

Cambridge IGCSE[™](9–1)

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

CHEMISTRY 0971/42

Paper 4 Theory (Extended)

May/June 2022

1 hour 15 minutes

You must answer on the question paper.

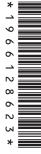
No additional materials are needed.

INSTRUCTIONS

- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do not use an erasable pen or correction fluid.
- Do not write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.



1 The symbols of the elements of Period 3 of the Periodic Table are shown.

Na Mg A <i>l</i> Si P S C <i>l</i> A
--

Answer the following questions about these elements. Each symbol may be used once, more than once or not at all.

Write the symbol of the element which:

(a)	forms a stable ion with a 2+ charge	[1]
(b)	is the least reactive in the period	[1]
(c)	is used in water treatment	[1]
(d)	forms an oxide which is the main impurity in iron ore	[1]
(e)	is an important component of fertilisers	[1]
(f)	is stored under oil	[1]
(g)	is used in food containers	[1]
(h)	is found in the ore zinc blende.	[1]
	[Total	: 8]

Question 2 starts on the next page.

2

Calciun	n hydroxide, Ca(OH) ₂ , is slightly soluble in water.				
(a) Ca	Calcium hydroxide can be made by the reaction of calcium with water.				
(i)	Write the chemical equation for this reaction.				
		[2]			
(ii)	Name another substance that reacts with water to form calcium hydroxide.				
		[1]			
	nen calcium hydroxide dissolves in water, it dissociates into ions and forms a weakly alka ution.	line			
(i)	Suggest the pH of aqueous calcium hydroxide.				
		[1]			
(ii)	Give the formula of the ion responsible for making the solution alkaline.				
		[1]			
(c) Lim	newater is a saturated solution of calcium hydroxide, $Ca(OH)_2(aq)$.				
(i)	Name the gas limewater is used to test for.				
		[1]			
(ii)	Suggest what is meant by the term saturated solution.				
		[2]			
(iii)	Describe how you would make a sample of limewater starting with solid calcium hydroxi	de.			
		[2]			
(iv)	Describe how you would test for the presence of calcium ions in a sample of limewate	r.			
	test				
	observations				
		 [3]			
		101			

(d)		$5.0\mathrm{cm^3}$ sample of limewater is placed in a conical flask. The concentration of $\mathrm{Ca(OH)_2}$ in the ewater is determined by titration with dilute hydrochloric acid, $\mathrm{HC}\mathit{l}$.
	(i)	Name the item of apparatus used to measure the volume of acid in this titration.
	(ii)	State the type of reaction which takes place.
		[1]
((iii)	As well as limewater and dilute hydrochloric acid, state what other type of substance must be added to the conical flask.
		[1]
(iv)	The equation for the reaction is shown.
		$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$
		$20.0\mathrm{cm^3}$ of $0.0500\mathrm{mol/dm^3}$ HC l reacts with the $25.0\mathrm{cm^3}$ of Ca(OH) ₂ .
		Determine the concentration of $Ca(OH)_2$ in g/dm^3 . Use the following steps.
		• Calculate the number of moles in 20.0 cm³ of 0.0500 mol/dm³ HC1.
		• Determine the number of moles of Ca(OH) ₂ in 25.0 cm ³ of the limewater.
		mol
		• Calculate the concentration of Ca(OH) ₂ in mol/dm ³ .
		 Determine the concentration of Ca(OH)₂ in g/dm³.
		g/dm³ [5]
		[Total: 21]

Transition elements are found in the middle block of the Periodic Table.

