**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.

A$l$ .....

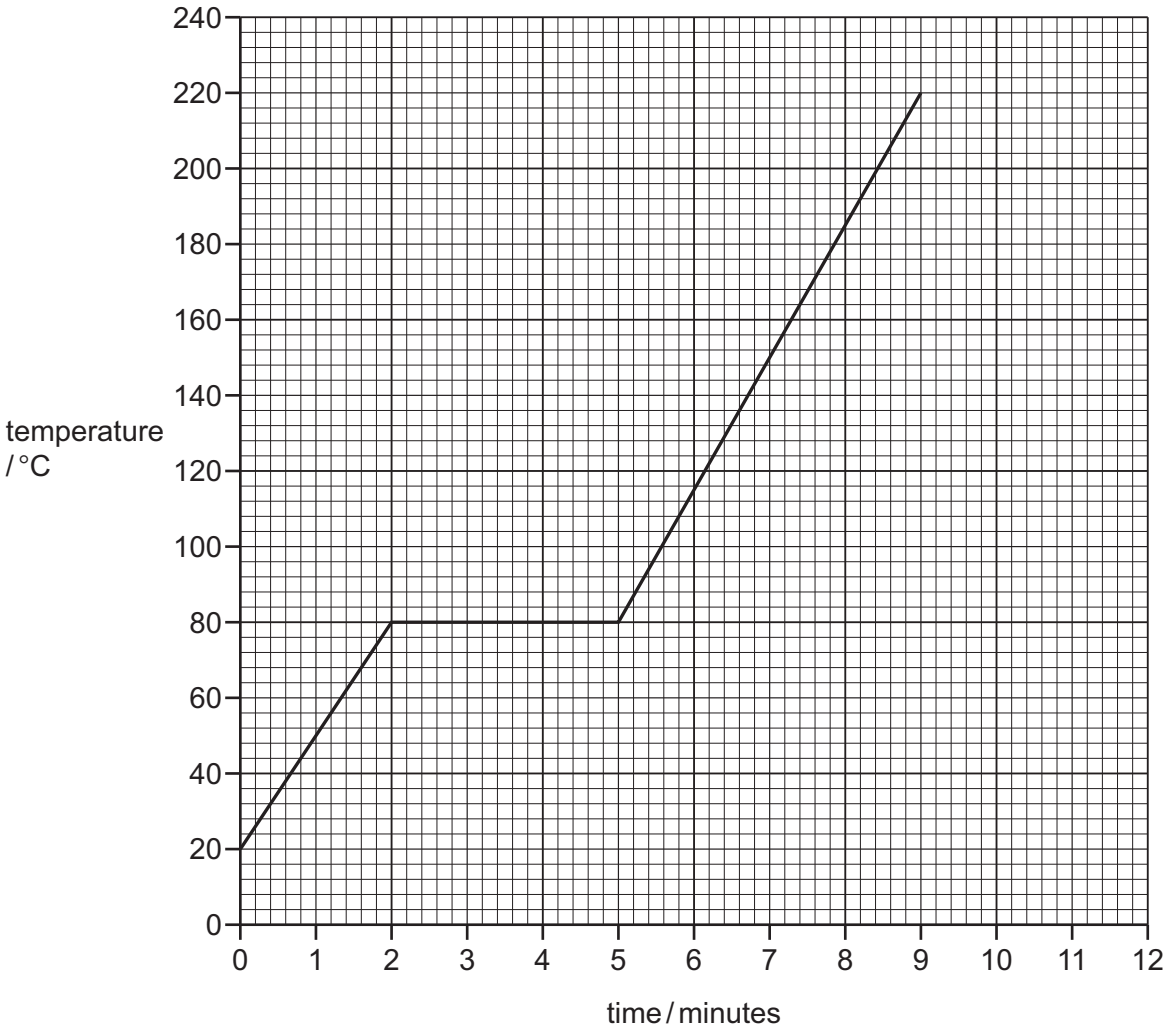
$S^{2-}$ .....

[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]

