Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

6148594183

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

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1 The symbols of the elements of Period 3 of the Periodic Table are shown.

Na	Mg	A*l*	Si	P	S	C*l*	Ar

Answer the following questions about these elements.
Each symbol may be used once, more than once or not at all.

Write the symbol of the element which:

(a) forms a stable ion with a 2+ charge ..... [1]

(b) is the least reactive in the period ..... [1]

(c) is used in water treatment ..... [1]

(d) forms an oxide which is the main impurity in iron ore ..... [1]

(e) is an important component of fertilisers ..... [1]

(f) is stored under oil ..... [1]

(g) is used in food containers ..... [1]

(h) is found in the ore zinc blende. ..... [1]

[Total: 8]

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Question 2 starts on the next page.

2 Calcium hydroxide, $Ca(OH)_2$, is slightly soluble in water.

(a) Calcium hydroxide can be made by the reaction of calcium with water.

(i) Write the chemical equation for this reaction.

..... [2]

(ii) Name another substance that reacts with water to form calcium hydroxide.

..... [1]

(b) When calcium hydroxide dissolves in water, it dissociates into ions and forms a weakly alkaline solution.

(i) Suggest the pH of aqueous calcium hydroxide.

..... [1]

(ii) Give the formula of the ion responsible for making the solution alkaline.

..... [1]

(c) Limewater is a saturated solution of calcium hydroxide, $Ca(OH)_2(aq)$.

(i) Name the gas limewater is used to test for.

..... [1]

(ii) Suggest what is meant by the term *saturated solution*.

.....

..... [2]

(iii) Describe how you would make a sample of limewater starting with solid calcium hydroxide.

.....

.....

..... [2]

(iv) Describe how you would test for the presence of calcium ions in a sample of limewater.

test .....

observations .....

.....

[3]

(d) A 25.0 cm^3 sample of limewater is placed in a conical flask. The concentration of $Ca(OH)_2$ in the limewater is determined by titration with dilute hydrochloric acid, HCl.

(i) Name the item of apparatus used to measure the volume of acid in this titration.

..... [1]

(ii) State the type of reaction which takes place.

..... [1]

(iii) As well as limewater and dilute hydrochloric acid, state what other type of substance must be added to the conical flask.

..... [1]

(iv) The equation for the reaction is shown.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

20.0 cm^3 of 0.0500 mol / dm^3 HCl reacts with the 25.0 cm^3 of $Ca(OH)_2$.

Determine the concentration of $Ca(OH)_2$ in g / dm^3. Use the following steps.

- Calculate the number of moles in 20.0 cm^3 of 0.0500 mol / dm^3 HCl.

..... mol

- Determine the number of moles of $Ca(OH)_2$ in 25.0 cm^3 of the limewater.

..... mol

- Calculate the concentration of $Ca(OH)_2$ in mol / dm^3.

..... mol / dm^3

- Determine the concentration of $Ca(OH)_2$ in g / dm^3.

..... g / dm^3
[5]

[Total: 21]

3 Transition elements are found in the middle block of the Periodic Table.

(a) Chromium has several isotopes. Manganese has only one isotope.

(i) State what is meant by the term *isotopes*.

.....

..... [2]

(ii) State the nucleon number of manganese.

..... [1]

(iii) Complete the table to show the number of protons, neutrons and electrons in a $^{52}_{24}Cr^{3+}$ ion.

protons	neutrons	electrons

[3]

(b) One chemical property of transition elements is that they form coloured compounds.

(i) Give the colours of the following hydrated salts.

- hydrated copper(II) sulfate .....
- hydrated cobalt(II) chloride .....

[2]

(ii) State two **other** chemical properties of transition elements.

1 .....

2 .....

[2]

(c) Transition elements and Group I elements are metals. They share many physical properties including the ability to:
- conduct electricity
- be hammered into shape.

(i) Explain why transition elements and Group I elements conduct electricity.

..... [1]

(ii) State the property that describes a material which can be hammered into shape.

..... [1]

(d) Transition elements and Group I elements differ in other physical properties. Transition elements are harder and stronger than Group I elements.

Describe two **other** ways in which the physical properties of transition elements differ from Group I elements.

1 .....

2 .....
[2]

[Total: 14]

4 Fluorine and chlorine are halogens.

(a) Suggest the appearance of fluorine.

..... [1]

(b) Fluorine reacts with sulfur to form a compound which has 25.2% sulfur by mass and a relative molecular mass of 254.

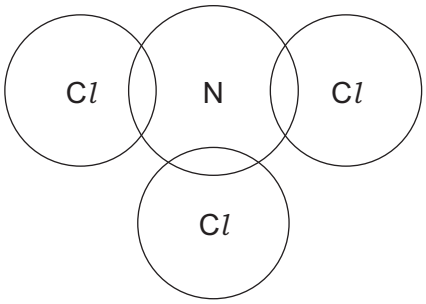
Determine the molecular formula of this compound.

molecular formula = ... [3]

(c) Nitrogen trichloride, NCl_3, is a covalent compound.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NCl_3.

