UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2325388848

CHEMISTRY **5070/21**

Paper 2 Theory **October/November 2013**

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.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

This document consists of **16** printed pages.

UNIVERSITY of CAMBRIDGE International Examinations

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 compounds to answer the questions below.

calcium oxide
carbon dioxide
carbon monoxide
copper(II) sulfate
ethanol
ethene
iron(II) chloride
iron(III) chloride
nitrogen dioxide
silver chloride
silver iodide
sulfur dioxide

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

Which compound is

(a) a solid, which when dissolved in water, gives a green precipitate with aqueous ammonia,

.....[1]

(b) a colourless gas which is formed when limestone is heated strongly,

.....[1]

(c) a gas which is formed in the atmosphere by lightning activity,

.....[1]

(d) a basic oxide,

.....[1]

(e) formed when ethane undergoes complete combustion,

.....[1]

(f) a white salt which is insoluble in water?

.....[1]

[Total: 6]

A2 Alkenes are a homologous series of unsaturated hydrocarbons.

For Examiner's Use

(a) Give the general formula of alkenes.

.....[1]

(b) In addition to having a general formula, state two **other** characteristics of a homologous series.

1 .....

2 .....[2]

(c) Alkenes can be made by cracking alkanes.

(i) Give **one** condition required for cracking.

.....[1]

(ii) Tetradecane, $C_{14}H_{30}$, can be cracked to form an alkene containing eight carbon atoms and an alkane.

Construct an equation for this reaction.

[1]

(d) Ethene reacts with bromine to form 1,2-dibromoethane, CH_2BrCH_2Br.

Name this type of reaction.

.....[1]

(e) Ethene reacts with hydrogen chloride to form the covalent compound chloroethane, CH_3CH_2Cl.

Suggest **two** physical properties of chloroethane.

1 .....

2 .....[2]

(f) Halogenoalkanes such as CCl_2F_2 are responsible for the depletion of ozone in the upper atmosphere.

Describe the importance of the ozone layer in the upper atmosphere.

.....

.....

.....[2]

[Total: 10]

A3 Calcium, proton number 20, is an element in Group II of the Periodic Table.

For Examiner's Use

(a) Give the electronic configuration for calcium.

.....[1]

(b) Calcium has six naturally-occurring isotopes.

(i) State the meaning of the term *isotopes*.

.....

.....[1]

(ii) Complete the following table to show the number of sub-atomic particles in two of these isotopes.

isotope	number of protons	number of electrons	number of neutrons
^{42}Ca			
^{48}Ca			

[3]

(c) Calcium chloride can be formed by reacting calcium carbonate with dilute hydrochloric acid.

(i) Construct an equation for this reaction.

[1]

(ii) Write both the formula and the electronic configuration for the ions present in calcium chloride.

[2]

(d) **(i)** Name the products formed at the anode and cathode when molten calcium chloride is electrolysed.

anode .....

cathode .....[1]

(ii) Predict the product formed at the cathode when a dilute aqueous solution of calcium chloride is electrolysed.

.....[1]

(iii) Explain why solid calcium chloride does not conduct electricity.

.....[1]

[Total: 11]

A4 Nitrogen and oxygen are present in dry air.

For Examiner's Use

(a) What is the percentage composition by volume of each of these gases in dry air?

nitrogen .....

oxygen .....[2]

(b) What method is used to separate these gases from each other?

.....[1]

(c) In a petrol engine, nitrogen and oxygen combine to form oxides of nitrogen such as nitrogen dioxide, NO_2.

State one harmful effect that nitrogen dioxide has on the environment.

.....[1]

(d) One of the hydrocarbons in petrol is octane, C_8H_{18}.
In a petrol engine, some of the octane reacts to form carbon monoxide and water.

Construct an equation for this reaction.

[2]

(e) Catalytic converters are used to remove carbon monoxide and nitrogen dioxide from the exhaust gases of petrol engines.
A catalyst containing rhodium and platinum or palladium is present in a catalytic converter.

