Cambridge O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 2015**

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 organic compounds to answer the questions below.

butane

butanoic acid

butyl ethanoate

ethanol

ethyl butanoate

methane

methanol

methyl propanoate

propane

propanoic acid

propanol

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

(a) Name a compound that reacts with magnesium to make hydrogen.

.....[1]

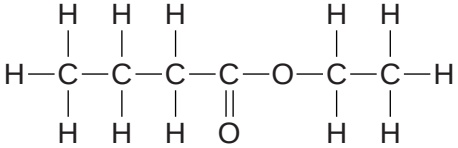
(b) Which compound can be oxidised to make propanoic acid?

.....[1]

(c) Name **two** compounds that react together to make an ester.

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

(d) Which compound has the following structure?



.....[1]

(e) Name a compound which has a molecule with eleven atoms only.

.....[1]

[Total: 5]

A2 Some calcium compounds are used by farmers.

(a) Calcium hydroxide dissolves in water to form limewater.

When carbon dioxide is bubbled through limewater, a white precipitate of calcium carbonate is formed.

Construct the equation for this reaction.

.....[1]

(b) Calcium hydroxide is used to neutralise acidic soils.

Explain, using an ionic equation, why calcium hydroxide can neutralise acidic soils.

.....

.....

.....[2]

(c) A farmer uses ammonium nitrate as a fertiliser on an acidic soil.

He then uses calcium hydroxide to neutralise the acidic soil.

Explain one disadvantage of using calcium hydroxide to neutralise this acidic soil.

.....

.....

.....[2]

(d) The farmer uses another fertiliser.

This fertiliser has the following percentage composition by mass.

Ca, 17.1%; H, 1.7%; P, 26.5%; O, 54.7%

Calculate the empirical formula of this compound and suggest the formula of the anion present in the fertiliser.

empirical formula is .....

anion is .....[4]

[Total: 9]

A3 Ozone molecules are continually being broken down and formed in the upper atmosphere.

(a) The equation shows one way in which ozone is formed in the upper atmosphere.

$$O_2 + O \longrightarrow O_3 \qquad \Delta H = -392\,kJ/mol$$

(i) Explain, in terms of bond breaking and bond forming, why this reaction is exothermic.

.....

.....

.....

.....[2]

(ii) When one mole of oxygen molecules reacts, 392 kJ of energy is released.

Calculate the amount of energy released when 48.0 g of oxygen molecules react.

energy released = ... kJ [2]

(b) Name a pollutant that depletes ozone in the upper atmosphere.

.....[1]

(c) Ozone molecules decompose into oxygen molecules in a reversible reaction.

$$2O_3(g) \rightleftharpoons 3O_2(g) \qquad \Delta H = +143\,kJ/mol$$

The reaction reaches an equilibrium if carried out in a closed system.

(i) The reaction is studied at a temperature of 400 °C.

Describe and explain what happens to the position of equilibrium if the pressure is increased.

.....

.....

.....

.....[2]

(ii) The reaction is studied at 25 atmospheres pressure.

Describe and explain what happens to the position of equilibrium if the temperature is decreased.

.....

.....

.....

.....[2]

(iii) Describe and explain what will happen to the rate of the reaction if the temperature is decreased.

.....

.....

.....

.....[2]

[Total: 11]

A4 Two isotopes of sulfur are $^{32}_{16}S$ and $^{33}_{16}S$.

(a) What is meant by the term *isotopes*?

.....

.....

.....[1]

(b) Complete the table for $^{33}_{16}S$.

number of neutrons	……
number of protons	……
electronic configuration	……

[3]

(c) Sulfur forms simple molecules which have a relative molecular mass of 256.

Suggest the formula of a sulfur molecule.

.....

.....[1]

(d) Sulfur has a low melting point and does not conduct electricity.

(i) Explain why sulfur has a low melting point.

.....

.....[1]

(ii) Explain why sulfur does not conduct electricity.

.....

.....[1]

(e) Sulfur reacts with potassium to form potassium sulfide.

