Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6591584314

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2020**

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.

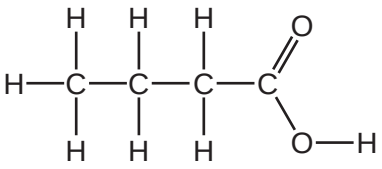
This document has **16** pages. Blank pages are indicated.

[Turn over

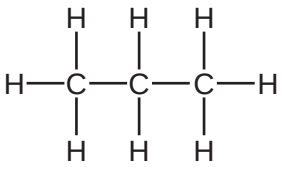
1 **(a)** The structures of five organic compounds, **A**, **B**, **C**, **D** and **E**, are shown.

Answer the questions that follow.
Each letter may be used once, more than once or not at all.

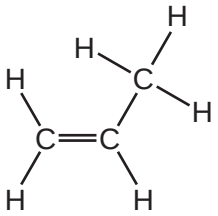
A



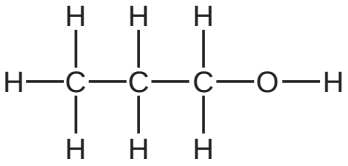
B



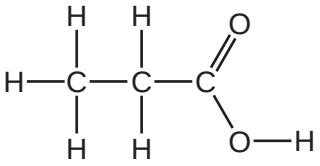
C



D



E



(i) Give the letter of the compound that is propan-1-ol.

..... [1]

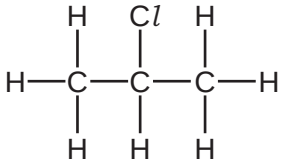
(ii) Give the letter of the compound that has the empirical formula CH_2.

..... [1]

(iii) Give the letter of **one** compound that reacts with bromine in an addition reaction.

..... [1]

(iv) Give the letter of **one** compound that reacts with chlorine to form the compound shown.



..... [1]

(v) Give the letters of **two** compounds that can react with each other to form an ester.

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

(vi) Give the letter of the compound that is in the same homologous series as hex-1-ene.

..... [1]

(vii) Give the letter of **one** compound that is an acid.

..... [1]

(viii) Draw a structural isomer of compound **D**.

Show all of the atoms and all of the bonds.

[1]

(b) Some acids are described as weak acids.

State the meaning of the term *weak acid*.

weak .....

acid .....

[2]

[Total: 10]

2 Ammonia is manufactured by the Haber process.

(a) The equation for the reaction is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) State what is meant by the symbol $\rightleftharpoons$.

..... [1]

(ii) State **one** source of hydrogen used in the manufacture of ammonia.

..... [1]

(b) The table shows some data for the production of ammonia.

pressure / atm	temperature / °C	percentage yield of ammonia
250	350	58
100	450	28
400	450	42
250	550	20

Deduce the effect on the percentage yield of ammonia of:

- increasing the pressure of the reaction

.....

- increasing the temperature of the reaction.

.....
[2]

(c) Explain, in terms of particles, what happens to the rate of this reaction when the temperature is increased.

.....

.....

.....

.....

.....

..... [3]

(d) Ammonia, NH_3, is used to produce nitric acid, HNO_3. This happens in a three-stage process.

Stage 1 is a redox reaction.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

(i) Identify what is oxidised in **stage 1**.

Give a reason for your answer.

substance oxidised .....

reason .....

.....

[2]

(ii) In this reaction the predicted yield of NO is 512 g. The actual yield is 384 g.

Calculate the percentage yield of NO in this reaction.

percentage yield of NO = ... [1]

(iii) The equation for the reaction in **stage 2** is shown.

$$2NO + O_2 \rightarrow 2NO_2$$

Which major environmental problem does NO_2 cause if it is released into the atmosphere?

.....

..... [1]

(iv) The equation for the reaction in **stage 3** is shown.

$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

Calculate the volume of O_2 gas, at room temperature and pressure (r.t.p.), needed to produce 1260 g of HNO_3.
Use the following steps.

- Calculate the number of moles of HNO_3.

moles of HNO_3 = ...

- Deduce the number of moles of O_2 that reacted.

moles of O_2 = ...

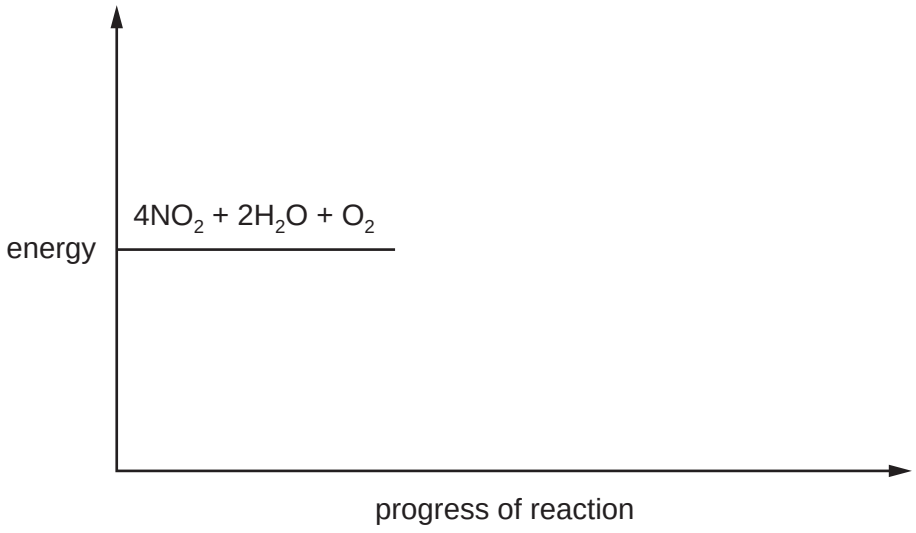
- Calculate the volume of O_2 gas that reacts at room temperature and pressure (r.t.p.).