3

(a) Ch	hromium has several isotopes. Manganese has only one isotope.						
(a) (i)							
(1)							
(11)		[2]					
(ii)							
(iii)	Complete the table to show the number of protons, neutrons and electrons	n a ⁵² Cr ³⁺ ion.					
	protons neutrons electrons						
		[3]					
(b) Or	ne chemical property of transition elements is that they form coloured compou	nds					
(i)							
(1)	hydrated copper(II) sulfate						
	hydrated copper(II) surface hydrated cobalt(II) chloride						
	Trydrated cobalt(11) chloride	[2]					
(ii)	State two other chemical properties of transition elements.						
	1						
	2						
		[2]					
	ransition elements and Group I elements are metals. They share many physicluding the ability to: conduct electricity be hammered into shape.	cal properties					
(i)	Explain why transition elements and Group I elements conduct electricity.						
		[1]					
(ii)		•					
		[1]					

(d)	Transition elements and Group I elements differ in other physical properties. Transition elements are harder and stronger than Group I elements.
	Describe two other ways in which the physical properties of transition elements differ from Group I elements.
	1
	2[2]
	[Total: 14]

(a)	Suggest the appearance of hubiline.	
		۲1

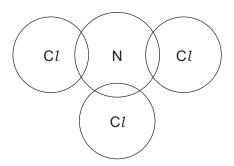
(b) Fluorine reacts with sulfur to form a compound which has 25.2% sulfur by mass and a relative molecular mass of 254.

Determine the molecular formula of this compound.

molecular formula =[3]

(c) Nitrogen trichloride, NCl_3 , is a covalent compound.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NCl_3 . Show outer electrons only.



[3]

(d) Lithium chloride, LiC*l*, is an ionic compound.

Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in lithium chloride.

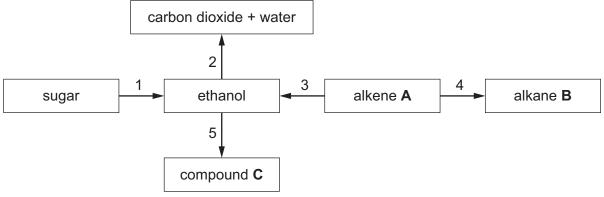
] []
Li		Ci	

[3]

(e)	Explain, in terms of attractive forces between particles, why LiC l is a solid at room temperature but NC l_3 is a liquid with a relatively low boiling point.						
	[3]						

[Total: 13]

5 The reaction scheme shows five organic reactions, numbered 1 to 5.



			compound C	
(a)	Nar	me reaction 1.		
				[1]
(b)	Nar	me reaction 2 and	write the chemica	al equation for this reaction.
	nan	ne		
	equ	ation		[3]
				[0]
(c)	Rea	action 3 forms eth	anol from alkene	A .
	(i)	Identify alkene A	١.	
				[1]
	(ii)	State the type of	reaction that occu	urs during reaction 3.
				[1]
	(iii)	State the reagen	its and conditions	needed for reaction 3.
				[2]
(d)	Alk	ene A is converte	d into alkane B in	reaction 4.
	(i)	State the reagen	nt and conditions fo	or reaction 4.
				[3]

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(ii) State the general formula of alkanes.

(e)	Eth	anol is oxidised in reaction 5 by heating it with dilute sulfuric acid and one other reagen	t.
	(i)	Identify the other reagent in reaction 5.	
			[1]
	(ii)	Name the homologous series compound C belongs to.	
			[1]
((iii)	Draw the structure of compound C .	
		Show all of the atoms and all of the bonds.	

[1]

[Total: 15]

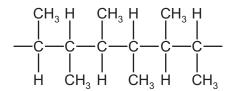
- **6** This question is about polymers.
 - (a) Polymer X is a condensation polymer.

Part of the structure of polymer **X** is shown.



(i	i) How many molecules of water are produced when this part of polymer X is formed from monomers?	ı its
		[1]
(ii	i) Complete the structures of the two monomers used to make polymer X .	
	Show all of the atoms and all of the bonds in the functional groups.	
	and	
		[2]
(iii	i) What type of condensation polymer is X?	
		[1]
(b) F	Part of polymer Y has the structure shown.	
S	State the number of different types of monomer needed to make polymer Y .	
		[4]

(c) Part of polymer **Z** has the structure shown.



(i) Draw and name the structure of the monomer which forms polymer **Z**.

