Cambridge
O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 2019**

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 **17** printed pages and **3** blank pages.

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Section A

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

The total mark for this section is 45.

1 Choose from the particles shown to answer the questions.

$^{79}_{35}Br$	$^{39}_{20}Ca$
$^{35}_{17}Cl$	$^{37}_{17}Cl^{-}$
$^{37}_{17}Cl$	$^{64}_{29}Cu$
$^{23}_{11}Na$	$^{20}_{10}Ne$
$^{17}_{8}O$	$^{18}_{8}O^{2-}$

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

(a) Which particle has only 20 protons in its nucleus?

..... [1]

(b) Which particle has a nucleon number of 35?

..... [1]

(c) Which particle has an electronic structure of 2.8.8?

..... [1]

(d) Which particle is an atom with only 10 neutrons in its nucleus?

..... [1]

(e) Which particle is an atom of a transition element?

..... [1]

[Total: 5]

[Turn over

2 The table shows some of the properties of the elements in Group II of the Periodic Table.

element	proton (atomic) number	atomic radius / nm	melting point / °C
Be	4	0.089	1280
Mg	12	0.136	650
Ca	20	0.174	850
Sr	38	0.191	768
Ba	56	0.198	714
Ra	88		

(a) Explain why the elements in Group II have similar chemical properties.

.....

..... [1]

(b) Explain why it is easier to predict the atomic radius of radium, Ra, than the melting point of radium.

.....

.....

..... [1]

(c) Magnesium chloride contains Mg^{2+} and Cl^{-} ions.

(i) Write the electronic configuration for a magnesium ion.

..... [1]

(ii) Magnesium is produced by the electrolysis of molten magnesium chloride.

Construct equations for the reactions taking place at the:

negative electrode .....

positive electrode. .....

[2]

(d) Magnesium reacts with aqueous copper(II) sulfate in a redox reaction.

$$Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$$

Which particle is reduced? .....

Explain your answer. .....

..... [1]

(e) Magnesium reacts with steam.

Name the products of this reaction.

..... [1]

(f) Calcium reacts with cold water.

Write the equation for this reaction.

..... [1]

(g) Magnesium chloride is a soluble salt.

Describe how a pure sample of magnesium chloride crystals can be made from magnesium.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 12]

3 Molybdenum, Mo, is a transition element.

(a) Suggest one physical property of molybdenum that is typical of a transition element.

..... [1]

(b) Suggest one chemical property of molybdenum compounds that is typical of compounds of transition elements.

..... [1]

(c) Molybdenum steel is an extremely hard alloy.

Suggest, using ideas about metallic structure, why molybdenum steel is much harder than pure iron.

A labelled diagram may help you answer this question.

.....

.....

..... [2]

(d) Molybdenum steel is made by reducing a mixture of MoO_3 and Fe_2O_3 with aluminium.

$$MoO_3 + 2Al \longrightarrow Mo + Al_2O_3$$

$$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3$$

Molybdenum steel contains 20.0% by mass of molybdenum.

Calculate the mass of MoO_3 needed to make 1000 g of molybdenum steel.

Give the answer to **three** significant figures.

[The relative atomic mass of molybdenum, Mo, is 96.]

mass of MoO_3 ..... g [3]

[Total: 7]

4 Air is a source of many gases.

(a) What is the percentage by volume of nitrogen in dry air?

..... [1]

(b) Outline the separation of oxygen, nitrogen and the noble gases from liquid air.

.....

.....

.....

.....

.....

..... [3]

(c) State one large scale use of nitrogen.

..... [1]

(d) Air contains gaseous pollutants.

(i) Name one gas that contributes to acid rain.

..... [1]

(ii) State one environmental consequence of an increase in the percentage of carbon dioxide in the air.

..... [1]

(iii) Describe the source of carbon monoxide in air.

.....

..... [1]

[Total: 8]

5 Acid **U** is a compound containing carbon, hydrogen and oxygen.

(a) A 6.30 g sample of **U** contains 1.68 g of carbon and 0.14 g of hydrogen.

Calculate the empirical formula of **U**.

empirical formula ..... [3]

(b) A 0.086 g sample of **U** is completely neutralised by 12.7 cm^3 of 0.150 mol/dm^3 KOH.

One mole of **U** reacts with two moles of KOH.

Calculate the relative formula mass of **U**.

relative formula mass ..... [3]

(c) What is the molecular formula of **U**?

..... [1]

[Total: 7]

6 Propanoic acid is a weak acid.

Calcium hydroxide and calcium oxide are bases.

(a) What is the meaning of the term *acid* in weak acid?

.....

..... [1]

(b) What is the meaning of the term *weak* in weak acid?

.....

..... [1]

(c) Describe how universal indicator can be used to find the pH of dilute propanoic acid.

.....

..... [1]

(d) Give a large scale use of calcium hydroxide that depends on its basic character.

..... [1]

(e) Calcium oxide reacts with water to form calcium hydroxide.

The reaction is exothermic.

Use ideas about bond breaking and bond forming to explain why the reaction is exothermic.

.....

.....

.....

.....

..... [2]

[Total: 6]

Section B

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

The total mark for this section is 30.