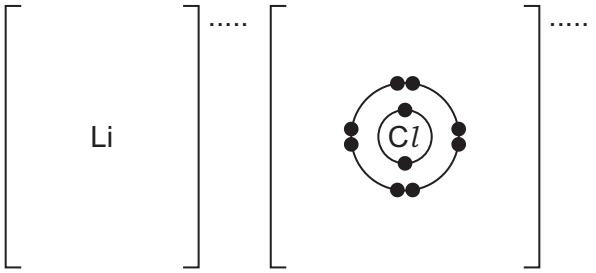
Show outer electrons only.



[3]

(d) Lithium chloride, LiC*l*, is an ionic compound.

Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in lithium chloride.



[3]

(e) Explain, in terms of attractive forces between particles, why LiC*l* is a solid at room temperature but NCl_3 is a liquid with a relatively low boiling point.

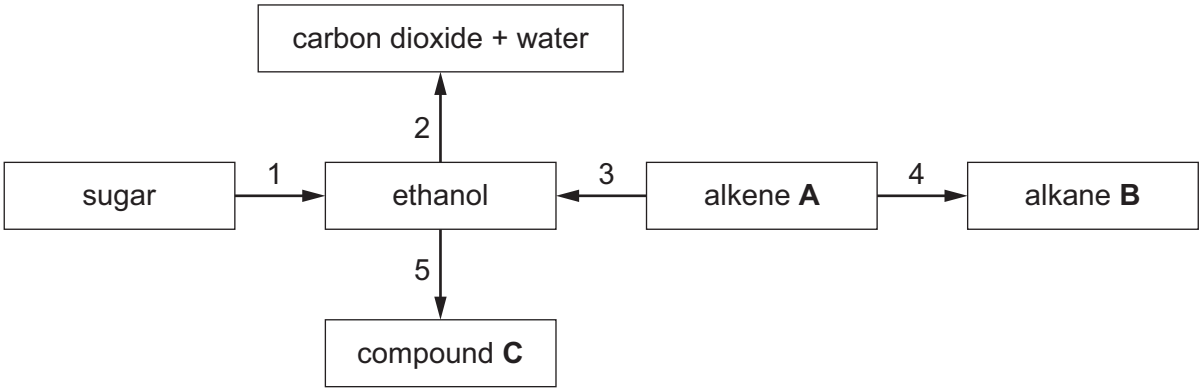
.....

.....

..... [3]

[Total: 13]

5 The reaction scheme shows five organic reactions, numbered 1 to 5.



(a) Name reaction 1.

..... [1]

(b) Name reaction 2 and write the chemical equation for this reaction.

name .....

equation .....
[3]

(c) Reaction 3 forms ethanol from alkene **A**.

(i) Identify alkene **A**.

..... [1]

(ii) State the type of reaction that occurs during reaction 3.

..... [1]

(iii) State the reagents and conditions needed for reaction 3.

.....

..... [2]

(d) Alkene **A** is converted into alkane **B** in reaction 4.

(i) State the reagent and conditions for reaction 4.

.....

..... [3]

(ii) State the general formula of alkanes.

..... [1]

(e) Ethanol is oxidised in reaction 5 by heating it with dilute sulfuric acid and one other reagent.

(i) Identify the other reagent in reaction 5.

..... [1]

(ii) Name the homologous series compound **C** belongs to.

..... [1]

(iii) Draw the structure of compound **C**.

Show all of the atoms and all of the bonds.

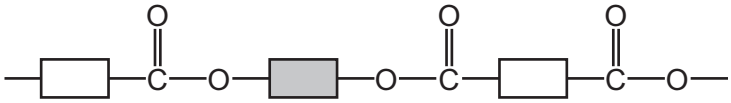
[1]

[Total: 15]

6 This question is about polymers.

(a) Polymer **X** is a condensation polymer.

Part of the structure of polymer **X** is shown.



(i) How many molecules of water are produced when this part of polymer **X** is formed from its monomers?

..... [1]

(ii) Complete the structures of the **two** monomers used to make polymer **X**.

Show all of the atoms and all of the bonds in the functional groups.

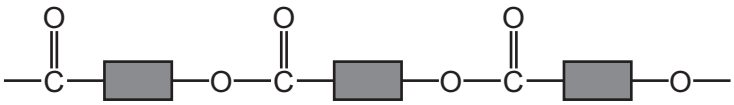
and

[2]

(iii) What type of condensation polymer is **X**?

..... [1]

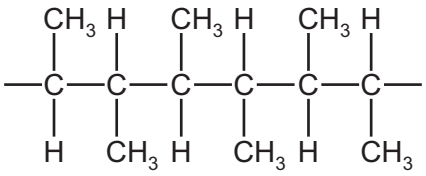
(b) Part of polymer **Y** has the structure shown.



State the number of different types of monomer needed to make polymer **Y**.

..... [1]

(c) Part of polymer **Z** has the structure shown.



(i) Draw and name the structure of the monomer which forms polymer **Z**.

Show all of the atoms and all of the bonds.

name .....

[3]

(ii) Name the chemical process used to make the monomer that forms polymer **Z**.

..... [1]

[Total: 9]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group

I	II											III	IV	V	VI	VII	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 –		

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.).

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