What is the function of a catalyst?

.....[1]

(f) In a catalytic converter, carbon monoxide and nitrogen dioxide undergo redox reactions. These reactions reduce the amount of carbon monoxide and nitrogen dioxide in car exhausts.

(i) What is meant by the term *redox reaction*?

.....

.....[1]

(ii) Explain how the redox reactions in the catalytic converter decrease the amounts of carbon monoxide and nitrogen dioxide in car exhausts.

.....

.....

.....[2]

[Total: 10]

A5 Hydrogen peroxide, H_2O_2, is a colourless liquid.

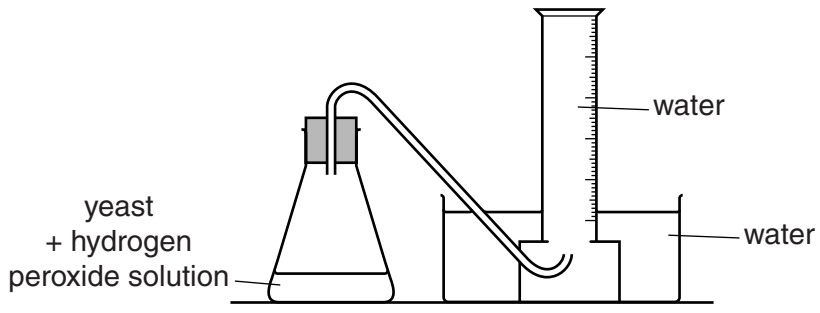
(a) Calculate the percentage by mass of oxygen in hydrogen peroxide.

.....% [2]

(b) The enzyme catalase is present in yeast. The enzyme catalyses the decomposition of aqueous hydrogen peroxide.

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

The apparatus below is used to monitor this reaction.



What measurements should be taken in order to monitor the rate of this reaction?

.....

.....[2]

(c) Describe and explain the effect of increasing the concentration of hydrogen peroxide on the rate of this reaction.

.....

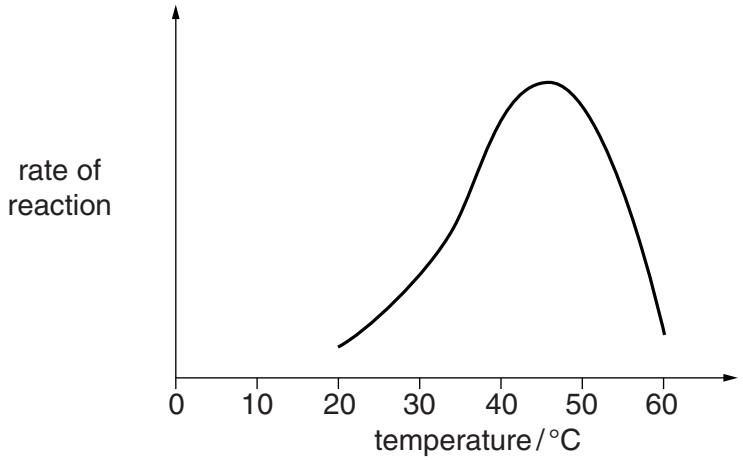
.....

.....

.....

.....[3]

(d) The graph below shows how the rate of decomposition of hydrogen peroxide, catalysed by yeast, varies with temperature. All other conditions are kept constant.



Suggest why the rate of reaction decreases rapidly from 45 °C to 60 °C.

.....[1]

[Total: 8]

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 Iron is extracted from its ore (haematite, Fe_2O_3) in a blast furnace.
Coke (carbon) and limestone (calcium carbonate) are also added to the furnace.

(a) Describe the essential reactions taking place in the blast furnace.

.....

.....

.....

