

Cambridge IGCSE[™]

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

CHEMISTRY

0620/32

Paper 3 Theory (Core)

February/March 2021

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: 5]

1 The diagram shows part of the Periodic Table.

-	Ш							Ш	IV	V	VI	VII	VIII
									С	N	0	F	
	Mg							Αl				Cl	Ar
K	Ca		Cr	Fe		Cu	Zn					Br	
												I	
					Pt								

Answer the following questions using only the symbols of the elements in the diagram. Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(a)	is extracted from bauxite	
	[1	1]
(b)	forms 21% of clean, dry air	
	[1	1]
(c)	forms an oxide which contributes to acid rain	
	[1	1]
(d)	forms an aqueous ion that gives a red-brown precipitate on addition of aqueou sodium hydroxide	S
	[1	1]
(e)	has an atom with a complete outer electron shell.	
	[1	1]

2 The table shows the mass of some of the ions in a 1000 cm³ sample of sea water.

name of ion	formula of ion	mass of ion in 1000 cm ³ of sea water/mg
bromide	Br⁻	65
calcium	Ca ²⁺	400
chloride	C1 ⁻	18 980
hydrogencarbonate	HCO ₃ -	140
magnesium	Mg ²⁺	1262
metaborate	B ₃ O ₆ ³⁻	26
	K ⁺	380
sodium	Na⁺	10556
strontium	Sr ²⁺	13
	SO ₄ ²⁻	2649

(a)	Ans	swer these questions using only the information in the table.
	(i)	State which negative ion has the lowest mass in 1000 cm³ of sea water.
		[1]
	(ii)	Give the formulae of the ions in potassium sulfate.
		and [1]
	(iii)	Calculate the mass of calcium ions in 200 cm³ of this sample of sea water.
		mass = mg [1]
	(iv)	A sample of this sea water is evaporated.
		State the name of the compound which is present in the greatest quantity when this sample is evaporated.
		[1]
	(v)	Give the name of the ion which reacts with aqueous silver nitrate to give a cream precipitate.

[Total: 12]

(b) The ${\rm B_3O_6^{3-}}$ ion can be converted to boric acid, ${\rm H_3BO_3}$.

Boric acid is also produced when boron trichloride, $\mathrm{BC}\mathit{l}_{\mathrm{3}},$ reacts with water.

Complete the equation for this reaction.

$$BCl_3 +H_2O \rightarrow H_3BO_3 +HCl$$
 [2]

(c) The symbol of a strontium ion is shown.

	Dec	duce the number of electrons, protons and neutrons in one atom of this strontium ion.		
	nur	nber of electrons		
	nur	nber of protons		
	number of neutrons			
			[3]	
(d)	Sor	me isotopes of strontium are radioactive.		
	(i)	Give one medical use of radioactive isotopes.		
			[1]	
	(ii)	The isotope ²³⁵ U is also radioactive.		
		State the major use of this isotope of uranium.		
			[1]	

3 The table shows some properties of four halogens.

element	melting point in °C	boiling point in °C	density of liquid at melting point in g/cm ³		
fluorine	-220	-188			
chlorine	-101		1.56		
bromine	-7	59	3.12		
iodine	114	184	4.93		

(a)	(i)	Complete the table by predicting:	
		 the boiling point of chlorine the density of fluorine at its melting point. 	[2]
	(ii)	Describe the trend in the melting points of the halogens down the group.	
			[1]
(iii)	Deduce the physical state of iodine at 130 °C. Explain your answer.	
			[2]
(b)	(i)	Give the electronic structure of a fluorine atom.	
			[1]
	(ii)	Explain why a fluoride ion has a single negative charge.	
			[1]
(c)		gnesium reacts with excess fluorine to produce magnesium fluoride. en 2.40g of magnesium is reacted, 6.20g of magnesium fluoride is produced.	
	Cal	culate the mass of magnesium needed to produce 1.24g of magnesium fluoride.	

mass of magnesium = g [1]

