Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 2014**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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 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.

This document consists of **18** printed pages and **2** blank pages.

CAMBRIDGE
International Examinations

[Turn over

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 equations to answer the questions below.

A $Ag^+(aq) + I^-(aq) \longrightarrow AgI(s)$

B $Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow BaSO_4(s)$

C $CO_3^{2-}(aq) + 2H^+(aq) \longrightarrow CO_2(g) + H_2O(l)$

D $Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$

E $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$

F $Cu^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_2(s)$

G $Fe(s) + 2H^+(aq) \longrightarrow Fe^{2+}(aq) + H_2(g)$

H $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$

I $2I^-(aq) + Br_2(aq) \longrightarrow I_2(aq) + 2Br^-(aq)$

J $NH_4^+(aq) + OH^-(aq) \longrightarrow H_2O(l) + NH_3(g)$

K $4OH^-(aq) \longrightarrow O_2(g) + 2H_2O(l) + 4e^-$

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

Give the letter of an equation which

(a) shows the formation of gas that turns moist red litmus blue,

..... [1]

(b) shows a reaction that forms a white precipitate,

..... [1]

(c) shows only reduction,

..... [1]

(d) shows the neutralisation of dilute hydrochloric acid by aqueous sodium hydroxide,

..... [1]

(e) shows the reaction at an inert positive electrode when copper(II) sulfate is electrolysed.

..... [1]

[Total: 5]

A2 A power station burns methane, CH_4, which is contaminated by hydrogen sulfide, H_2S.

The equation shows the combustion of methane.

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$$

The combustion of the hydrogen sulfide forms water and sulfur dioxide.

(a) Construct the equation to show the combustion of hydrogen sulfide.

..... [1]

(b) Explain why the burning of the contaminated methane at the power station causes atmospheric problems.

.....

.....

.....

..... [2]

(c) A 1000 dm^3 sample of the contaminated methane gas burnt at the power station produces 999 dm^3 of carbon dioxide and 1 dm^3 of sulfur dioxide. All gas volumes are measured at room temperature and pressure.

(i) What is the volume of methane, at room temperature and pressure, in the 1000 dm^3 of the gas burnt?

volume of methane = ... dm^3 [1]

(ii) What is the volume of hydrogen sulfide, at room temperature and pressure, in the 1000 dm^3 of the gas burnt?

volume of hydrogen sulfide = ... dm^3 [1]

(iii) Calculate the percentage, by volume, of hydrogen sulfide in the contaminated methane. You must show your working.

percentage = ...% [2]

[Turn over

(d) The volume of a gas changes if the pressure is increased or the temperature is increased.

(i) Describe and explain qualitatively the effect of increasing the pressure on the volume of a gas if the temperature remains constant.

.....

.....

..... [2]

(ii) Describe and explain qualitatively the effect of increasing the temperature on the volume of a gas if the pressure remains constant.

.....

.....

..... [2]

[Total: 11]

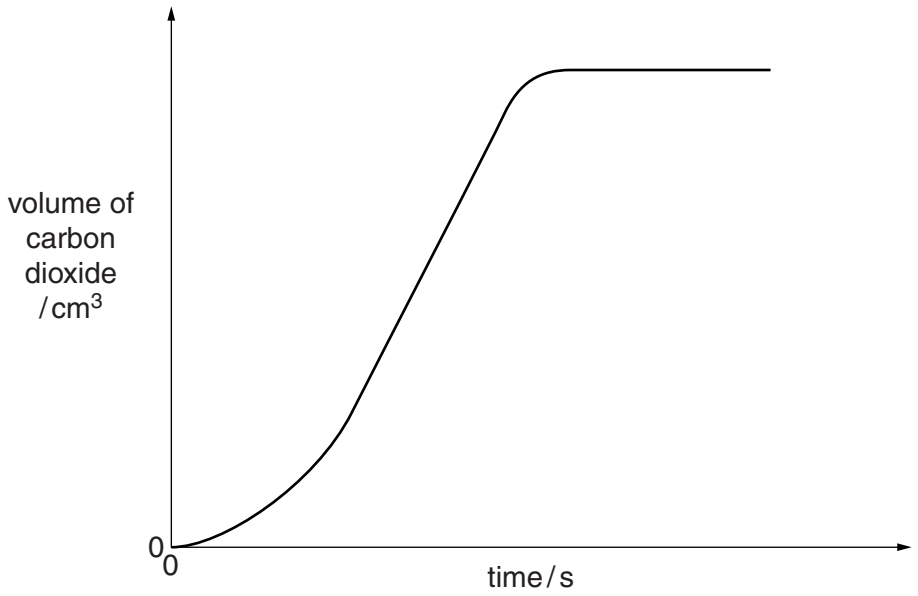
A3 Zinc carbonate thermally decomposes to form zinc oxide and carbon dioxide.

$$ZnCO_3(s) \longrightarrow ZnO(s) + CO_2(g)$$

In an experiment, a sample of zinc carbonate is heated in a test-tube using a Bunsen burner.

