



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

* 5 9 2 4 4 1 5 4 2 9 6 *



CHEMISTRY

0620/42

Paper 4 Theory (Extended)

May/June 2017

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 **14** printed pages and **2** blank pages.

1 (a) State the name of the process that is used to

0620/42/M/J/17

(i) separate oxygen from liquid air,

..... [1]

(ii) separate the individual dyes in ink,

..... [1]

(iii) produce ethanol from simple sugars,

..... [1]

(iv) obtain water from aqueous sodium chloride,

..... [1]

(v) separate the precipitate formed when aqueous silver nitrate is added to aqueous sodium chloride.

..... [1]

Q1 (b) State what is meant by the terms

0620/42/M/J/17

(i) *element*,

.....
..... [1]

(ii) *compound*,

.....
..... [1]

(iii) *ion*.

.....
..... [1]

[Total: 8]

- 2 Carbon and silicon are elements in Group IV of the Periodic Table. Both carbon and silicon exist as more than one isotope.

0620/42/M/J/17

- (a) Define the term *isotopes*.

.....
 [2]

- Q2 (b) Complete the following table which gives information about carbon atoms and silicon atoms.

0620/42/M/J/17

	carbon	silicon
proton number		
electronic structure		
nucleon number	12	28
number of neutrons in one atom		

[3]

- Q2 (c) Silicon has a giant structure which is similar to the structure of diamond.

0620/42/M/J/17

- (i) Name the type of bond which is present between silicon atoms in silicon.

..... [1]

- (ii) Suggest **two** physical properties of silicon.

Use your knowledge of structure and bonding to explain why silicon has these physical properties.

property 1

reason 1

property 2

reason 2

[4]

- Q2 (d) Samples of air taken from industrial areas are found to contain small amounts of carbon monoxide.

- (i) Explain how this carbon monoxide is formed.

.....
 [2]

- (ii) State why carbon monoxide should **not** be inhaled.

..... [1]

Q2 (e) Carbon dioxide, CO_2 , is a gas at room temperature and pressure, whereas silicon(IV) oxide, SiO_2 , is a solid.

(i) Name the type of structure which the following compounds have.

carbon dioxide [1]

silicon(IV) oxide [1]

Q2E (ii) Use your knowledge of structure and bonding to explain why carbon dioxide is a gas at room temperature and pressure, whereas silicon(IV) oxide is a solid.

.....
.....
.....
..... [3]

Q2 (f) Silicon(IV) oxide is an acidic oxide. When silicon(IV) oxide reacts with alkalis, the salts formed contain the ion SiO_3^{2-} .

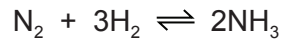
Write a chemical equation for the reaction between silicon(IV) oxide and aqueous sodium hydroxide.

..... [2]

[Total: 20]

3 This question is about nitrogen and some of its compounds.

- (a) Nitrogen in the air can be converted into ammonia by the Haber process. The chemical equation for the reaction is shown.



- (i) State the temperature and pressure used in the Haber process.

temperature

pressure

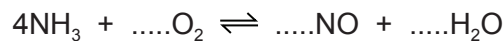
[2]

- (ii) Name the catalyst used in the Haber process.

..... [1]

Q3 (b) The ammonia produced in the Haber process can be oxidised to nitrogen(II) oxide at 900 °C. The reaction is exothermic.

- (i) Balance the chemical equation for this reaction.



[2]

- (ii) Suggest a reason, other than cost, why a temperature greater than 900 °C is **not** used.

..... [1]

- (iii) Suggest a reason why a temperature less than 900 °C is **not** used.

..... [1]

Q3 (c) Nitrogen(II) oxide can be reacted with oxygen and water to produce nitric acid as the only product.

Write a chemical equation for this reaction.

..... [2]

Q3 (d) Describe how you would prepare a pure dry sample of copper(II) nitrate crystals in the

laboratory using dilute nitric acid and solid copper(II) carbonate.

Include a series of key steps in your answer.

You should include a chemical equation for the reaction.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 15]

Question 4 starts on the next page.

4 Nickel, copper and zinc are three consecutive elements in the Periodic Table.

(a) Nickel and copper are transition elements.

