



## **Cambridge IGCSE**<sup>™</sup>

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

**CHEMISTRY** 0620/32

Paper 3 Theory (Core)

February/March 2023

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.

[Total: 6]

1 7 that of dynhadia diffa formulae is affect	1	A list of	symbols	and formulae	is	show
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 $\begin{array}{c} Br_2 \\ CH_4 \\ C_2H_4 \\ C\ell^- \\ CO_2 \\ Cr^{3+} \\ Cu^{2+} \\ H_2 \\ K^+ \\ N_2 \\ N^{3-} \\ O_2 \\ SO_4^{2-} \end{array}$ 

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

State which symbol or formula represents:

(a)	a molecule containing only five atoms	
		[1]
(b)	a diatomic molecule of an element in Group VII of the Periodic Table	
		[1]
(c)	an ion formed when an atom gains one electron	
		[1]
(d)	an ion which forms a green precipitate when a few drops of aqueous sodium hydroxide a added to it	are
		[1]
(e)	a compound produced by the thermal decomposition of calcium carbonate	
		[1]
(f)	a product of photosynthesis.	
		[1]

2 (a) A sample of soil is shaken with distilled water.

Draw a diagram to show the filtration apparatus used to separate the soil from the solution obtained by shaking the soil with distilled water.

On your diagram, label:

- the filtrate
- the residue.

[3]

**(b)** Table 2.1 shows the masses of some of the ions in 1000 cm<sup>3</sup> of the solution obtained by filtering a sample of soil with distilled water.

Table 2.1

name of ion	formula of ion	mass of ion in 1000 cm <sup>3</sup> of solution/mg
ammonium	NH <sub>4</sub> <sup>+</sup>	25.0
calcium	Ca <sup>2+</sup>	0.4
chloride	C1 <sup>-</sup>	0.5
iron(II)	Fe <sup>2+</sup>	27.0
magnesium	Mg <sup>2+</sup>	4.0
nitrate	NO <sub>3</sub> -	23.0
phosphate	PO <sub>4</sub> <sup>3-</sup>	15.5
potassium	K <sup>+</sup>	29.0
sodium	Na⁺	2.0
	SO <sub>4</sub> <sup>2-</sup>	6.0

Answer these questions using the information in Table 2.1.

(i)	Name the negative ion that has the lowest concentration.	
		[1

	(ii)	State	e the r	name of	the SO	) <sub>4</sub> <sup>2–</sup> ion.					[1]
(	iii)	Calc	ulate	the mas	s of pho	osphate id	ons in 200 c		he solution.		[,]
(c)	Cor	the e	electro	2.1 to shonic conf	figuratio	on of a so	dium ion		mass =	mg	[1]
	•	ine c	onar ye	e on the	1011.		Na				
						ı	Fig. 2.1				[2]
(d)	Wat	ter fro	m na	tural sou	ırces co	ontains di	ssolved gas	ses.			
	Cho	ose f	rom tl	ne list th	e gas w	vhich is e	ssential for	aquatio	c life.		
	Dra	w a c	ircle a	round y	our cho	sen ansv	ver.				
				argon	h	ydrogen	nitro	gen	oxygen		[1]
(e)	Poll	uted	water	may coi	ntain se	ewage or	nitrates.				
	Stat	te <b>on</b>	<b>e</b> harr	nful effe	ct of ea	ch of the	se water po	llutants	5.		
	sew	/age									
	nitra	ates .									 [2]
										[Total:	

- 3 This question is about compounds of nitrogen.
  - (a) Complete the dot-and-cross diagram in Fig. 3.1 of a molecule of ammonia.

Show outer shell electrons only.

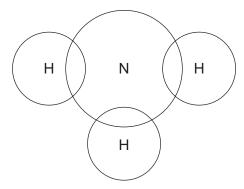


Fig. 3.1

[2]

- **(b)** Oxides of nitrogen are air pollutants.
  - (i) State **one** source of oxides of nitrogen in the air.

.....[1]

(ii) State **one** adverse effect of oxides of nitrogen.

......[1]

**(c)** State whether nitrogen dioxide is an acidic or basic oxide.

Give a reason for your answer.

......[1]

[Total: 5]

[1]

- 4 This question is about metals and compounds of metals.
  - (a) Table 4.1 shows some properties of five metals, A, B, C, D and E.

Table 4.1

metal	density in g/cm <sup>3</sup>	melting point in °C	colour of metal chloride
Α	5.90	30	white
В	5.96	1890	green
С	11.34	328	white
D	8.90	1455	yellow
E	1.53	39	white

sodium chloride

(c) Magnesium chloride is produced when magnesium burns in chlorine.

$$Mg + Cl_2 \rightarrow MgCl_2$$

Fig. 4.1 shows an incomplete reaction pathway diagram for this reaction.