Write the formula and the electronic configuration of the positive ion and of the negative ion in potassium sulfide.

positive ion

formula ..... electronic configuration .....

negative ion

formula ..... electronic configuration .....

[2]

(f) Sulfur reacts with hydrogen to form hydrogen sulfide, H_2S.

Draw the 'dot-and-cross' diagram to show the bonding in a molecule of hydrogen sulfide.

Only draw the outer shell electrons.

[2]

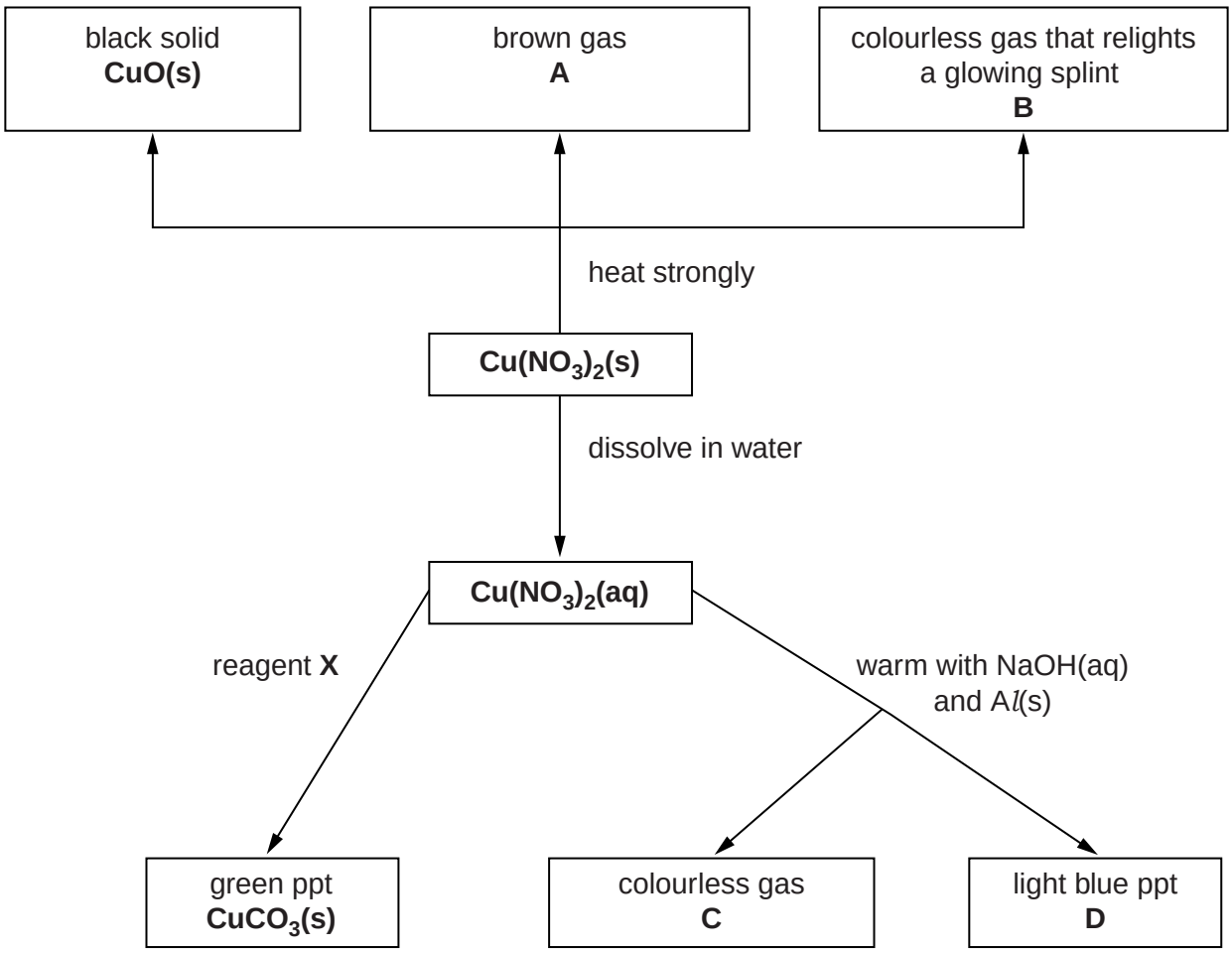
(g) Hydrogen sulfide reacts with sulfur dioxide to form sulfur and water.

