UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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

For Examiner's Use

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?

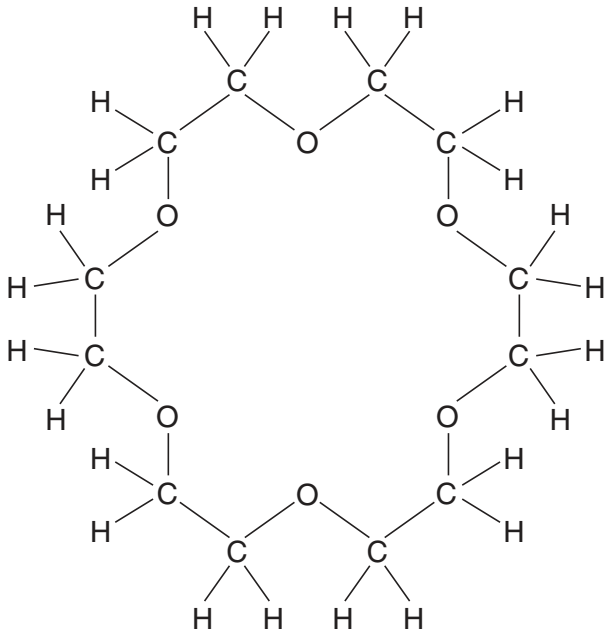
..... [1]

[Total: 5]

A2 Sodium can react with compounds called crown ethers.

For Examiner's Use

(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.

For Examiner's Use

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

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow 2H_2O(l) + I_2(aq)$$

(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.

.....

.....

.....

.....

..... [2]

[Turn over

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

For Examiner's Use

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

protons .....

electrons .....

neutrons ..... [2]

[Total: 8]

A4 A plant contains the coloured compounds chlorophyll and carotene.

For Examiner's Use

(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.

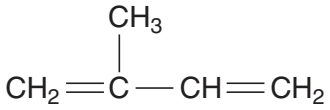
(i) Complete the word equation which describes photosynthesis.

..... + water ⟶ ..... + 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.



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.

For Examiner's Use

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

[2]

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

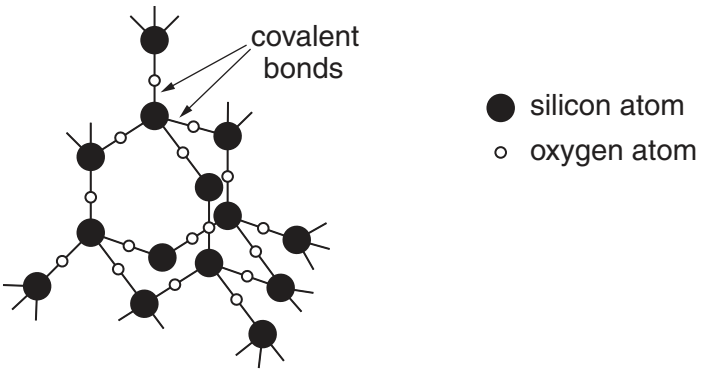
malleable, ...

..... [1]

good conductors of electricity. .....

..... [1]

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



Suggest why silicon dioxide

does not conduct electricity, ...

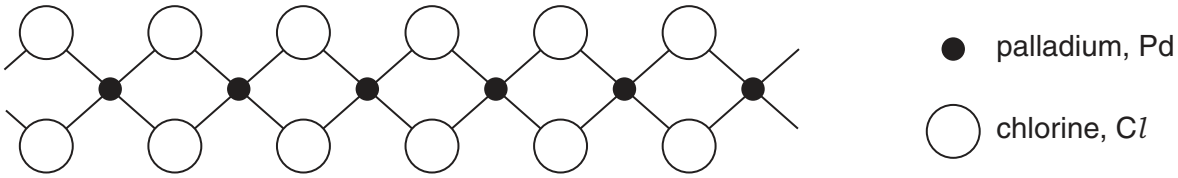
..... [1]

is hard. .....

..... [1]

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

For Examiner's Use



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]

Section B

For Examiner's Use

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B6 A student prepares some crystals of hydrated sodium sulfate by titrating aqueous sodium hydroxide with sulfuric acid.

(a) Describe how he can obtain pure dry crystals of sodium sulfate using this method.

.....

.....

.....

.....

.....

.....

..... [4]

(b) The student uses 25.0 cm^3 of 1.60 mol/dm^3 sodium hydroxide to prepare the crystals.

$$2NaOH(aq) + H_2SO_4(aq) + 8H_2O(l) \rightarrow Na_2SO_4.10H_2O(s)$$

Calculate the maximum mass of hydrated sodium sulfate crystals that can be formed.

[4]

(c) When hydrated sodium sulfate crystals are heated gently, water is given off.

Describe a chemical test for water.

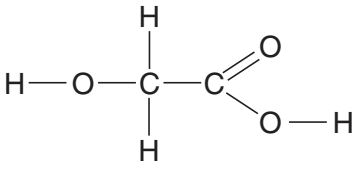
test .....

observation ..... [2]

[Total: 10]

B7 The structure of glycollic acid is shown below.

For Examiner's Use



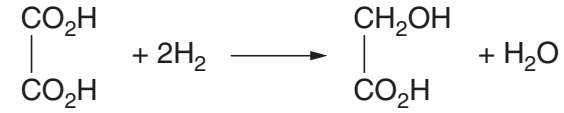
(a) Name the two functional groups present in glycollic acid.

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

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

.....$HOCH_2CO_2H + Na_2CO_3 \rightarrow$ ..... + ... + ... [2]

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



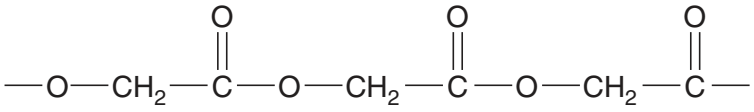
oxalic acid glycollic acid

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.

For Examiner's Use

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

.....

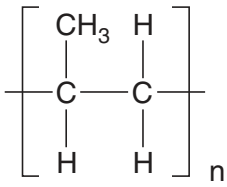
.....

..... [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.

For Examiner's Use

(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.

For Examiner's Use

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

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$$

(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.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \quad \Delta H = -9.6\,kJ/mol$$

(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]

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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 Sulfur 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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

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

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