



# Cambridge IGCSE<sup>™</sup>(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	Αl	Si	Р	S	Cl	Ar
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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.

Calcium	hydroxide, Ca(OH) <sub>2</sub> , is slightly soluble in water.
<b>(a)</b> Cal	cium 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]
	en calcium hydroxide dissolves in water, it dissociates into ions and forms a weakly alkaline ution.
(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)	
(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 hydroxide.
	[2]
(iv)	Describe how you would test for the presence of calcium ions in a sample of limewater.
(14)	
	test
	observations
	[3]
	[ي]

		$5.0\mathrm{cm^3}$ 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.
(i	ii)	As well as limewater and dilute hydrochloric acid, state what other type of substance must be added to the conical flask.
(i	v)	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) <sub>2</sub> .
		Determine the concentration of Ca(OH) <sub>2</sub> in g/dm <sup>3</sup> . 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) <sub>2</sub> in 25.0 cm <sup>3</sup> of the limewater.
		• Calculate the concentration of Ca(OH) <sub>2</sub> in mol/dm <sup>3</sup> .
		<ul> <li>Determine the concentration of Ca(OH)<sub>2</sub> in g/dm<sup>3</sup>.</li> </ul>
		g/dm³ [5]
		[Total: 21]

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

3

(a) Ch	romium has several isotope	es. Manganese has only	y one isotope.	
(i)	State what is meant by the	e term isotopes.		
				[2]
(ii)	State the nucleon number	of manganese.		
				[1]
(iii)	Complete the table to sho	w the number of proton	s, neutrons and electr	rons in a $^{52}_{24}$ Cr <sup>3+</sup> ion.
	protons	neutrons	electrons	
	protono	Hodiono	Clockerio	
				[3]
<b>(b)</b> On	e chemical property of trans	sition elements is that the	hey form coloured con	npounds.
(i)	Give the colours of the fol	lowing hydrated salts.		
	<ul><li>hydrated copper(II) s</li></ul>	ulfate		
	<ul> <li>hydrated cobalt(II) ch</li> </ul>	loride		[2]
(ii)	State two <b>other</b> chemical	properties of transition	elements.	
( )	1			
	2			
				[2]
	insition elements and Grou luding the ability to: conduct electricity be hammered into shape.	p I elements are metal	s. They share many բ	physical properties
(i)	Explain why transition ele	ments and Group I eler	ments conduct electric	ity.
				[1]
(ii)	State the property that des	scribes a material which	h can be hammered ir	nto shape.
				[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 <b>other</b> ways in which the physical properties of transition elements differ from Group I elements.
	1
	2
	[2]
	[Total: 14]

4 Fluorine and chlorine are haloge
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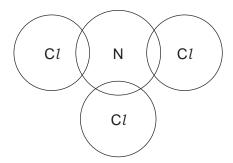
(a)	Suggest the appearance of fluorine.	
		Г1

**(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.

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

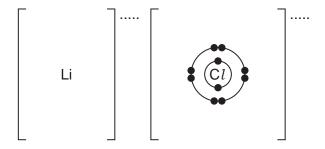
Complete the dot-and-cross diagram to show the electron arrangement in a molecule of  $NCl_3$ . Show outer electrons only.



[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.

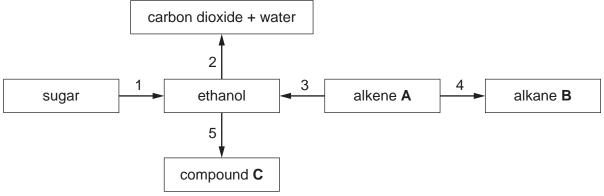


[3]

(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	ne reaction 1.	
		[	1]
(b)	Nar	ne reaction 2 and write the chemical equation for this reaction.	
	nan	ne	
	equ	ation[	 [3]
(c)	Por	etion 3 forms othernal from alkana A	
(6)	Kea	ction 3 forms ethanol from alkene A.	
	(i)	Identify alkene A.	
		[	1]
	(ii)	State the type of reaction that occurs during reaction 3.	
		[	1]
	(iii)	State the reagents and conditions needed for reaction 3.	
		[	2]
(d)	Alke	ene A is converted into alkane B in reaction 4.	
	(i)	State the reagent and conditions for 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 reagent.		
	(i)	Identify the other reagent in reaction 5.		
			[1]	
	(ii)	Name the homologous series compound <b>C</b> belongs to.		
			[1]	
(	(iii)	Draw the structure of compound <b>C</b> .		
		Show all of the atoms and all of the bonds.		

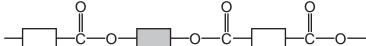
[1]

[Total: 15]

6	This	question	is	about	pol	ymers

(a) Polymer X is a condensation polymer
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Part of the structure of polymer **X** is shown.



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

(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 <b>Z</b> .	
		[1]
	Π	Total: 9]

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The Periodic Table of Elements

	<b>  </b>	2 He	helium 4	10	Se	neon 20	18	Ar	argon 40	36	궃	krypton 84	54	Xe	xenon 131	98	Rn	radon			
	<b>=</b>			6	ட	fluorine 19	17	Cl	chlorine 35.5	35	南	bromine 80	53	П	iodine 127	85	At	astatine -			
	5			8	0	oxygen 16	16	ഗ	sulfur 32	34	Se	selenium 79	52	<u>e</u>	tellurium 128	84	Ъ	nolonium	116		/ermorium -
	>								shosphorus 31												=
	2								silicon pt										114	Εl	erovium
									lluminium 27												=
									alt									mercury th	112	ت ت	copernicium —
																		gold m			
													$\vdash$					platinum 195			Ē
Group																					
				]														iridium 192			Ε
		- I	hydroger 1							26	Fe	iron 56	44	Ru	rutheniun 101	92	Os	osmium 190	108	H	hassium
							1			25	Mn	manganese 55	43	ည	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	g	niobium 93	73	ā	tantalum 181	105	<u>6</u>	dubnium
					ato	rela				22	ı=	titanium 48	40	Zr	zirconium 91	72	茔	hafnium 178	104	፟ጟ	rutherfordium -
							•			21	Sc	scandium 45	39	>	yttrium 89	57-71	lanthanoids		89–103	actinoids	
	=			4	Be	beryllium 9	12	Mg	magnesium 24	20	Ca	calcium 40	38	ട്	strontium 88	56	Ва	barium 137	88	Ra	radium
	_			8	:=	lithium 7	1	Na	sodium 23	19	¥	potassium 39	37	Rb	rubidium 85	55	S	caesium 133	87	ъ.	francium —

		_			
r Lu	lutetium 175	103	۲	lawrencium	I
° 4 Vb	ytterbium 173	102	%	nobelium	ı
ee Tm	thulium 169	101	Md	mendelevium	ı
88 Fr	erbium 167	100	Fm	ferminm	I
67 H0	holmium 165	66	Es	einsteinium	ı
° ^	dysprosium 163	86	ŭ	californium	1
65 <b>Tb</b>	terbium 159	97	Ř	perkelium	ı
<sup>2</sup> Q	gadolinium 157	96	Cm	curium	ı
в Еп	europium 152	92	Am	americium	ı
Sm	samarium 150	94	Pu	plutonium	ı
Pm	promethium —	93	dN	neptunium	ı
。 9 <b>P</b>	neodymium 144	92	$\supset$	uranium	238
59 Pr	praseodymium 141	91	Ра	protactinium	231
C 28	cerium 140	06	H	thorium	232
57 <b>La</b>	lanthanum 139	88	Ac	actinium	ı

lanthanoids

actinoids

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