ds Darmstadtium 110	111 Rg Roentgenium 111	112 Cn Copernicium 112	113 Nh Nihonium 113	114 Fl Flerovium 114	115 Mc Moscovium 115	116 Lv Livermorium 116	117 Ts Tennessine 117	118 Og Oganesson 118

8–71 Lanthanoid series
90–103 Actinoid series

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

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