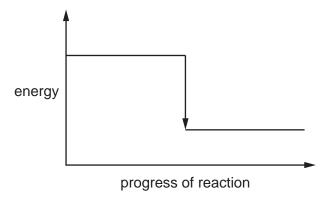


Fig. 4.1

- (i) Complete Fig. 4.1 by writing these formulae on the diagram:
  - Mg +  $Cl_2$
  - $\bullet \quad \mathsf{MgC} \mathit{l}_{2}.$

[1]

(ii) Explain how Fig. 4.1 shows that the reaction is exothermic.

	[1]

(d) Table 4.2 shows the reactions of four different metals with steam.

Table 4.2

metal	reaction with steam
iron	reacts slowly
magnesium	reacts very rapidly
nickel	reacts very slowly
niobium	does not react

Put the four metals in order of their reactivity. Put the least reactive metal first.

least reactive —		-	most reactive

[2]

(e) A compound of nickel has the molecular formula  $NiP_4F_{12}$ .

Complete Table 4.3 to calculate the relative molecular mass of  $NiP_4F_{12}$ .

Table 4.3

atom	number of atoms	relative atomic mass	
fluorine	12	19	12 × 19 = 228
nickel		59	
phosphorus		31	

relative molecular mass = ..... [2]

[Total: 10]

5

Potass	ium iodide is an ionic compo	und.		
(a) Sta	ate <b>two</b> properties of an ionic	compound.		
1.				
2.				
				[2]
<b>(b)</b> Mo	olten potassium iodide is elec	trolysed using graphite ele	ectrodes.	
(i)	Name the products formed			
(-)	positive electrode			
	negative electrode			
	negative electrode			[2]
(ii)	State the name of the posit	ive electrode in an electro	lysis experiment.	
				[1]
( <b>c</b> ) De	duce the number of protons	and neutrons in the iodide	ion shown.	
		$^{127}_{53}\mathrm{I}^{-}$		
nu	mber of protons			
nu	mber of neutrons			
				[2]
<b>(d)</b> Ac	ueous chlorine reacts with a	queous potassium iodide.		
(i)	Complete the symbol equa	tion for this reaction.		
	$Cl_2$	+ 2KI → +KC	1	[2]
(ii)	Choose from the list the na	me of this type of reaction		
	Draw a circle around your	chosen answer.		
	addition combus	tion displacement	neutralisation	[1]
(iii)	State the colour of chlorine	gas at room temperature	and pressure.	
. ,			•	[1]
				[Total: 11]
				[10(0), 11]

**6 (a)** Fig. 6.1 shows the displayed formula of a molecule of crotyl alcohol.

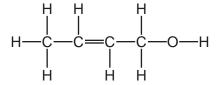


Fig. 6.1

	(i)	On Fig. 6.1 draw a circle around the alcohol functional group. [1]
	(ii)	Describe the feature of crotyl alcohol that shows it is an unsaturated compound.
		[1]
(	iii)	Deduce the molecular formula of crotyl alcohol.
		[1]
(	iv)	Crotyl alcohol is soluble in water.
		The boiling point of crotyl alcohol is 121 °C. The boiling point of water is 100 °C.
		Suggest how fractional distillation can be used to separate a mixture of crotyl alcohol and water.
		[2]
(b)	Eth	anol is also an alcohol.
	Des	cribe <b>two</b> conditions for the manufacture of ethanol by the fermentation of aqueous glucose.
	1	
	2	[2]
(c)	Eth	anol can be converted to ethene.
	Cho	ose from the list the general formula for the homologous series to which ethene belongs.
	Dra	v a circle around your chosen answer.
		$C_nH_n$ $C_nH_{2n}$ $C_nH_{2n+2}$ $C_{2n}H_n$ [1]

(d)	Eth	ene can be converted to ethane.	
. ,	(i)	Ethane is an alkane.	
		Name the type of bonding in alkanes.	
			[1]
	(ii)	Draw the displayed formula of a molecule of ethane.	
			[1]
(	(iii)	Complete this sentence.	
		Alkanes are unreactive except in terms of combustion and substitution by	
			[1]
(	(iv)	Complete the symbol equation for the complete combustion of methane.	
		$CH_4 + \dots O_2 \rightarrow \dots + 2H_2O$	[2]
		[Total:	13]

7	This qu	estion is about iron.
	(a) Iror	n is extracted from iron ore in a blast furnace.
	(i)	Name the main ore of iron.
		[1]
	(ii)	The main ore of iron contains iron(III) oxide.
		Describe the extraction of iron from iron ore in the blast furnace.
		In your answer, describe:
		the production of carbon monoxide
		the role of carbon monoxide
		the role of calcium carbonate, added to the blast furnace.
	/:::\	[4]
	(iii)	Iron collects at the base of the blast furnace as a liquid.
		Describe the arrangement and motion of the particles in a liquid.
		arrangement
		motion
		[2]