The total volume of carbon dioxide formed is measured every 10 seconds.

The results are plotted on the graph below.



(a) Suggest why the volume of carbon dioxide does not increase by very much when the zinc carbonate is first heated.

.....

..... [1]

(b) How is the graph used to find out when the decomposition has finished?

..... [1]

(c) The same mass of zinc carbonate is heated using a **hotter** Bunsen flame.

On the axes above, draw the graph you would expect from the results of this experiment.

Explain your answer.

.....

.....

.....

..... [4]

[Turn over

(d) The experiment is repeated with different metal carbonates.

The Bunsen burner flame is not altered and the same number of moles of metal carbonate is used for each experiment.

The table shows the time taken for complete decomposition.

metal carbonate	time for decomposition to finish / s
$CaCO_3$	360
$FeCO_3$	60
$ZnCO_3$	70

Predict and explain the time it would take magnesium carbonate and lead carbonate to decompose.

magnesium carbonate .....s

lead carbonate .....s

explanation .....

.....

.....

..... [2]

[Total: 8]

A4 Aluminium is manufactured by the electrolysis of aluminium oxide dissolved in molten cryolite.

(a) Give the equations for the reactions that occur at the electrodes during this electrolysis.

positive electrode .....

negative electrode ..... [2]

(b) Aluminium is a useful metal as it does not corrode in moist air.

Explain why aluminium does not corrode in moist air.

.....

.....

..... [2]

(c) Underground iron pipes rust easily. This can be prevented by attaching a piece of magnesium to the pipe.

Explain this form of rust prevention.

.....

.....

..... [2]

(d) Aluminium sulfate is a soluble salt.

Describe how a sample of aluminium sulfate crystals can be prepared from aluminium oxide.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

[Turn over

A5 Ethene has the formula C_2H_4.

(a) Draw a 'dot-and-cross' diagram to show the bonding in a molecule of ethene. Draw only the outer shell electrons.

[2]

(b) Describe the manufacture of pure ethanol starting from ethene. Include an equation and the conditions needed.

.....

.....

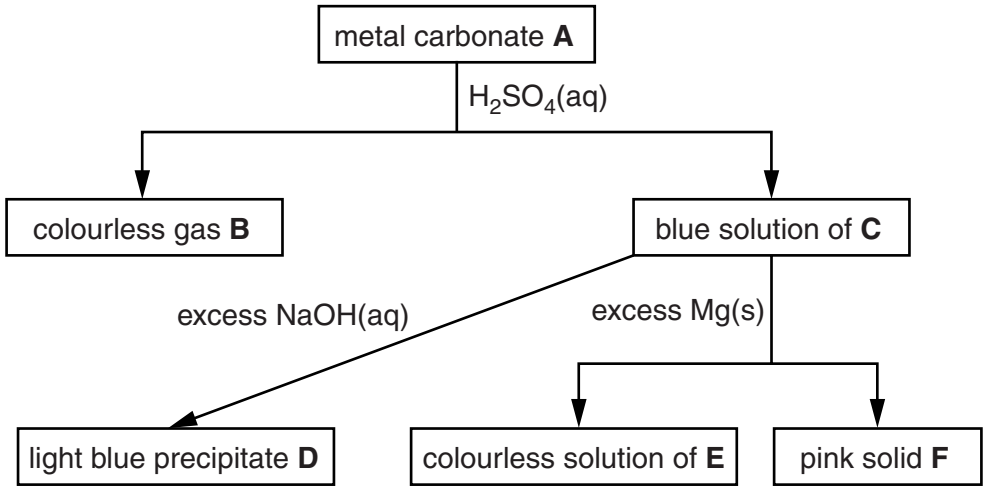
.....

.....

..... [3]

[Total: 5]

A6 The flow chart shows some reactions of the compounds of a metal.



Identify, by name, each of the substances.

A .....

B .....

C .....

D .....

E .....

F .....