Show all of the atoms and all of the bonds.

	name	[3]
(ii)	Name the chemical process used to make the monomer that forms polymer Z .	اما
()		[1]
	רן	Гotal: 9]

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The Periodic Table of Elements

	₹	E 5	helium 4	10	Ne	neon 20	18	Ā	argon 40	36	궃	krypton 84	25	Xe	xenon 131	98	R	radon			
	=			6	ட	fluorine 19	17	Cl	chlorine 35.5	35	ğ	bromine 80	53	Н	iodine 127	85	Αŧ	astatine -			
				8	0	oxygen 16	16	S	sulfur 32	34	Se	selenium 79	52	<u>a</u>	tellurium 128	84	Ъ	polonium —	116	^	livermorium -
	>			7	z	nitrogen 14	15	۵	phosphorus 31	33	As	arsenic 75	51	Sb	antimony 122	83	<u>B</u>	bismuth 209			
	≥			9	O	carbon 12	14	S	silicon 28	32	Ge	germanium 73	20	Sn	tin 119	82	Pb	lead 207	114	Εl	flerovium
	=			5	В	boron 11	13	Ρl	aluminium 27	31	Ga	gallium 70	49	In	indium 115	81	11	thallium 204			
										30	Zu	zinc 65	48	ပ်	cadmium 112	80	Ρ̈́	mercury 201	112	ű	copernicium
										29	Cn	copper 64	47	Ag	silver 108	62	Au	gold 197	111	Rg	roentgenium -
Group										28	Z	nickel 59	46	Pd	palladium 106	78	₽	platinum 195	110	Ds	darmstadtium -
Gre				-						27	ဝိ	cobalt 59	45	몬	rhodium 103	77	'n	iridium 192	109	¥	meitnerium -
		- エ	hydrogen 1							26	Fe	iron 56	44	Ru	ruthenium 101	9/	Os	osmium 190	108	Hs	hassium -
							_			25	Mn	manganese 55	43	ပ	technetium -	75	Re	rhenium 186	107	Bh	bohrium –
					pol	ass				24	ပ်	chromium 52	42	Mo	molybdenum 96	74	≥	tungsten 184	106	Sg	seaborgium -
			Key	atomic number	atomic symbo	name relative atomic mass				23	>	vanadium 51	41	Q N	niobium 93	73	Б	tantalum 181	105	Op	dubnium -
					atc	- re				22	j	titanium 48	40	Zr	zirconium 91	72	Ξ	hafnium 178	104	짪	rutherfordium -
										21	Sc	scandium 45	39	>	yftrium 89	57-71	lanthanoids		89–103	actinoids	
	=			4	Be	beryllium 9	12	Mg	magnesium 24	20	Ca	calcium 40	38	ഗ്	strontium 88	56	Ва	barium 137	88	Ra	radium
	_			8	=	lithium 7	1	Na	sodium 23	19	\prec	potassium 39	37	&	rubidium 85	55	Cs	caesium 133	87	ቷ	francium -

71	lutetium 175	103	ב	lawrencium	ı
0 X	ytterbium 173	102	%	nobelium	ı
69 L	thulium 169	101	Md	mendelevium	I
88 7	erbium 167	100	Fm	fermium	1
⁶⁷	holmium 165	66	Es	einsteinium	I
99	dysprosium 163	86	ŭ	californium	ı
65 T	terbium 159	97	BK	berkelium	1
₆₄	gadolinium 157	96	Cm	curium	ı
83 <u>T</u>	europium 152	92	Am	americium	ı
62 Sm	samarium 150	94	Pu	plutonium	ı
61 D	promethium	93	δ	neptunium	ı
09 Z	neodymium 144	92	\supset	uranium	238
59 7	praseodymium 141	91	Ра	protactinium	231
₈₈ م	cerium 140	06	Ч	thorium	232
57	lanthanum 139	68	Ac	actinium	I

lanthanoids

actinoids

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.).

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