(b)	The	equation for the reaction of iron with steam is shown.
		$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
	Des	scribe how this equation shows that iron is oxidised.
		[1]
(c)	Rus	et is hydrated iron(III) oxide.
	(i)	Define the term hydrated.
		[1]
	(ii)	Name the <b>two</b> substances needed for iron to rust.
		and [2]
(d)	Cry	stals of iron(II) chloride can be prepared by adding excess iron to dilute hydrochloric acid.
	(i)	Suggest how the unreacted iron is removed from the reaction mixture.
		[1]
	(ii)	Describe how dry crystals of $iron(II)$ chloride are made from a dilute solution of $iron(II)$ chloride.
		[2]
		[Total: 14]

- **8** A student investigates the reaction of iron powder with dilute hydrochloric acid at 20 °C. The hydrochloric acid is in excess.
  - (a) Fig. 8.1 shows the volume of hydrogen gas released as the reaction proceeds.

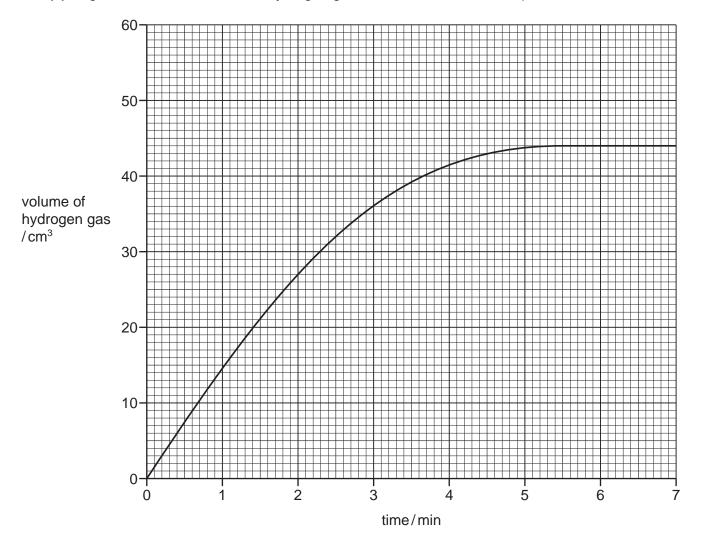


Fig. 8.1

(i) Deduce the volume of hydrogen gas released after 2 minutes.

volume of hydrogen gas = ...... cm<sup>3</sup> [1]

(ii) The student repeats the experiment using dilute hydrochloric acid of a higher concentration.

All other conditions stay the same.

Draw a line on the grid in Fig. 8.1 to predict how the volume of hydrogen gas changes when dilute hydrochloric acid of a higher concentration is used. [2]

(b) (i)	The student	t repeat	s the exp	periment	with	large pie	eces of i	ron.		
	All other co	nditions	stay the	same.						
	Describe ho	w the ra	ate of rea	action dif	fers \	when lar	ge piece	es of in	on are used.	
										[1]
(ii)	The student	repeat	s the exp	periment	with	iron pov	vder at a	tempe	erature of 15°C.	
	All other co	nditions	stay the	same.						
	Describe ho	w the ra	ate of rea	action dif	fers \	when a t	tempera	ture of	15°C is used.	
										[1]
(a) 11,4	مند مامام سام	ما مامم س	o o o to with	ممريده ما		د ما د مدر داد د	د ما بری در اما م			
	drochloric aci			-		_	/aroxiae	•		
(i)	Complete th	ne wora	equation	1 for this	reac	ion.		$\neg$		
hy	drochloric acid	+	sodiu hydrox	ım	$\rightarrow$			+		
	aciu		Tiyuto	Ride						
										[2]
(ii)	Write the fo	rmula o	f the ion	present i	in all	acids.				
										[1]
(iii)	Choose from	n the lis	t a poss	ible pH v	alue	of aque	ous sodi	um hy	droxide.	
	Draw a circ	e aroun	d your c	hosen ar	nswe	r.				
		рН	2	pH 4		pH 7	рН	13		[1]
(iv)	State the co	olour of	methyl o	range in	aque	ous soc	lium hyc	roxide		
										[1]
									[Tota	al: 10]

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The Periodic Table of Elements

