



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

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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.



2

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]

3

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

P³⁻ [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]

4

(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]

5

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.



[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.



Calculate the volume of $8.00 \text{ mol/dm}^3 \text{ HCl}(\text{aq})$ 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]

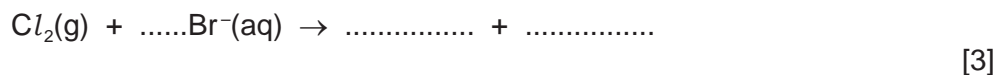
(b) A student bubbled chlorine gas into a test-tube containing aqueous potassium bromide.

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

from to
[2]

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

Include state symbols.



(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]

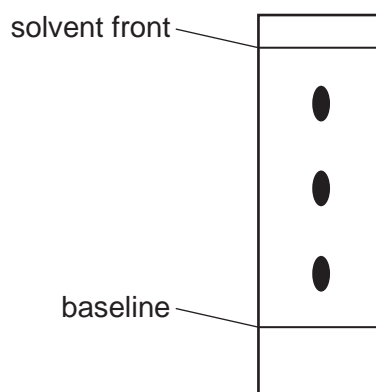
(ii) Suggest a condition needed to convert proteins into amino acids.

..... [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]

13

- (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]

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The Periodic Table of Elements

		Group							
I	II	III	IV	V	VI	VII	VIII		
1	2	3	4	5	6	7	8	9	10
H hydrogen 1	He helium 4	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20		
Key									
atomic number atomic symbol name relative atomic mass									
3	4	11	12	13	14	15	16	17	18
Li lithium 7	Be beryllium 9	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40		
19	20	21	22	23	24	25	26	27	28
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59
37	38	39	40	41	42	43	44	45	46
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106
55	56	57–71	72	73	74	75	76	77	78
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195
87	88	89–103	104	105	106	107	108	109	110
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —
81	82	83	84	85	86	87	88	89	90
Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —	Cn copernicium —	Nh nihonium —	Dl dubnium —	Fl flerovium —
67	68	69	70	71	72	73	74	75	76
Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175	La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —
99	100	101	102	103	104	105	106	107	108
Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —
66	67	68	69	70	71	72	73	74	75
Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175	La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144
98	99	100	101	102	103	104	105	106	107
Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238
65	66	67	68	69	70	71	72	73	74
Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175	La lanthanum 139	Ce cerium 140	Pr praseodymium 141
97	98	99	100	101	102	103	104	105	106
Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Ac actinium —	Th thorium 232	Pa protactinium 231

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).