Write the equation for this reaction.

.....[1]

[Total: 12]

A5 The flow chart shows some reactions of copper(II) nitrate, $Cu(NO_3)_2$.



(a) When two moles of $Cu(NO_3)_2$ is heated strongly, two moles of CuO, four moles of **A** and one mole of **B** are made.

(i) Write the formula for **B**.

.....[1]

(ii) Construct the equation for the action of heat on $Cu(NO_3)_2$.

.....[2]

(b) Aqueous copper(II) nitrate is warmed with aqueous sodium hydroxide and aluminium powder.

Name **C** and **D**.

C is .....

D is .....
[2]

(c) Suggest the name of reagent **X** and construct the ionic equation, with state symbols, for the formation of the green precipitate, $CuCO_3(s)$.

name of reagent **X** .....

ionic equation .....
[3]

[Total: 8]

Section B

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

The total mark for this section is 30.

B6 An aqueous solution of ammonium nitrite, NH_4NO_2, decomposes when heated gently.

$$NH_4NO_2(aq) \longrightarrow N_2(g) + 2H_2O(l)$$

(a) Describe how you could show that aqueous ammonium nitrite contains ammonium ions.

.....

.....

.....

.....[2]

(b) A sample of 25.0 cm^3 of 0.500 mol/dm^3 aqueous ammonium nitrite is heated.

Calculate the volume of nitrogen formed, measured at room temperature and pressure.

volume of nitrogen = ...[3]

(c) Ammonium nitrate, NH_4NO_3, decomposes when heated, in a similar way to ammonium nitrite.

Suggest the formulae of the two products made in this reaction.

.....[1]

(d) Describe how a pure sample of aqueous ammonium nitrate can be prepared from dilute nitric acid.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 10]

B7 Molybdenum is a transition element.

It is used to make steel that is extremely hard.

Molybdenum can be manufactured by heating together molybdenum(VI) oxide, MoO_3, and aluminium.

(a) Construct the equation for this reaction.

.....[1]

(b) Explain why this reaction involves both oxidation and reduction.

.....

.....

.....[1]

(c) What mass of molybdenum can be made from 125 g of molybdenum(VI) oxide?
[A_r: Mo, 96]

mass of molybdenum = ... g [3]

(d) Which metal is the less reactive, aluminium or molybdenum?

Explain your answer.

.....

.....

.....[1]

(e) Molybdenum has a melting point of 2623 °C.

(i) Describe metallic bonding, with the aid of a labelled diagram.

.....

.....

.....[2]

(ii) Suggest why molybdenum has a much higher melting point than aluminium.

.....

.....

.....