7 Ammonium carbonate, $(NH_4)_2CO_3$, is a white solid which decomposes when heated.

$$(NH_4)_2CO_3(s) \rightarrow 2NH_3(g) + CO_2(g) + H_2O(g)$$

(a) A small sample of ammonium carbonate is heated in a test-tube.

Describe how you will know when all the ammonium carbonate has decomposed.

.....

..... [1]

(b) Calculate the total volume of ammonia and carbon dioxide, measured at room temperature and pressure, formed when 4.80 g of ammonium carbonate is completely decomposed.

volume of gas ..... [3]

(c) Describe a chemical test for the ammonium ion.

test .....

observation .....

.....
[2]

(d) Aqueous ammonium carbonate reacts with dilute hydrochloric acid.

Construct the ionic equation, including state symbols, for this reaction.

..... [2]

(e) Solid ammonium carbonate does not conduct electricity.

Aqueous ammonium carbonate conducts electricity.

Explain these two observations.

.....

.....

..... [2]

[Total: 10]

8 A scientist heats a sample of phosphorus(V) chloride in a closed container.

A dynamic equilibrium is established.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

(a) Describe what is meant by the term *dynamic equilibrium*.

.....

.....

..... [2]

(b) The pressure of the equilibrium mixture is increased.

The temperature of the equilibrium mixture is kept constant.

Predict and explain what will happen, if anything, to the **composition** of the equilibrium mixture.

prediction .....

.....

explanation .....

.....

.....

[2]

(c) The temperature of the equilibrium mixture is increased.

The pressure of the equilibrium mixture is kept constant.

(i) Suggest why the position of equilibrium moves to the right.

..... [1]

(ii) Explain why the rate of the reaction increases.

.....

.....

..... [2]

(d) Draw the 'dot-and-cross' diagram for a molecule of PCl_3.

Only include the outer shell electrons.

[2]

(e) PCl_5 reacts with water to form hydrogen chloride and phosphoric acid, H_3PO_4.

Construct an equation for this reaction.

..... [1]

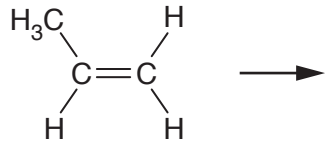
[Total: 10]

9 Food packaging produces lots of waste.

This waste includes both plastic and glass.

(a) One of the plastics is the addition polymer poly(propene).

Complete the equation by drawing the partial structure of poly(propene).



[2]

(b) Plastic waste is disposed of by combustion.

Construct an equation to show the complete combustion of poly(propene).

Use the empirical formula of poly(propene), CH_2, in the equation.

..... [2]

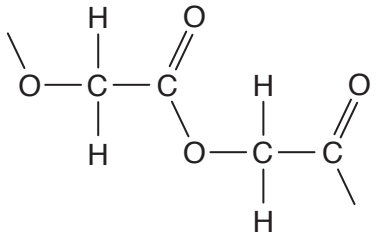
(c) Some plastics are biodegradable.

(i) Suggest an advantage of a plastic that is biodegradable.

.....

..... [1]

(ii) The partial structure of a condensation polymer is shown.



Draw the structure of the monomer used to make this polymer.

[1]

(d) Glass waste is melted and then made into new objects.

Use the kinetic particle theory to describe the changes in movement and arrangement of the particles when a solid becomes a liquid.

.....

.....

.....

.....

..... [2]

(e) Glass is made from sand, SiO_2.

Explain, in terms of structure and bonding, why sand has a high melting point.

.....

.....

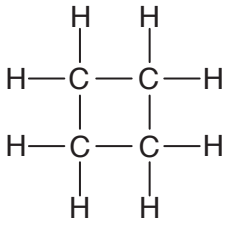
.....

.....

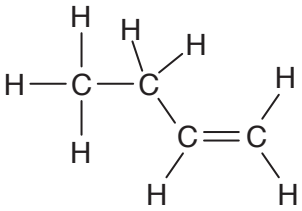
..... [2]

[Total: 10]

10 Cyclobutane and butene are both hydrocarbons.



cyclobutane



butene

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

.....

..... [1]

(b) Explain why cyclobutane and butene are isomers.

.....

.....

..... [1]

(c) Cyclobutane is saturated and butene is unsaturated.

Describe a chemical test that can distinguish cyclobutane from butene.

test .....

result for cyclobutane .....

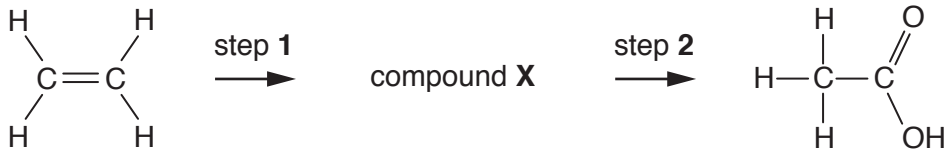
result for butene .....

[3]

(d) Calculate the percentage by mass of carbon in butene.

percentage by mass ..... [2]

(e) Ethene can be converted into ethanoic acid in a two-step process.



(i) Identify compound **X**.

..... [1]

(ii) Identify the reagent used in step **1**.

..... [1]

(iii) Identify the reagent used in step **2**.

..... [1]

[Total: 10]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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