Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1251990751

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2019**

1 hour 15 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.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

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 syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **13** printed pages and **3** blank pages.

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1 This question is about the structures of atoms and ions.

(a) Define the term *proton number*.

.....

..... [2]

(b) (i) Complete the table to show the number of protons, neutrons and electrons present in atoms of $^{24}_{12}Mg$ and $^{26}_{12}Mg$.

	number of protons	number of neutrons	number of electrons
$^{24}_{12}Mg$			
$^{26}_{12}Mg$			

[2]

(ii) What term is used to describe atoms of the same element, such as $^{24}_{12}Mg$ and $^{26}_{12}Mg$?

..... [1]

(iii) Explain why the chemical properties of $^{24}_{12}Mg$ and $^{26}_{12}Mg$ are the same.

.....

..... [2]

(c) Complete the table to identify the atoms and ions which have the following numbers of protons, neutrons and electrons.

	number of protons	number of neutrons	number of electrons
$^{23}_{11}Na^+$	11	12	10
	4	5	4
	17	20	18

[4]

(d) State the electronic structure of the following atom and ion.

Al .....

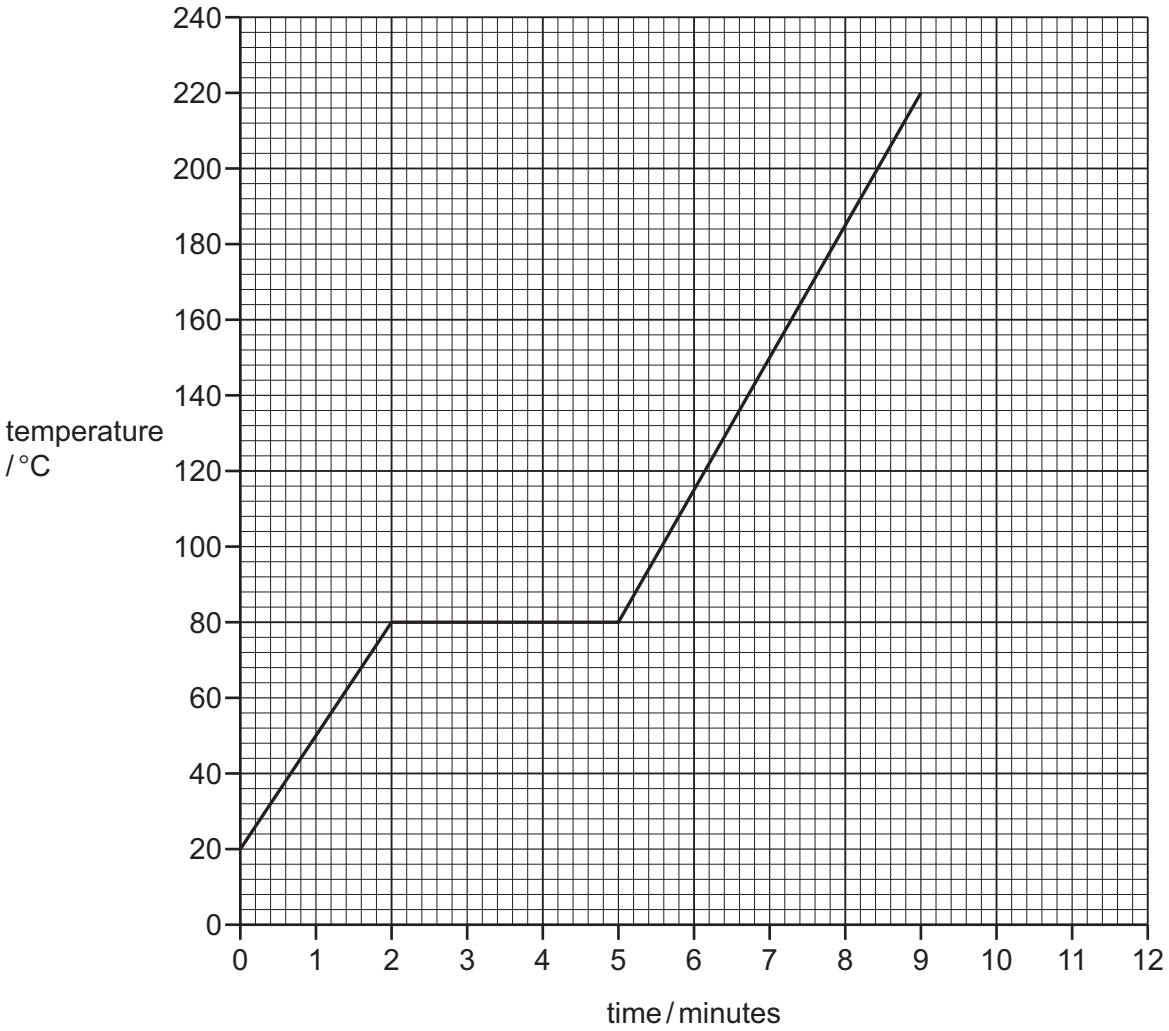
S^{2-} .....

