Cambridge IGCSE

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

| | |
|---|---|
| CANDIDATE NAME | |
| CENTRE NUMBER | |
| CANDIDATE NUMBER | |

*5182765417*

**CHEMISTRY** **0620/42**

Paper 4 Theory (Extended) **October/November 2016**

**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.

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 **15** printed pages and **1** blank page.


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**1** Particles behave differently when in different physical states.

**(a)** Solids have a fixed volume and a definite shape.
Gases have no fixed volume and take the shape of the container.

Describe the volume and shape of liquids.

.....

..... [1]

**(b)** Complete the table to show the separation, arrangement and movement of particles in each physical state.

| state | separation of particles | arrangement of particles | movement of particles |
|---|---|---|---|
| solid | | | |
| liquid | touching one another | randomly arranged | move over one another |
| gas | | | |

[6]

**(c)** Name the following changes of state.

**(i)** Ice turning into water.

..... [1]

**(ii)** Solid carbon dioxide turning directly into gaseous carbon dioxide at room temperature.

..... [1]

[Total: 9]

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**2** This question is about atoms, ions and isotopes.

**(a)** Define the term *nucleon number*.

.....

..... [2]

**(b)** Give the electronic structure of the following atom and ion.

Na .....

$P^{3-}$ .....
[2]

**(c)** State **one** medical use of radioactive isotopes.

..... [1]

**(d)** What is meant by the term *relative atomic mass*?

.....

.....

..... [2]

**(e)** Suggest why the relative atomic mass of chlorine is **not** a whole number.

.....

.....

..... [2]

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**[Turn over**

**(f)** Aluminium is a metal in Group III.

Describe the bonding in aluminium.
Include a labelled diagram and any appropriate charges in your answer.

[3]

[Total: 12]

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**3** Clean, dry air contains a small amount of carbon dioxide.

**(a)** The percentages of the **other** gases present in clean, dry air are shown in the table.

Complete the table by inserting the names of these gases.

| name of gas | percentage present |
|---|---|
| | 78 |
| | 21 |
| | 1 |

[2]

**(b)** Oxides of nitrogen are atmospheric pollutants which can cause acid rain.

Describe the formation of oxides of nitrogen and suggest how they can cause acid rain.

.....

.....

.....

..... [3]

**(c)** Methane contributes to the greenhouse effect.

State **two** sources of methane.

1 .....

2 .....

[2]

**(d)** Combustion and respiration add carbon dioxide to the atmosphere.

Name **one** natural process which removes carbon dioxide from the atmosphere.

..... [1]

[Total: 8]

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**[Turn over**

**4** Dilute nitric acid behaves as a typical acid in some reactions but **not** in other reactions.

**(a)** Dilute nitric acid behaves as a typical acid when reacted with copper(II) oxide and with copper(II) carbonate.

Describe what you would **see** if excess dilute nitric acid is added separately to solid samples of copper(II) carbonate and copper(II) oxide followed by warming the mixtures.

copper(II) carbonate

.....

.....

copper(II) oxide

.....

.....
[4]

**(b)** When dilute nitric acid is added to pieces of copper and heated, a reaction takes place and copper(II) nitrate is formed.

**(i)** Part of the chemical equation for the reaction between copper and dilute nitric acid is shown.

Complete the chemical equation by inserting the formula of copper(II) nitrate and balancing the equation.

.....Cu(s) + $8HNO_3$(aq) $\rightarrow$ .....(aq) + $4H_2O$(l) + 2NO(g)
[2]

**(ii)** How is the reaction of dilute nitric acid with copper different from that of a typical metal with a typical acid?

.....

..... [1]

[Total: 7]

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**5** Chlorine, bromine and iodine are halogens.

**(a)** Chlorine can be made in the laboratory by heating manganese(IV) oxide with concentrated hydrochloric acid.

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

Calculate the volume of 8.00 mol / $dm^3$ $HCl(aq)$ needed to react with 3.48 g of $MnO_2$.

- moles of $MnO_2$ used

..... mol

- moles of $HCl$ needed

..... mol

- volume of $HCl$ needed

..... $cm^3$

[4]

**(b)** A student bubbled chlorine gas into a test-tube containing aqueous potassium bromide.

**(i)** Describe the colour change seen in the test-tube.

from ..... to .....