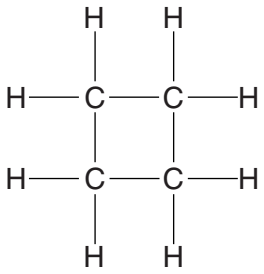
[Total: 6]

Section B

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

The total mark for this section is 30.

B7 Cyclobutane has the following structure.



(a) What evidence from the structure indicates that cyclobutane is a saturated compound?

.....

..... [1]

(b) Deduce the empirical formula for cyclobutane.

..... [1]

(c) Cyclobutane has several isomers which are alkenes.

Draw the structure, showing all the atoms and all the bonds, of one of these isomers.

[1]

(d) The complete combustion of one mole of cyclobutane releases 2702 kJ of heat energy.

(i) Construct an equation for the complete combustion of cyclobutane.

..... [2]

(ii) Calculate the heat energy released when 600 dm^3 of cyclobutane, at room temperature and pressure, is completely combusted.

heat energy = ... kJ [2]

(iii) Explain, in terms of the energy associated with bond breaking and bond making, why the combustion of cyclobutane is exothermic.

.....

.....

.....

.....

..... [3]

[Total: 10]

B8 Butanoic acid, $CH_3CH_2CH_2CO_2H$, and ethanoic acid, CH_3CO_2H, are both weak acids.

(a) Explain, with the aid of an equation, what is meant by the term *weak acid*.

.....

.....

..... [2]

(b) Butanoic acid reacts with magnesium.

Name the gas formed and describe the chemical test for the gas.

gas .....

chemical test .....

..... [2]

(c) Butanoic acid reacts with magnesium carbonate.

Give the formula of the magnesium salt formed in the reaction of butanoic acid with magnesium carbonate.

..... [1]

(d) Ethanoic acid reacts with ethanol to make an organic compound.

Draw the structure, showing all the atoms and all the bonds, of this organic compound.

[1]

(e) A solution containing 0.172 g of an unknown carboxylic acid, $C_xH_yCO_2H$, is titrated with 0.100 mol / dm^3 aqueous sodium hydroxide. The volume of sodium hydroxide solution needed to exactly neutralise the acid is 23.2 cm^3.

$$C_xH_yCO_2H + NaOH \longrightarrow C_xH_yCO_2Na + H_2O$$

Calculate the relative formula mass, M_r, of the carboxylic acid and suggest its identity.

relative formula mass = ...

identity of the acid ..... [4]

[Total: 10]

B9 When carbon dioxide reacts with hydrogen in a sealed container, an equilibrium mixture is obtained.

$$CO_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2O(g) \qquad \Delta H = -205\,kJ/mol$$

This reaction is exothermic.

(a) Describe and explain what happens to the rate of the forward reaction when the pressure is increased. The temperature remains constant.

.....

.....

.....

..... [2]

(b) Describe and explain what happens to the position of equilibrium when the temperature is increased. The pressure remains constant.

.....

.....

.....

..... [2]

(c) In an experiment, 220 g of carbon dioxide and an excess of hydrogen are reacted in a sealed container until an equilibrium is established.

A mass of 46 g of methane is produced.

(i) Calculate the mass of methane that should have been made if the percentage yield was 100%.

mass of methane = ... g [2]

(ii) Calculate the percentage yield of methane in this experiment.

percentage yield = ...% [1]

(d) The experiment with 220 g of carbon dioxide and an excess of hydrogen is repeated but this time a catalyst is added.

(i) State what happens, if anything, to the position of equilibrium compared with the non-catalysed reaction.

.....

..... [1]

(ii) Describe and explain what happens to the rate of reaction compared with the non-catalysed reaction.

.....

.....

.....

..... [2]

[Total: 10]

B10 Francium, Fr, is a highly reactive element in Group I of the Periodic Table.

The table shows some information about two isotopes of francium.

atomic symbol	number of protons	number of electrons	number of neutrons
$^{223}_{87}Fr$	87	.....	136
.....	87	.....	138

(a) Complete the table. [2]

(b) Construct an equation to show the reaction of francium with water.

..... [1]

(c) Francium oxide, Fr_2O, contains Fr^+ and O^{2-} ions.

(i) Describe how a francium ion and an oxide ion are formed from a francium atom and an oxygen atom.

.....

.....

.....

..... [2]

(ii) Predict **two** physical properties of francium oxide.

1. .....

2. ..... [2]

(d) Describe, with the aid of a labelled diagram, the structure of a metal and use it to explain why francium is a good conductor of electricity.

.....

.....

..... [3]

[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.).