Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*2711517754*

**CHEMISTRY** **0620/41**

Paper 4 Theory (Extended) **May/June 2018**

**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 12.
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.

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

This document consists of **12** printed pages.

**1** Substances can be classified as elements, compounds or mixtures.

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

.....

.....

..... [2]

**(b)** Mixtures can be separated by physical processes.

A sequence of physical processes can be used to separate common salt (sodium chloride) from a mixture containing sand and common salt only.

Give the order and the correct scientific term for the physical processes used to separate the common salt from the mixture.

1 .....

2 .....

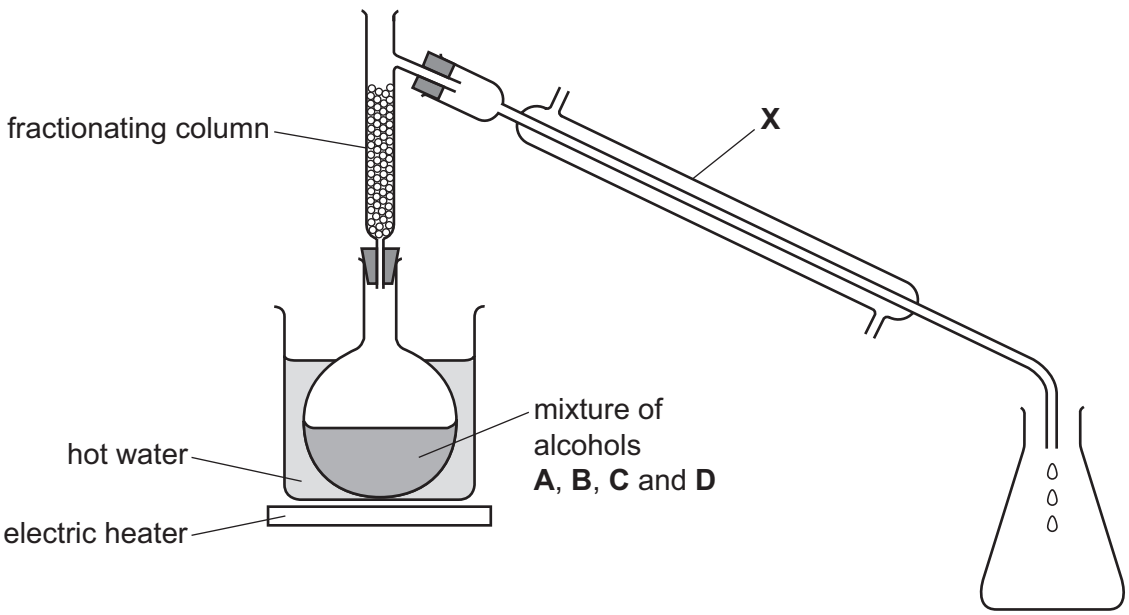
3 .....

[4]

The boiling points of four different alcohols, **A**, **B**, **C** and **D**, are shown.

| alcohol | **A** | **B** | **C** | **D** |
|---|---|---|---|---|
| boiling point / °C | 56 | 78 | 122 | 160 |

**(c)** A student suggested that the apparatus shown could be used to separate the mixture of alcohols.



**(i)** Apparatus **X** needs to have cold water flowing through it.

- Draw an arrow on the diagram to show where the cold water enters apparatus **X**.
- Name apparatus **X**.

.....

[2]

**(ii)** Part of the fractionating column is missing. This means that the experiment will not work.

- Draw on the diagram the part of the fractionating column which is missing.
- Explain why the experiment will **not** work with this part of the fractionating column missing.

.....

.....

[2]

**(iii)** Suggest why a Bunsen burner is **not** used to heat the flask.

..... [1]

**(iv)** A hot water bath cannot be used to separate alcohols **C** and **D**.

Explain why.

.....

.....

..... [2]

[Total: 13]





**[Turn over**

**2** Flerovium, F*l*, atomic number 114, was first made in research laboratories in 1998.

**(a)** Flerovium was made by bombarding atoms of plutonium, Pu, atomic number 94, with atoms of element **Z**.

- The nucleus of **one** atom of plutonium combined with the nucleus of **one** atom of element **Z**.
- This formed the nucleus of **one** atom of flerovium.

Suggest the identity of element **Z**.

..... [1]

**(b)** In which period of the Periodic Table is flerovium?

..... [1]

**(c)** Predict the number of outer shell electrons in an atom of flerovium.

..... [1]

**(d)** Two isotopes of flerovium are $^{286}Fl$ and $^{289}Fl$. The nuclei of both of these isotopes are unstable and emit energy when they split up.

**(i)** State the term used to describe isotopes with unstable nuclei.

..... [1]

**(ii)** Complete the table to show the number of protons, neutrons and electrons in the atoms of the isotopes shown.

| isotope | number of protons | number of neutrons | number of electrons |
|---|---|---|---|
| $^{286}Fl$ | | | |
| $^{289}Fl$ | | | |

[2]

**(e)** Only a relatively small number of atoms of flerovium have been made in the laboratory and the properties of flerovium have not yet been investigated.