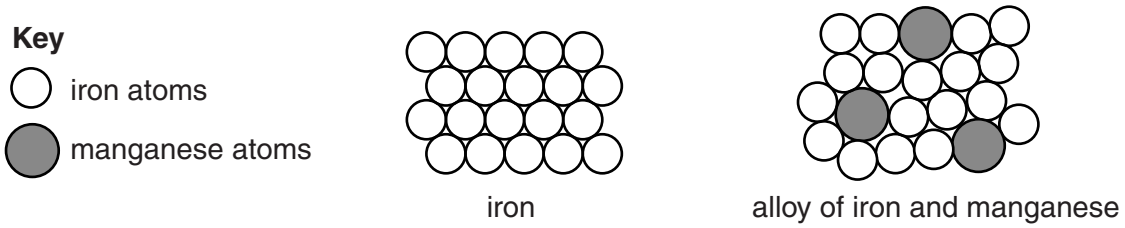
.....

.....

.....

.....[4]

(b) Steel is an alloy made by the addition of carbon or metals to iron.
Use the diagrams below to explain why an alloy of iron and manganese is less malleable than pure iron.



.....

.....

.....

.....[2]

(c) Iron reacts with dilute hydrochloric acid to form iron(II) chloride.

$$Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$$

A student added 2.1 g of iron to 50 cm^3 of 0.10 mol/dm^3 hydrochloric acid.

(i) Calculate the amount, in moles, of iron present.

..... mol [1]

(ii) Calculate the amount, in moles, of hydrochloric acid present.

..... mol [1]

(iii) Calculate the volume of hydrogen formed in this reaction, measured at room temperature and pressure.

..... cm^3 [2]

[Total: 10]

B7 **(a)** A compound of carbon, hydrogen and chlorine contains 0.48 g of carbon, 0.08 g of hydrogen and 1.42 g of chlorine.

For Examiner's Use

(i) Deduce the empirical formula of this compound.

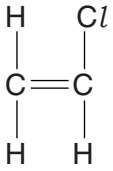
[2]

(ii) The relative molecular mass of this compound is 99.

Deduce the molecular formula of this compound.

[1]

(b) Chloroethene is another compound containing carbon, hydrogen and chlorine.
The structure of chloroethene is shown below.



Draw a section of the polymer formed when chloroethene undergoes polymerisation to form poly(chloroethene).

[2]

(c) Poly(chloroethene) is an addition polymer but nylon is a condensation polymer.

Describe the difference between an addition polymer and a condensation polymer in terms of how they are formed from their monomers.

.....

.....

.....

.....[1]

(d) Chloroethene is made by reacting ethene with hydrogen chloride and oxygen in the presence of a catalyst of copper(II) chloride, $CuCl_2$. The other product of the reaction is water.

(i) Construct an equation for this reaction.

[1]

(ii) Copper(II) chloride is made by heating copper(II) oxide, CuO, with hydrochloric acid.

Construct an equation for this reaction.

[1]

(iii) Copper is a transition element.

State **two** physical properties of copper which are different from those of a typical Group I element such as sodium.

1 .....

2 .....[2]

[Total: 10]

B8 Zinc sulfide is a compound that can be made by heating zinc powder with sulfur powder.

For Examiner's Use

(a) Describe **two** differences between a mixture of zinc and sulfur and a compound of zinc and sulfur.

1 .....

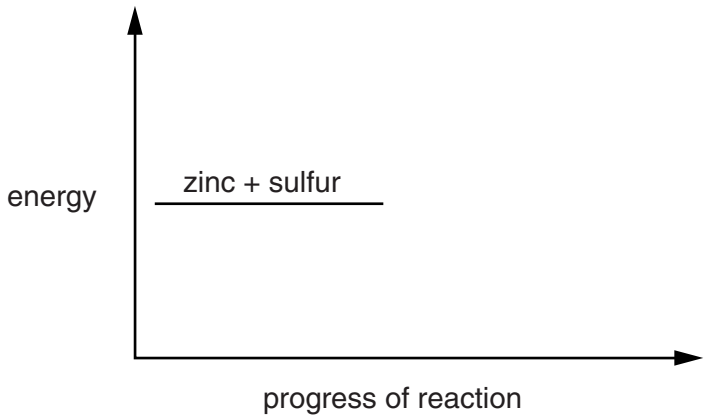
.....