0620/42/M/J/17

State **three** chemical properties of transition elements.

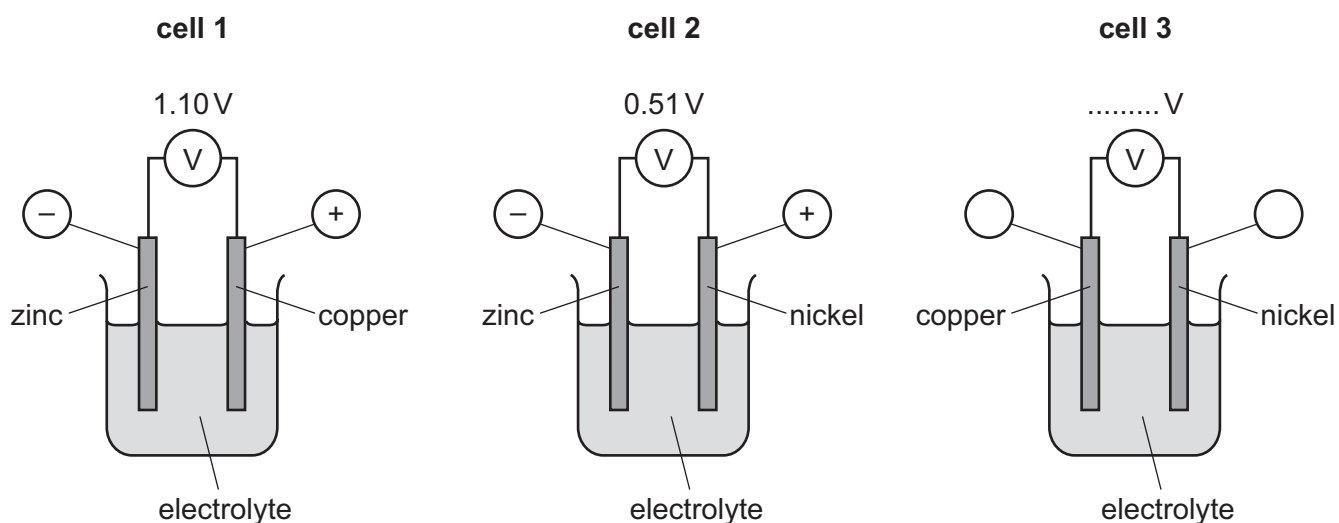
.....
.....
..... [3]

Q4 (b) Copper(II) oxide is a basic oxide but zinc oxide is an amphoteric oxide. Both oxides are insoluble in water.

You are provided with a mixture of solid copper(II) oxide and solid zinc oxide. Describe how you would obtain a sample of copper(II) oxide from this mixture.

.....
.....
.....
..... [3]

Q4 (c) Three cells are set up each using two metals.



(i) Write the ionic half-equation for the reaction occurring at the zinc electrode in **cell 1**.

..... [2]

(ii) Put the **three** metals, copper, nickel and zinc, in order of reactivity.

most reactive

↓

.....

least reactive

[1]

(iii) Complete the labelling in **cell 3** by writing the polarity (+/-) of each electrode in the circles and calculating the reading on the voltmeter. [2]

[Total: 11]

5 (a) The elements in Group VII are known as the halogens. Some halogens react with aqueous solutions of halides.

(i) Complete the table by adding a ✓ to indicate when a reaction occurs and a x to indicate when no reaction occurs.

0620/42/M/J/17

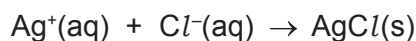
	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide
chlorine	x	✓	
bromine		x	
iodine			x

[3]

(ii) Write a chemical equation for the reaction between chlorine and aqueous potassium bromide.

..... [1]

Q5 (b) A sample of vanadium chloride was weighed and dissolved in water. An excess of aqueous silver nitrate, acidified with dilute nitric acid, was added. A precipitate of silver chloride was formed. The ionic equation for this reaction is shown.



0620/42/M/J/17

The mass of silver chloride formed was 2.87 g.

Q5B (i) State the colour of the precipitate of silver chloride.

0620/42/M/J/17

..... [1]

(ii) The relative formula mass of silver chloride, AgCl, is 143.5.