[2]

[Total: 13]

2 **Z** is a covalent substance. In an experiment, a sample of pure solid **Z** was continually heated for 11 minutes.

The graph shows how the temperature of the sample of pure **Z** changed during the first 9 minutes.



(a) What is the melting point of pure **Z**?

..... °C [1]

(b) The sample of pure **Z** began to boil at 9 minutes. It was boiled for 2 minutes.

Use this information to sketch on the grid how the temperature of the sample of pure **Z** changed between 9 minutes and 11 minutes. [1]

(c) The sample of pure **Z** was continually heated between 2 minutes and 5 minutes.

Explain, in terms of attractive forces, why there was no increase in the temperature of the sample of pure **Z** between 2 minutes and 5 minutes.

.....

.....

..... [2]

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(d) Describe how the motion of particles of pure **Z** changed from 0 minutes to 2 minutes.

.....

..... [2]

(e) The experiment was repeated using a solid sample of **impure Z**.

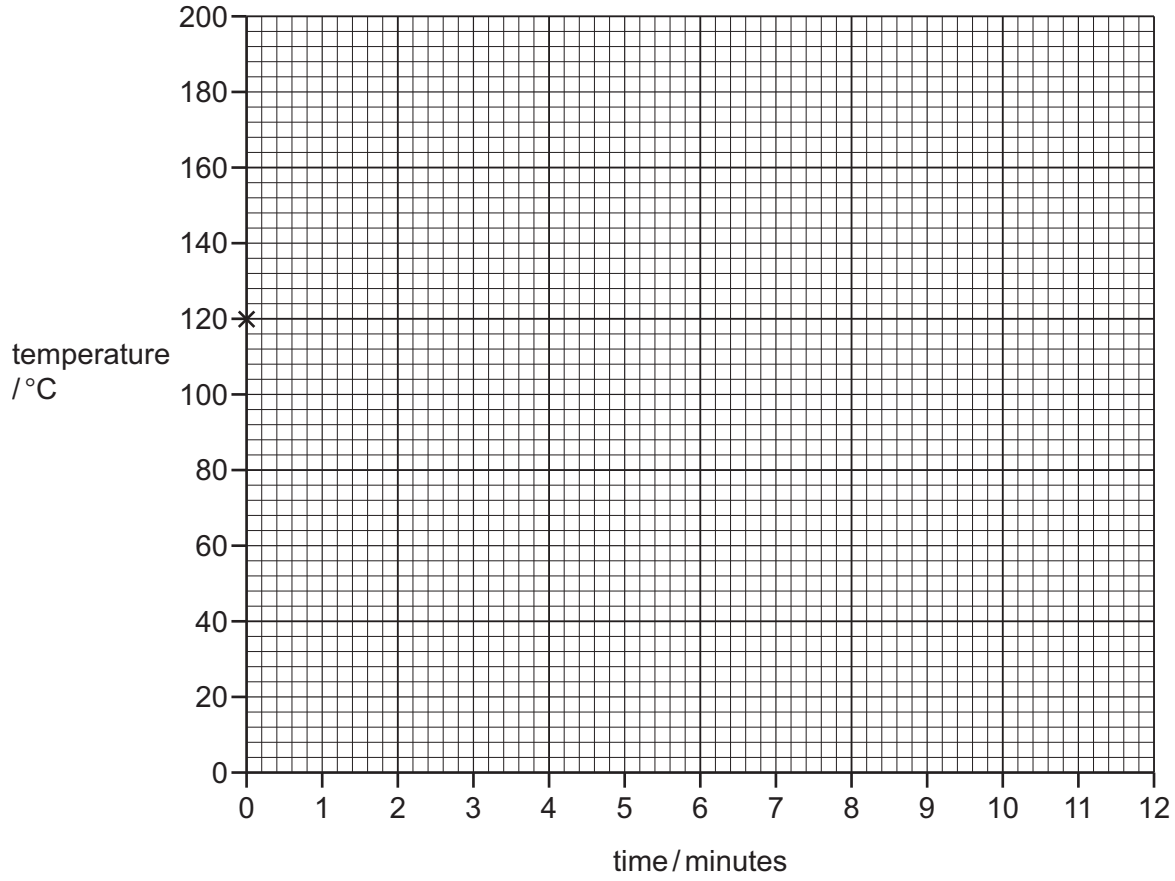
Suggest the differences, if any, in the melting point and boiling point of the sample of impure **Z** compared to the sample of pure **Z**.