It has been suggested that flerovium is a typical metal.

**(i)** Suggest **two** physical properties of flerovium.

1 .....

2 .....

[2]

**(ii)** Suggest **one** chemical property of flerovium oxide.

..... [1]

[Total: 9]

**3** This question is about iron.

**(a)** Three of the raw materials added to a blast furnace used to extract iron from hematite are coke, hematite and limestone.

Name **one** other raw material added to the blast furnace.

..... [1]

**(b)** A series of reactions occurs in a blast furnace during the extraction of iron from hematite.

Describe these reactions.
Include:

- **one** chemical equation for the reduction of hematite
- **one** chemical equation for the formation of slag.

.....

.....

.....

.....

.....

.....

.....

..... [5]

**(c)** The iron extracted from hematite using a blast furnace is impure.

Identify the main impurity in this iron and explain how it is removed in the steel-making process.

main impurity .....

how it is removed .....

.....

.....

[3]

[Total: 9]





**[Turn over**

**4** This question is about masses, volumes and moles.

**(a)** Which term is defined by the following statement?

*The average mass of naturally occurring atoms of an element on a scale where the $^{12}C$ atom has a mass of exactly 12 units.*

..... [1]

**(b)** Butane, $C_4H_{10}$, has a relative **molecular** mass of 58.
Potassium fluoride, KF, has a relative **formula** mass of 58.

Explain why the term relative molecular mass can be used for butane but **cannot** be used for potassium fluoride.

.....

..... [2]

**(c)** A 0.095 g sample of gaseous element **Y** occupies 60.0 $cm^3$ at room temperature and pressure.

- Determine the number of moles of element **Y** in 60.0 $cm^3$.

moles of element **Y** = ..... mol

- Calculate the relative molecular mass of element **Y** and hence suggest the identity of element **Y**.

relative molecular mass = .....

identity of element **Y** = .....
[3]

**(d)** A 1.68 g sample of phosphorus was burned and formed 3.87 g of an oxide of phosphorus.

Calculate the empirical formula of this oxide of phosphorus.

empirical formula = ..... [4]

**(e)** Another oxide of phosphorus has the empirical formula $P_2O_3$.
One molecule of this oxide of phosphorus contains four atoms of phosphorus.

Calculate the mass of **one** mole of this oxide of phosphorus.

mass = ..... g [2]

[Total: 12]

**5** **(a)** The table gives some chemical properties of transition elements and their compounds, and of Group I elements and their compounds.

| chemical property | transition elements | Group I elements |
|---|---|---|
| ability to act as catalysts | yes | no |
| exist as coloured compounds | yes | no |

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

.....

.....

..... [2]

**(ii)** Give **one** other chemical property shown by transition elements which is **not** shown by Group I elements.

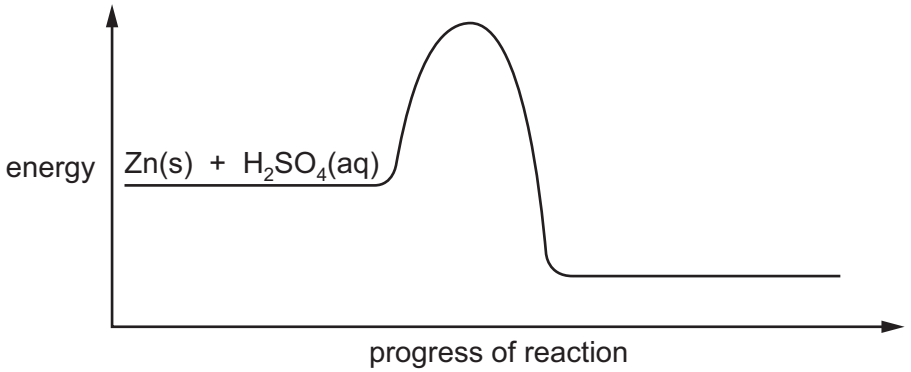
..... [1]

**(b)** Give **two** physical properties shown by transition elements which are **not** shown by Group I elements.

1 .....

2 .....
[2]

**(c)** The energy level diagram shows the energy profile for the reaction between zinc and dilute sulfuric acid.




**(i)** Complete the diagram by adding the formulae of the products. Include state symbols. [3]

**(ii)** Draw an arrow on the diagram to represent the activation energy. [1]

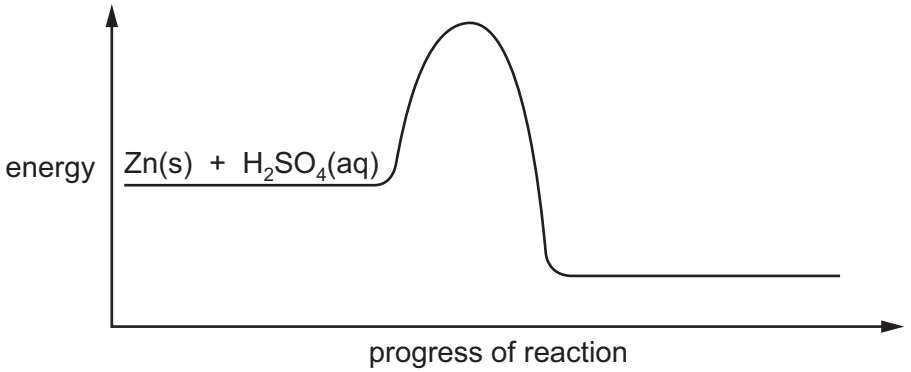
**(iii)** Is the reaction endothermic or exothermic? Explain your answer.