volume of O_2 gas = ... dm^3
[4]

(e) The reaction in **stage 3** is exothermic.

$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

Complete the energy level diagram for this reaction. Include an arrow that clearly shows the energy change during the reaction.



[3]

[Total: 18]

3 Chlorine is in Group VII of the Periodic Table.

(a) Two isotopes of chlorine are chlorine-35 and chlorine-37.

(i) State why these two isotopes of chlorine have the same chemical properties.

.....

.....

..... [2]

(ii) Complete the table to show the number of electrons, neutrons and protons in each atom and ion.

	number of electrons	number of neutrons	number of protons
$^{35}_{17}Cl$			
$^{37}_{17}Cl^-$			

[3]

(b) (i) Chlorine reacts with aqueous sodium bromide.

The equation for the reaction is shown.

$$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$$

State the type of reaction shown.

..... [1]

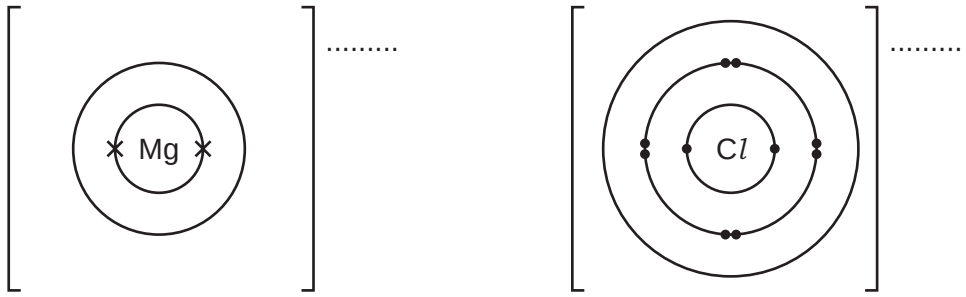
(ii) Why is there **no** reaction between iodine and aqueous sodium bromide?

..... [1]

(c) Magnesium reacts with chlorine to form magnesium chloride.

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

The inner shells have been completed.



[3]

(d) Hydrogen and chlorine react to form hydrogen chloride gas, as shown in the equation.

$$H_2 + Cl_2 \rightarrow 2HCl$$

This equation can be represented as shown.

$$H–H + Cl–Cl \rightarrow 2H–Cl$$

Some bond energies are shown in the table.

bond	bond energy in kJ / mol
H–H	436
Cl–Cl	243
H–Cl	432

Calculate the energy change for the reaction between hydrogen and chlorine, using the following steps.

- Calculate the energy needed to break the bonds.

..... kJ

- Calculate the energy released when bonds are formed.

..... kJ

- Calculate the energy change for the reaction.

..... kJ / mol
[3]

[Total: 13]

4 **(a)** Filtration and chlorination are two stages in water treatment.

State the purpose of each stage.

filtration .....

.....

chlorination .....

.....

[2]

(b) A student uses anhydrous copper(II) sulfate to test for the presence of water.

(i) What colour change is seen if water is present?

from ..... to ..... [2]

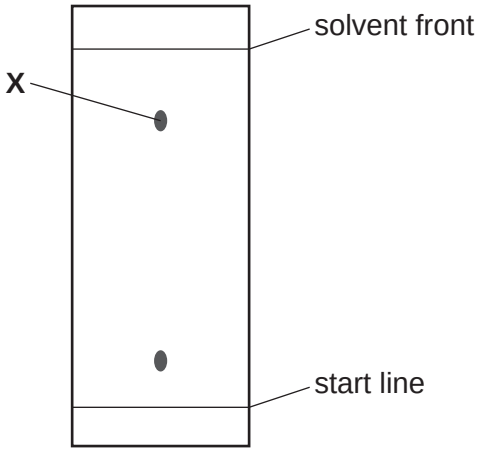
(ii) The purity of a sample of water can be assessed by measuring its boiling point.

How is the boiling point of water affected by impurities?

..... [1]

(c) Chromatography can be used to test the purity of substances.

The diagram shows the chromatogram of a coloured substance.



(i) How does this chromatogram show that this substance is **not** pure?

..... [1]

(ii) Draw a circle round the correct R_f value for the spot labelled **X**.

0.2 0.4 0.8 1.2 [1]

(iii) State how a colourless substance can be made visible on a chromatogram.