2 .....

.....[2]

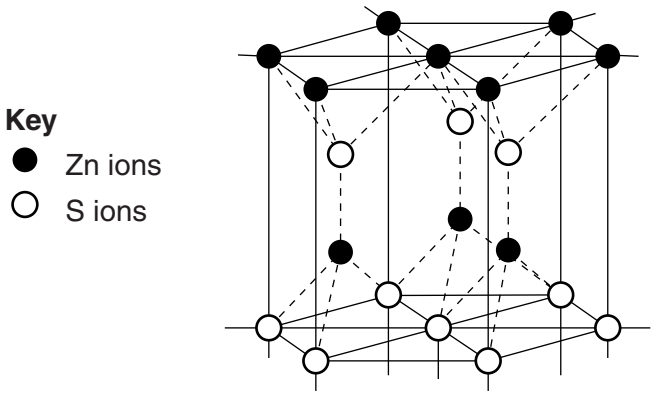
(b) The reaction between zinc and sulfur is exothermic.

Complete the energy profile diagram for this reaction.
On your diagram label
the product,
the enthalpy change for the reaction, ΔH.



[2]

(c) Part of the structure of zinc sulfide is shown below.



Deduce the empirical formula of zinc sulfide from this structure.

.....[1]

(d) Zinc sulfide reacts with hydrochloric acid to form hydrogen sulfide.
An aqueous solution of hydrogen sulfide behaves as a weak acid.

Describe what is meant by the term *weak acid*.

.....

.....[1]

(e) Zinc sulfate can be made by reacting zinc with dilute sulfuric acid.

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

(i) Write an ionic equation for this reaction.

[1]

(ii) Describe how you would prepare crystals of pure, dry zinc sulfate using this reaction.

.....

.....

.....

.....

.....[3]

[Total: 10]

B9 Ethanoic acid reacts with sodium hydroxide to form water and a salt.

For Examiner's Use

(a) Give the formula of the salt.

.....[1]

(b) The reaction between ethanoic acid and sodium hydroxide is described as a neutralisation reaction.

Write the simplest ionic equation for this reaction.

.....[1]

(c) Ethanoic acid reacts with methanol to form an ester and water.

$$CH_3CO_2H + CH_3OH \rightleftharpoons CH_3CO_2CH_3 + H_2O$$

The reaction is endothermic.

(i) Describe what happens to the position of this equilibrium when the concentration of methanol is **increased**. Explain your answer.

.....

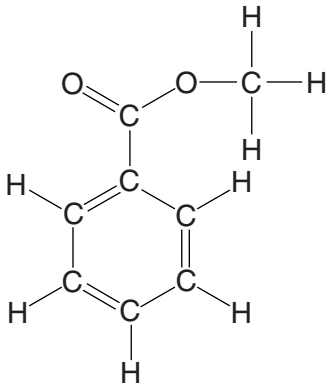
.....[1]

(ii) Describe what happens to the position of this equilibrium when the temperature of the reaction mixture is **decreased**. Explain your answer.

.....

.....[1]

(d) The structure of the ester methyl benzoate is shown below.



Deduce the molecular formula for methyl benzoate.

.....[1]

(e) Sodium hydroxide is an alkali.

Give the formula of the ion present in sodium hydroxide which causes it to be alkaline.

.....[1]

(f) A student titrated a metal hydroxide with 0.200 mol/dm^3 hydrochloric acid.
It required 12.5 cm^3 of hydrochloric acid to neutralise 25.0 cm^3 of 0.0500 mol / dm^3 metal hydroxide solution.

(i) Calculate the amount, in moles, of hydrochloric acid used.

..... mol [1]

(ii) Calculate the amount, in moles, of metal hydroxide present.

..... mol [1]

(iii) Construct an equation for this reaction.
Use the letter **M** to represent the metal in the metal hydroxide solution.

[1]

(g) Name a metal hydroxide which can be used to treat excess acidity in soils.

.....[1]

[Total: 10]

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).