melting point .....

boiling point .....
[2]

(f) A sample of pure **Z** was allowed to cool from 120 °C to 20 °C. The total time taken was 8 minutes.

Starting from point ×, sketch on the grid how the temperature of the sample of pure **Z** changed between 0 minutes and 8 minutes.



[2]

[Total: 10]

3 Zinc and copper are elements next to each other in the Periodic Table.

(a) Zinc is obtained from zinc blende in a two-step process.

- In **step 1**, zinc blende is converted into zinc oxide.
- In **step 2**, zinc oxide is converted into zinc in a blast furnace.

Outline how each of these steps are done.

In your answer:
- give **one** chemical equation for each step
- describe how zinc is removed from the blast furnace in **step 2**.

step 1 .....

.....

chemical equation .....

step 2 .....

.....

chemical equation .....

removal of zinc in **step 2** .....

.....

[5]

(b) Name the alloy formed when zinc is mixed with copper.

..... [1]

(c) Copper is a transition element. It can have variable oxidation states.

State **two** other chemical properties of transition elements which make them different from Group I elements.

1 .....

2 .....

[2]

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(d) A compound of copper can be used to test for water.

(i) State the full name of this compound of copper.

..... [1]

(ii) State the colour change that occurs when water is added to this compound of copper.

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

(e) Aqueous potassium iodide reacts with aqueous copper(II) sulfate to produce iodine.

(i) Balance the chemical equation for this reaction.

$$KI + CuSO_4 \rightarrow CuI + I_2 + K_2SO_4$$

[2]

(ii) Deduce the charge on the copper ion in CuI.

..... [1]

(iii) In terms of electron transfer, explain why copper is reduced in this reaction.

..... [1]

(iv) Identify the reducing agent.

..... [1]

[Total: 16]

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[Turn over

4 Ethanoic acid is a weak acid and hydrochloric acid is a strong acid.
Both ethanoic acid and hydrochloric acid dissociate in aqueous solution.

(a) (i) Define the term *acid*.

..... [1]

(ii) The chemical equation shows the changes which occur when the **strong** acid, hydrochloric acid, is added to water.

$$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$$

Complete the chemical equation to show the changes which occur when the **weak** acid, ethanoic acid, is added to water.

$CH_3COOH(aq)$ ..... [2]

(b) A student does experiments to show that hydrochloric acid is a strong acid and ethanoic acid is a weak acid. The student adds an excess of hydrochloric acid and an excess of ethanoic acid to separate samples of lumps of calcium carbonate.

Only the identity of the acid is changed between the experiments. All other conditions are kept the same.

(i) State **two** observations which would show that hydrochloric acid is a stronger acid than ethanoic acid.

1 .....

2 .....
[2]

(ii) The student uses the same size container and checks that the pressure is the same for each experiment.

State **three** other conditions which must be kept the same to ensure fair testing.

1 .....

2 .....

3 .....
[3]

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(c) Hydrochloric acid produces salts called chlorides.

Magnesium carbonate reacts with hydrochloric acid to produce magnesium chloride.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$$

A student used 50.00 cm^3 of 2.00 mol/dm^3 hydrochloric acid in an experiment to produce magnesium chloride.

Calculate the mass, in g, of magnesium carbonate needed to react exactly with 50.00 cm^3 of 2.00 mol/dm^3 hydrochloric acid using the following steps.

- Calculate the number of moles of HCl present in 50.00 cm^3 of 2.00 mol/dm^3 HCl.

..... mol

- Determine the number of moles of $MgCO_3$ which would react with 50.00 cm^3 of 2.00 mol/dm^3 HCl.

..... mol

- Calculate the relative formula mass, M_r, of $MgCO_3$.

M_r of $MgCO_3$ = ...