[2]

**(ii)** Complete the **ionic** equation for this reaction.

Include state symbols.

$$Cl_2(g) + .....Br^-(aq) \rightarrow ..... + .....$$

[3]

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**[Turn over**

**(c)** When one mole of bromine, $Br_2$, reacts with one mole of propene, one organic product is formed.

**(i)** Which part of the propene molecule reacts with bromine?

..... [1]

**(ii)** What is the name of the type of reaction which takes place between bromine and propene?

..... [1]

**(d)** When one mole of chlorine, $Cl_2$, reacts with one mole of propane, a mixture of two structural isomers is formed.

**(i)** What is the name of the type of reaction which takes place between chlorine and propane?

..... [1]

**(ii)** Explain what is meant by the term *structural isomers*.

.....

..... [2]

**(iii)** Draw the structure of **two** structural isomers formed when **one** mole of chlorine reacts with **one** mole of propane.

[2]

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**(e)** Iodine forms an oxide which has the composition by mass: I, 76.0%; O, 24.0%.

**(i)** Use this information to determine the empirical formula of this oxide of iodine.

empirical formula ..... [3]

**(ii)** The oxide of iodine in **(e)(i)** dissolves in water.

Predict and explain the effect of adding Universal Indicator to an aqueous solution of this oxide of iodine.

effect on Universal Indicator .....

explanation .....
[2]

[Total: 21]

**6** Aluminium is a very important metal.

Aluminium is extracted from its ore, bauxite, by electrolysis. Bauxite is an impure form of aluminium oxide, $Al_2O_3$.

**(a)** Describe how aluminium is extracted from **bauxite**. Include an ionic half-equation for the reaction at each electrode.

description .....

.....

.....

.....

.....

.....

.....

.....

ionic half-equation for the anode reaction .....

ionic half-equation for the cathode reaction.....

[5]

**(b)** Explain why the anodes have to be replaced regularly.

.....

..... [2]

**(c)** Give **two** uses of aluminium and give a reason why aluminium is suitable for each use.

use 1 .....

reason .....

use 2 .....

reason .....

[4]

[Total: 11]

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**Question 7 starts on the next page.**

**7** Proteins are a major constituent of food.

Proteins are polymers.

**(a)** What is a polymer?

.....

.....

..... [2]

**(b)** Proteins can be converted into amino acids.

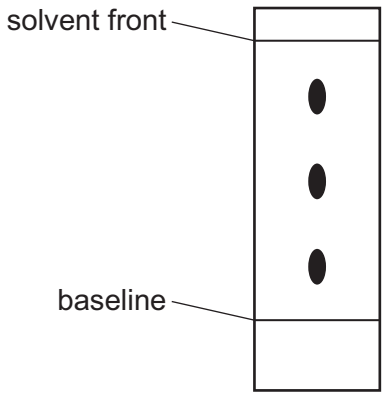
**(i)** Name the type of chemical reaction which occurs when proteins are converted into amino acids.

..... [1]

**(ii)** Suggest a condition needed to convert proteins into amino acids.

..... [1]

**(c)** A colourless mixture of amino acids was separated by chromatography.
Amino acid **X** has an $R_f$ value of 0.8.
The chromatogram of the mixture after treatment with a locating agent is shown.




**(i)** How is an $R_f$ value calculated?

$R_f$ =

[1]

**(ii)** On the diagram put a ring around the spot caused by amino acid **X**. [1]

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**(iii)** Describe how you would perform a chromatography experiment to produce the chromatogram shown in **(c)**. Assume you have been given the mixture of amino acids and a suitable locating agent. You are provided with common laboratory apparatus.

.....

.....

.....

.....

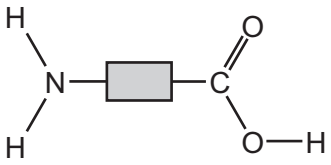
.....

..... [3]

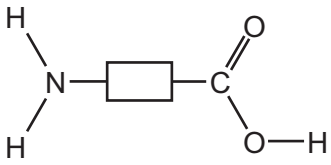
**(d)** When one molecule of an amino acid **A** combines with one molecule of another amino acid **B**, two different dipeptide molecules could be formed.

Draw the structures of the **two** different dipeptide molecules.
Show all of the atoms and all of the bonds in the linkages.

amino acid **A**




amino acid **B**




[3]

[Total: 12]

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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.).