Clarity and mission   Company   Co																							_	$\neg$
Care			$\equiv$	F F	helium 4	10	Se	neon 20	18	Ar	argon 40	36	첫	krypton 84	54	Xe	xenon 131	98	R	radon	118	Og	oganessor	I
Tright   Carton   C						6	Щ	fluorine 19	17	Cl	chlorine 35.5	35	ğ	bromine 80	53	П	iodine 127	85	Αt	astatine -	117	<u>N</u>	tennessine	ı
Time Tention Contains   Time			5			8	0	oxygen 16	16	ഗ	sulfur 32	34	Se	selenium 79	52	<u>e</u>	tellurium 128	84	Ъ	polonium	116	^	livermorium	ı
Tright Plant of the first continue and the following stands of the first continue and the			>			7	z	nitrogen 14	15	۵	phosphorus 31	33	As	arsenic 75	51	Sp	antimony 122	83	<u>B</u>	bismuth 209	115	Mc	moscovium	ı
The Periodic Patrice of Carlotte   The Periodic Patrice   The Periodic Patri			2			9	ပ	carbon 12	14	: <u>S</u>	silicon 28	32	Ge	germanium 73	20	Sn	tin 119	82	Pb	lead 207	114	ŀΙ	flerovium	ı
1			=			2	В	boron 11	13	Αl	aluminium 27	31	Ga	gallium 70	49	In	indium 115	81	11	thallium 204	113	R	nihonium	1
Tries   Table   Tabl												30	Zu	zinc 65	48	S	cadmium 112	80	Hg	mercury 201	112	S	copernicium	ı
Key   atomic number   atomic number   atomic symbol   atomic symbol   atomic symbol   atomic mass   Sc   Ti   V   Cr   Mn   Atomic   Scandium   attendame   Atomic   Atomic	ments											59	Cn	copper 64	47	Ag	silver 108	62	Au	gold 197	111	Rg	roentgenium	ı
Key   atomic number   atomic number   atomic symbol   atomic symbol   atomic symbol   atomic mass   Sc   Ti   V   Cr   Mn   Atomic   Scandium   attendame   Atomic   Atomic	or Ere	dn										28	Z	nickel 59	46	Pd	palladium 106	78	Ŧ	platinum 195	110	Ds	darmstadtium	ı
Key   atomic number   atomic number   atomic symbol   atomic symbol   atomic symbol   atomic mass   Sc   Ti   V   Cr   Mn   Atomic   Scandium   attendame   Atomic   Atomic	logic lar	Gro										27	ဝိ	cobalt 59	45	Rh	rhodium 103	77	'n	iridium 192	109	¥	meitnerium	ı
Charles   Char	lue Fer			- I	hydrogen 1							26	Fe	iron 56	44	Ru	ruthenium 101	92	SO	osmium 190	108	Hs	hassium	ı
Key						J						25	Mn	manganese 55	43	ည	technetium -	75	Re	rhenium 186	107	Bh	pohrium	ı
21 SC Ti Scandium 45 48 48 40 Yrium 39 91 57-71 72 Ianthanoids Highling 178 89 178 89 178 89-103 104 actinoids Rf rutherford							loc	SS				24	ပ်	chromium 52	42	Mo	molybdenum 96	74	>	tungsten 184	106	Sg	seaborgium	ı
21 SC Ti Scandium 45 48 48 40 Yrium 39 91 57-71 72 Ianthanoids Highling 178 89 178 89 178 89-103 104 actinoids Rf rutherford					Key	tomic number	mic sym	name tive atomic ma				23	>	vanadium 51	41	g	niobium 93	73	<u>n</u>	tantalum 181	105	op O	dubnium	ı
						100	ato	rela				22	F	titanium 48	40	Zr	zirconium 91	72	茔	hafnium 178	104	꿆	rutherfordium	ı
									1			21	Sc	scandium 45	39	>	yttrium 89	57–71	lanthanoids		89–103	actinoids		
H   A   A   A   A   A   A   A   A   A			=			4	Be	beryllium 9	12	Mg	magnesium 24	20	Ca	calcium 40	38	Š	strontium 88	56	Ba	barium 137	88	Ra	radium	ı
Li			_			3	:=	lithium 7	11	Na	sodium 23	19	¥	potassium 39	37	Rb	rubidium 85	55	S	caesium 133	87	ъ.	francium	ı

71	n	lutetium 175	103	۲	lawrencium	I
20	Υp	ytterbium 173	102	%	nobelium	I
69	Tm	thulium 169	101	Md	mendelevium	I
89	ш	erbium 167	100	Fm	ferminm	I
29	웃	holmium 165	66	Es	einsteinium	I
99	Ο	dysprosium 163	86	ŭ	californium	I
65	Tp	terbium 159	26	Ř	berkelium	I
64	Gd	gadolinium 157	96	Cm	curium	I
63	En	europium 152	92	Am	americium	I
62	Sm	samarium 150	94	Pu	plutonium	I
61	Pm	promethium —	93	ď	neptunium	I
09	pZ	neodymium 144	92	$\supset$	uranium	238
59	P	praseodymium 141	91	Ра	protactinium	231
28	Ce	cerium 140	06	Ч	thorium	232
57	La	lanthanum 139	88	Ac	actinium	I

lanthanoids

actinoids

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