Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 5 1 8 2 7 6 5 4 1 7 *

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]

(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]

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) → .....(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]

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 HC*l*(aq) needed to react with 3.48 g of MnO_2.

- moles of MnO_2 used

..... mol

- moles of HC*l* needed

..... mol

- volume of HC*l* 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]

(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]

(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]

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.

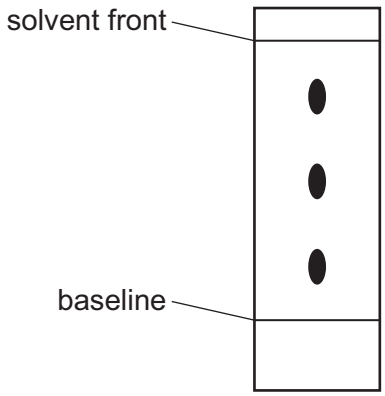
(i) Name the type of chemical reaction which occurs when proteins are converted into amino acids.

..... [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]

(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.

.....

.....

.....

.....

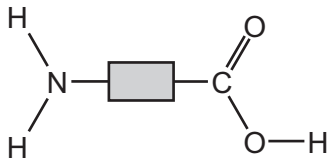
.....

..... [3]

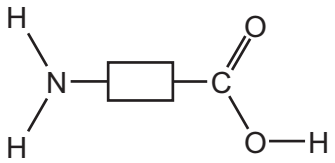
(d) When one molecule of an amino acid **A** combines with one molecule of another amino acid **B**, two different dipeptide molecules could be formed.

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.).

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