**(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**.

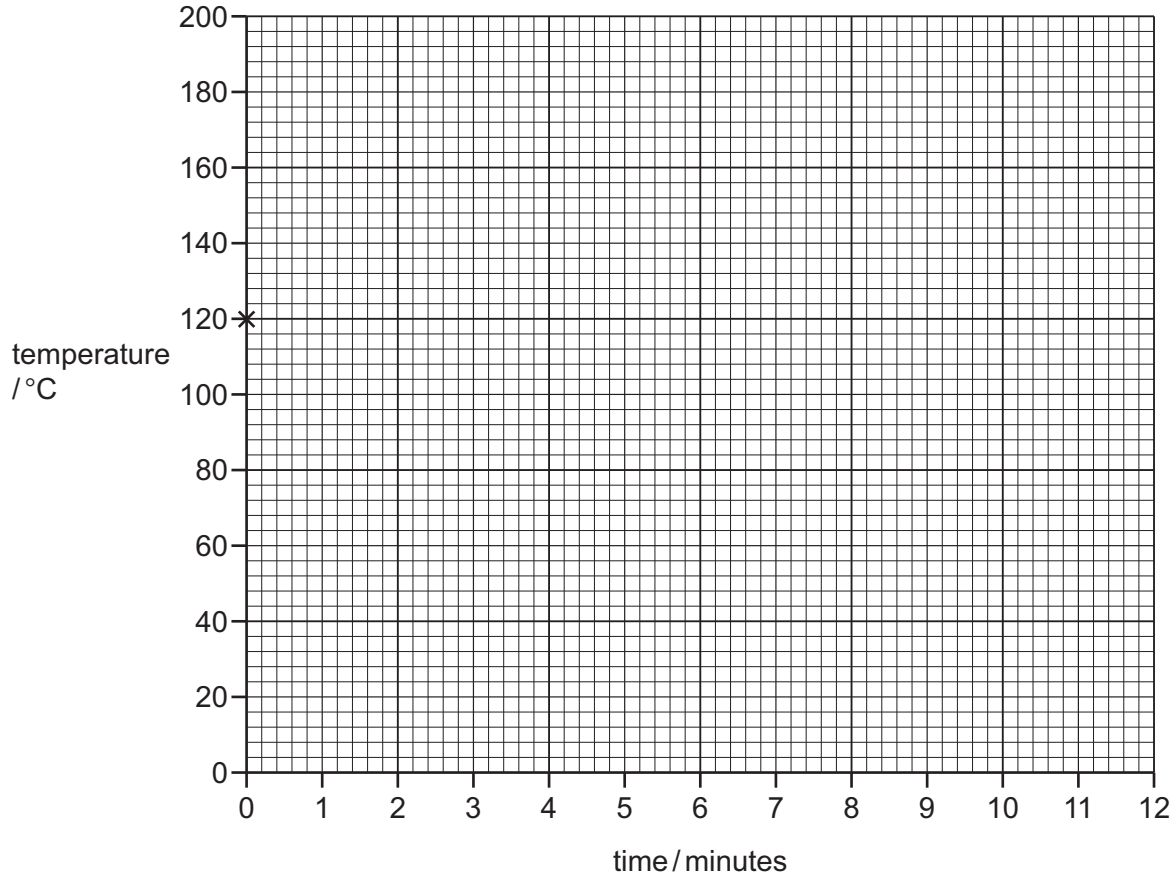
Suggest the differences, if any, in the melting point and boiling point of the sample of impure **Z** compared to the sample of pure **Z**.

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]

**(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]



**[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]

**(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]



**[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 .....

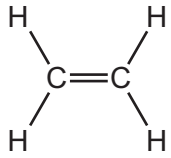
$BaCl_2$ + ..... → ..... + .....

[3]

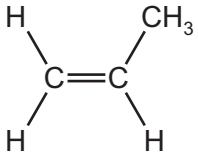
[Total: 22]

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

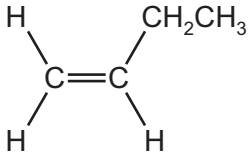
**A**



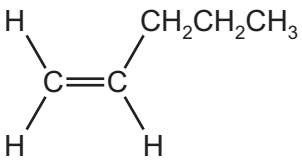
**B**



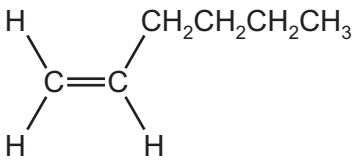
**C**



**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 .....

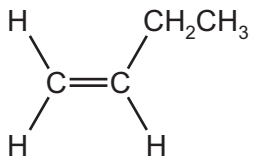
.....
[2]



**[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.

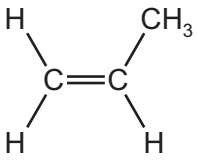
colour change from ..... to .....

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 .....

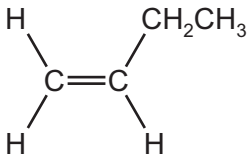
conditions .....

.....

[3]

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

**C**



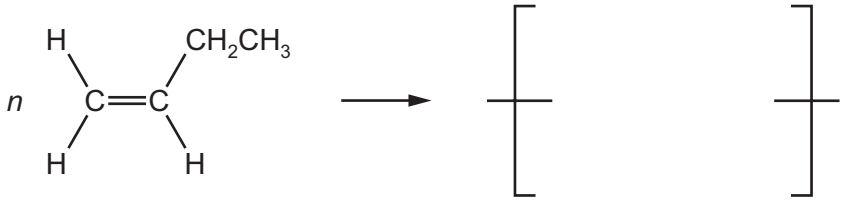

**(i)** What type of polymerisation occurs?

..... [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.).