Calculate the number of moles in 2.87 g of AgCl.

moles of AgCl = mol [1]

(iii) Use your answer to (b)(ii) and the ionic equation to deduce the number of moles of chloride ions, Cl⁻, that produced 2.87 g of AgCl.

moles of Cl⁻ = mol [1]

(iv) The amount of vanadium chloride in the sample was 0.01 moles.

Use this and your answer to (b)(iii) to deduce the **whole number** ratio of moles of vanadium chloride : moles of chloride ions.
Deduce the formula of vanadium chloride.

moles of vanadium chloride : moles of chloride ions :

formula of vanadium chloride

[2]

Q5 (c) Astatine is at the bottom of Group VII. Use your knowledge of the properties of the halogens to

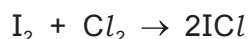
- (i) predict the physical state of astatine at room temperature and pressure,

..... [1]

- (ii) write a chemical equation for the reaction between sodium and astatine.

..... [2]

Q5 (d) Iodine reacts with chlorine. The chemical equation is shown.



Use the bond energies to answer the questions.

bond	bond energy in kJ/mol
I–I	151
Cl–Cl	242
I–Cl	208

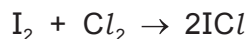
- (i) Calculate the total amount of energy required to break the bonds in 1 mole of I_2 and 1 mole of Cl_2 .

..... kJ [1]

- (ii) Calculate the total amount of energy given out when the bonds in 2 moles of ICl are formed.

..... kJ [1]

- (iii) Use your answers to (d)(i) and (d)(ii) to calculate the overall energy change for the reaction.



..... kJ/mol [1]

[Total: 15]

6 (a) An homologous series is a 'family' of organic compounds whose names have the same ending.

(i) Name the homologous series for which the names of the organic compounds end in *-ene* and *-oic acid*.

-ene [1]

-oic acid [1]

(ii) State **two** characteristics of an homologous series.

0620/42/M/J/17

.....

..... [2]

Q6 (b) Propan-1-ol is a member of the homologous series of alcohols. It reacts in the same way as ethanol with acidified potassium manganate(VII) and with carboxylic acids.

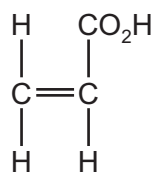
Name the **type** of compound that is formed when propan-1-ol is heated with

acidified potassium manganate(VII),

ethanoic acid and a suitable catalyst.

0620/42/M/J/17 [2]

Q6 (c) The structure of prop-2-enoic (acrylic) acid is shown.



- (i) What would you see if prop-2-enoic acid were added to
 aqueous bromine,
 a solution of sodium carbonate.

[2]

- (ii) Prop-2-enoic acid can be polymerised to form poly(acrylic acid).
 Suggest the type of polymerisation that occurs and draw **one** repeat unit of the polymer.
 type of polymerisation
 repeat unit

[3]

[Total: 11]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

The Periodic Table of Elements

		Group																																			
I	II	III	IV	V	VI	VII	VIII																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																				
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18	K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36										
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 90	Nb niobium 91	Mo molybdenum 92	Tc technetium 93	Ru ruthenium 94	Rh rhodium 95	Pd palladium 96	Ag silver 97	Cd cadmium 98	In indium 99	Sn tin 100	Sb antimony 101	Te tellurium 102	I iodine 103	Xe xenon 104	Cs caesium 133	Ba barium 137	La lanthanum 139	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium 210	At astatine 210	Rn radon 222		
87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Fr francium —	Ra radium —	Ac actinium —	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Uu unbinilium —	Uub unbinilium —	Uuc unbinilium —	Uud unbinilium —	Uue unbinilium —	Uuq unbinilium —	Uur unbinilium —	Uus unbinilium —	Uut unbinilium —	Uuq unbinilium —	Uur unbinilium —	Uus unbinilium —	Uut unbinilium —	Uuq unbinilium —	Uur unbinilium —	Uus unbinilium —	Uut unbinilium —	Uuq unbinilium —	Uur unbinilium —	Uus unbinilium —	Uut unbinilium —	Uuq unbinilium —	Uur unbinilium —	

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids

actinoids

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —

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