..... [1]

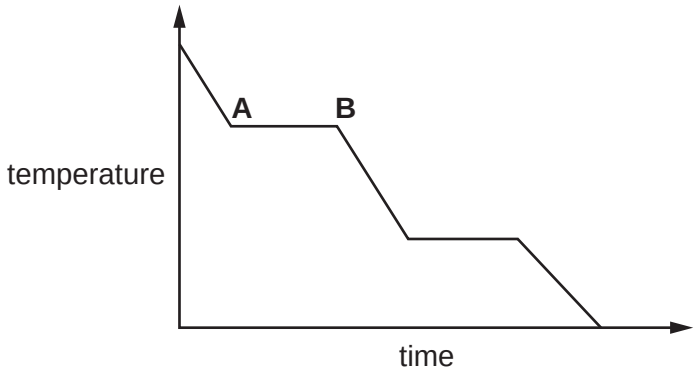
[Total: 8]

5 **(a)** Complete the table about solids, liquids and gases.

	particle separation	particle arrangement	type of motion
solid		regular	vibrate only
liquid	touching		random
gas	apart	random	

[3]

(b) The graph shows the change in temperature as a sample of a gas is cooled.



Name the change of state taking place between **A** and **B**.

..... [1]

(c) A bottle of liquid perfume is left open at the front of a room.

After some time, the perfume is smelt at the back of the room.

Name the **two** physical processes taking place.

1 .....

2 .....

[2]

[Total: 6]

6 **(a)** An endothermic reaction occurs when calcium nitrate is heated.

(i) Balance the equation for this reaction.

$$.....Ca(NO_3)_2 \rightarrow .....CaO + ...NO_2 + ...O_2$$ [1]

(ii) State the type of reaction shown by the equation.

..... [1]

(b) Describe the test for a nitrate ion.

test .....

.....

result .....

.....

[3]

[Total: 5]

7 Aluminium is extracted by electrolysis. Iron is extracted from its ore by reduction with carbon.

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

.....

..... [2]

(b) Name the main ore of aluminium.

..... [1]

(c) (i) Explain why aluminium **cannot** be extracted by reduction with carbon.

..... [1]

(ii) Describe the role of cryolite in the extraction of aluminium by electrolysis.

..... [1]

(iii) Name the product formed at the positive electrode.

..... [1]

(iv) Write the ionic half-equation for the reaction at the negative electrode.

..... [2]

(d) Aluminium is used in overhead electricity cables.

Give **two** properties of aluminium that make it suitable for use in overhead electricity cables.

1 .....

2 .....
[2]

(e) Iron is a transition element.

(i) Iron forms hydrated iron(III) oxide when it rusts.

Write a word equation to represent the formation of rust.

..... [2]

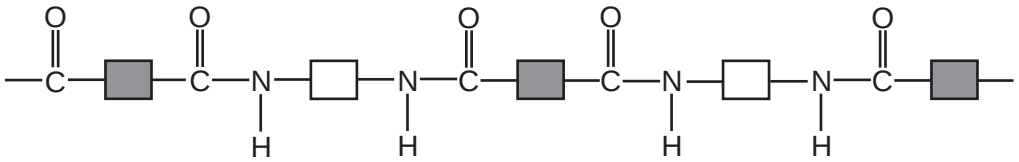
(ii) Give **two** ways in which the properties of transition elements differ from the properties of Group I metals.

1 .....

2 .....
[2]

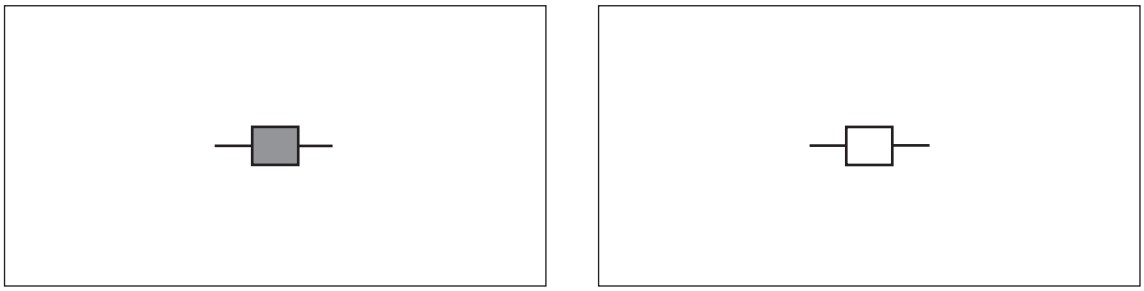
[Total: 14]

8 **(a)** Part of the synthetic polymer, nylon, is shown in the diagram.



(i) Circle **one** amide linkage **on the diagram**. [1]

(ii) Complete the structures of the **two** monomers that react to form nylon.



[2]

(iii) Name the other product formed when nylon is produced.

..... [1]

(b) Items made from nylon are often disposed of by burying them in the ground. This is called landfill.

Why is the disposal of nylon using landfill a problem?

.....

..... [1]

(c) Give the name of a natural polymer.

..... [1]

[Total: 6]

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The Periodic Table of Elements

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 –		

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.).