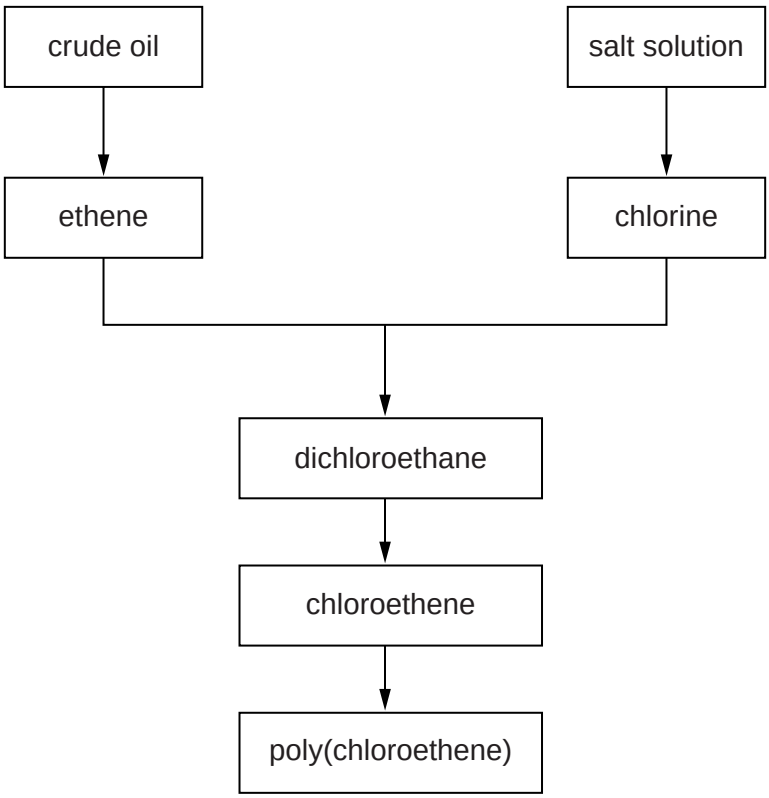
.....

.....[2]

[Total: 10]

B8 Large quantities of poly(chloroethene) are manufactured annually.

The flow chart shows the steps involved in the manufacture of poly(chloroethene).



(a) Name the **two** processes used to manufacture ethene from crude oil.

.....

.....[2]

(b) The salt solution is electrolysed using a carbon anode (positive electrode).

Write the equation for the reaction occurring at the anode.

.....[1]

(c) Draw the structure, showing all the atoms and all the bonds, of the dichloroethane.

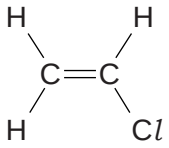
[1]

(d) When dichloroethane, $C_2H_4Cl_2$, is heated strongly chloroethene, C_2H_3Cl, is formed.

Name the other product of this reaction.

.....[1]

(e) The structure of chloroethene is shown.



Draw part of the structure of poly(chloroethene).

[2]

(f) A factory uses 2250 tonnes of chloroethene to make poly(chloroethene).

(i) Deduce the maximum mass of poly(chloroethene) the factory could make.

maximum mass = ... tonnes [1]

(ii) The actual yield of poly(chloroethene) is 2175 tonnes.

Calculate the percentage yield.

percentage yield = ... % [2]

[Total: 10]

B9 Alkanes are a homologous series of saturated hydrocarbons.

The table shows information about some alkanes.

alkane	molecular formula	melting point / °C	boiling point / °C
ethane	C_2H_6	–183	–89
butane	C_4H_{10}	–138	0
hexane	C_6H_{14}	–95	69
decane	$C_{10}H_{22}$	–30	174
dodecane	$C_{12}H_{26}$	–10	216

(a) Dodecane is a liquid at 25 °C.

How can you make this deduction from the data in the table?

.....

.....

.....[2]

(b) Butane melts at –138 °C.

Use the kinetic particle theory to explain what happens when butane melts.

.....

.....

.....

.....[2]

(c) A sample of ethane gas at 0 °C is at a pressure of 1 atmosphere.

The pressure is increased but the temperature is maintained at 0 °C.

Describe and explain, in terms of the kinetic particle theory, what happens to the volume of the gas.

.....

.....

.....[2]

(d) Suggest a method of separating a mixture of hexane, decane and dodecane.

Explain your answer.

.....

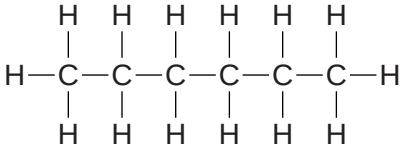
.....

.....[1]

(e) Draw the structure, showing all the atoms and all the bonds, for two isomers with the molecular formula C_4H_{10}.

[2]

(f) The structure of hexane is shown.



Draw the structure, showing all the atoms and all the bonds, of an organic product of the reaction of hexane with chlorine.

[1]

[Total: 10]

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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	55 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.).