.....

..... [1]

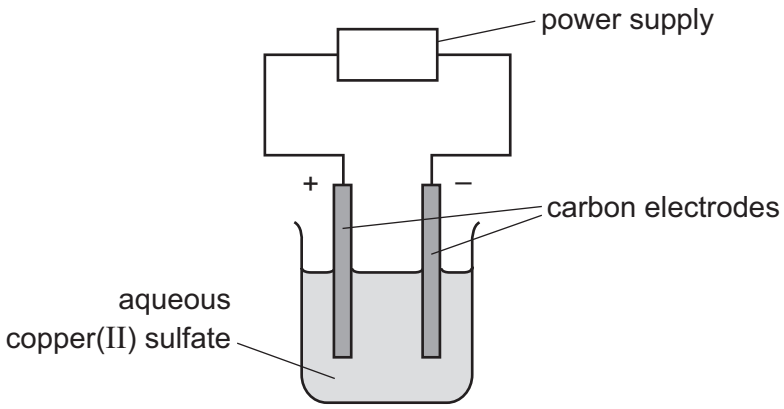
**(d)** The reaction between zinc and dilute sulfuric acid can be catalysed by the addition of aqueous copper(II) sulfate.

On the diagram, add the energy profile for the catalysed reaction.




[1]

**(e)** A student electrolyses aqueous copper(II) sulfate using the apparatus shown.




Oxygen gas forms at the positive electrode (anode).

**(i)** Write an ionic half-equation for the reaction at the negative electrode (cathode). Include state symbols.

..... [3]

**(ii)** Describe what the student observes at the negative electrode.

..... [1]

**(iii)** Give **two other** observations which the student makes during the electrolysis.

1 .....

2 .....

[2]

**(iv)** What difference would the student observe at the positive electrode if the aqueous copper(II) sulfate were replaced by concentrated aqueous copper(II) chloride?

..... [1]

[Total: 18]

**6** The table shows the structures of four hydrocarbons.

| P | Q | R | S |
|---|---|---|---|
| $CH_3–CH_3$ | $CH_2=CH_2$ | $CH_2=CH–CH_3$ | $CH_2=CH–CH_2–CH_3$ |

**(a)** Why are compounds **P**, **Q**, **R** and **S** known as hydrocarbons?

.....

..... [2]

**(b)** Compound **P** is saturated.

What is meant by the term *saturated*?

.....

..... [1]

**(c)** Compound **P** undergoes a substitution reaction with chlorine.

**(i)** What is meant by the term *substitution reaction*?

.....

..... [1]

**(ii)** State a condition required for this reaction to occur.

..... [1]

**(iii)** Write a chemical equation for this reaction.

..... [2]

**(d)** Compound **R** undergoes an addition reaction with bromine.

**(i)** Why is this reaction an addition reaction?

..... [1]

**(ii)** A compound containing bromine is formed in this reaction.

Draw the structure of this compound. Show all of the atoms and all of the bonds.

[1]

**(e)** Draw the structure of an unbranched isomer of compound **S**. Show all of the atoms and all of the bonds. Name this unbranched isomer of compound **S**.

structure

name .....
[2]

**(f)** Compound **Q** undergoes polymerisation.

**(i)** Name the polymer formed.

..... [1]

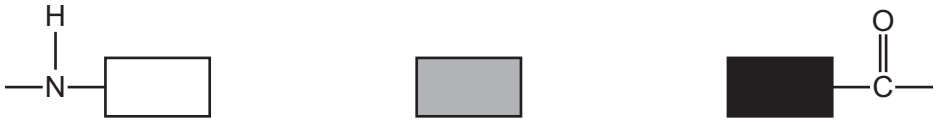
**(ii)** Complete the chemical equation to show the polymerisation of compound **Q**.

$n\ CH_2{=}CH_2 \rightarrow$

[2]

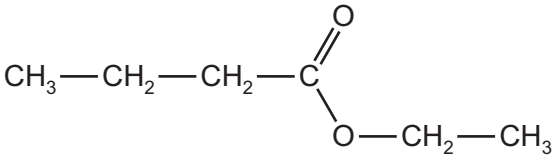
**(g)** Amino acids undergo polymerisation to form proteins. Part of a protein molecule with the linkages missing is shown.

Draw the linkages on the diagram. Show all of the atoms and all of the bonds.




[2]

**(h)** The structure shows an ester.




Write the word equation for a reaction which could be used to make this ester.

..... [3]

[Total: 19]

## 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.).