- Calculate the mass of $MgCO_3$ needed to react exactly with 50.00 cm^3 of 2.00 mol/dm^3 HCl.

mass = ... g
[4]

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[Turn over

(d) A student prepares crystals of magnesium chloride by adding an excess of magnesium carbonate to 50.00 cm^3 of 2.00 mol / dm^3 hydrochloric acid.

The student filters the mixture and rinses the residue.

(i) Why does the student add an **excess** of magnesium carbonate?

..... [1]

(ii) Why does the student rinse the residue?

..... [1]

(iii) Describe how the student would obtain pure crystals of magnesium chloride from the filtrate.

.....

.....

..... [3]

(e) Silver chloride, AgC*l*, is insoluble. It can be made by a precipitation reaction between aqueous barium chloride and a suitable aqueous silver salt.

(i) What is meant by the term *precipitate*?

.....

..... [2]

(ii) Name a suitable silver salt to use to prepare silver chloride.
Complete the chemical equation to show the formation of insoluble silver chloride from aqueous barium chloride and the silver salt you have named.

name of a suitable silver salt .....

$BaCl_2$ + ... → ..... + ...

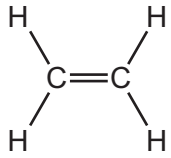
[3]

[Total: 22]

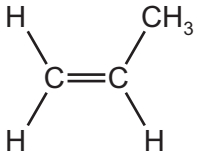
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5 The structures of five alkenes, **A**, **B**, **C**, **D** and **E**, are shown.

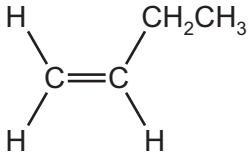
A



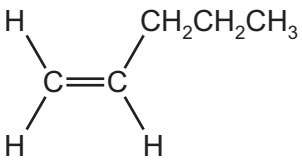
B



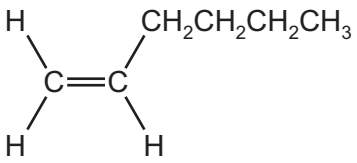
C



D



E



(a) What is the general formula of alkenes?

..... [1]

(b) What is the molecular formula of alkene **D**?

..... [1]

(c) Predict which alkene, **A**, **B**, **C**, **D** or **E**, has the highest boiling point.
Explain your answer.

alkene .....

explanation .....

.....
[2]

(d) Which alkene, **A**, **B**, **C**, **D** or **E**, diffuses most quickly?
Explain your answer.

alkene .....

explanation .....

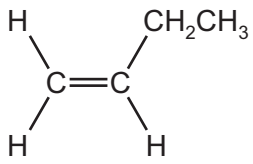
.....
[2]

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[Turn over

(e) A student added aqueous bromine to alkene **C**.

C



Describe the colour change seen and draw the structure of the product. Show all of the atoms and all of the bonds.

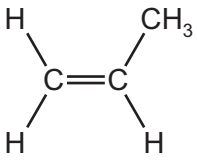
colour change from ..... to .....

structure

[2]

(f) Two different alcohols can be produced from alkene **B** by an addition reaction.

B



(i) Draw the structures of the **two** alcohols. Show all of the atoms and all of the bonds.

[2]

(ii) State the reagent and conditions needed to produce an alcohol from alkene **B**.

reagent .....

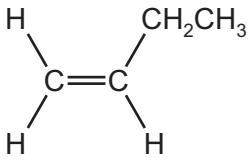
conditions .....

.....

[3]

(g) Alkene **C** can be converted into a polymer.

C



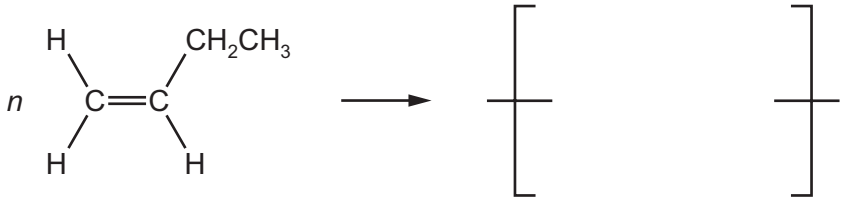
(i) What type of polymerisation occurs?

..... [1]

(ii) Suggest the name of the polymer formed.

..... [1]

(iii) Complete the chemical equation to show this polymerisation.



[3]

(iv) State the empirical formula of the polymer formed.

..... [1]

[Total: 19]

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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.).