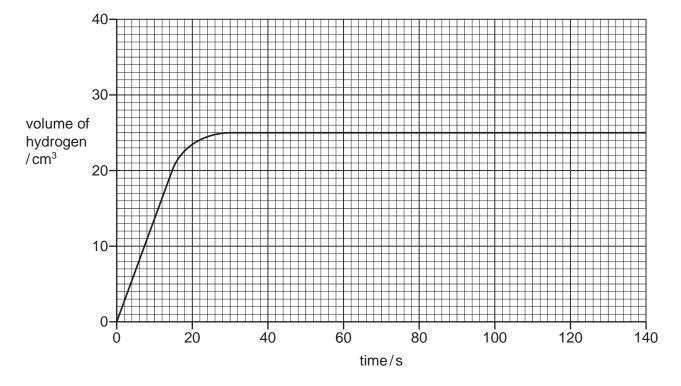
[Total: 8]

4 A student investigates the reaction of magnesium powder with dilute hydrochloric acid. The magnesium is in excess.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

The rate of reaction can be found by measuring the increase in volume of hydrogen with time.

The results are shown on the graph.



(a) Deduce the time taken for the reaction to finish.

(b) The experiment is repeated using dilute hydrochloric acid of a lower concentration.

Draw a line **on the grid** to show how the volume of hydrogen changes with time using dilute hydrochloric acid of a lower concentration.

All other conditions stay the same. [2]

(c)		scribe the effect each of the following has on the rate of reaction of magnesium wit Irochloric acid.	h				
	•	The temperature is increased.					
		All other conditions stay the same.					
	•	Magnesium ribbon is used instead of magnesium powder.					
		All other conditions stay the same.					
		[2	 2]				
(d)	Нус	drochloric acid reacts with calcium carbonate.					
	Naı	me the products of this reaction and give the observations.					
	pro	ducts					
	observations						
	••••	[4	 4]				
		[Total: 9	9]				

- 5 This question is about sulfur and compounds of sulfur.
 - (a) Sulfur is a non-metal.

Describe three physical properties which are typical of non-metals.

1

2

3

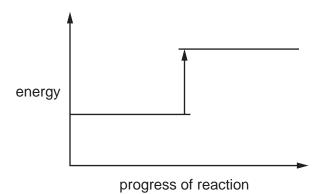
(b) Name one source of sulfur.

.....[1]

(c) When carbon is heated with sulfur, carbon disulfide, CS₂, is produced.

$$C + 2S \rightarrow CS_2$$

- (i) Complete the energy level diagram for the production of carbon disulfide by writing these formulae on the diagram:
 - C + 2S
 - CS₂.



[1]

(ii) Explain, using information on the energy level diagram, how you know that this reaction is endothermic.

......[1]

(d)	Car	bon disulfide is a liquid at room temperature.
	Des	scribe the separation and motion of the particles in carbon disulfide liquid.
	sep	aration
	mot	ion[2]
(0)	Llvc	Irogen sulfide is a gas which turns filter paper soaked in aqueous lead($ m II$) ethanoate from
(e)		te to black.
	Нус	lrogen sulfide is slightly soluble in water.
	A lo	ng glass tube is set up as shown.
		long glass tube
		cotton wool soaked in filter paper soaked in
		aqueous hydrogen sulfide aqueous lead(II) ethanoate
		irst, the filter paper soaked in aqueous lead(II) ethanoate does not turn black. α a short time, the filter paper soaked in aqueous lead(II) ethanoate turns black.
	Ехр	lain these observations using the kinetic particle model.
		[3]
(f)	Sulf	fur dioxide is a pollutant in the air.
	(i)	Give one adverse effect of sulfur dioxide on buildings.
		[1]
	(ii)	Sulfur dioxide is used to bleach paper.
		Give one other use of sulfur dioxide.
		[1]
		[Total: 13]

[2]

6 The structure of compound **A** is shown.

(a) (i)	On the structure of compound A , draw a circle around the carboxylic acid functional group. [1]
(ii)	State the name of the carboxylic acid that has only two carbon atoms.
	[1]
(iii)	Deduce the molecular formula of compound ${\bf A}$ to show the number of carbon, hydrogen and oxygen atoms.
	[1]
(iv)	Explain, by referring to its structure, why compound A is described as unsaturated.
	[1]
(b) Eth	ene is an unsaturated hydrocarbon.

Draw the structure of ethene to show all of the atoms and all of the bonds.

			[2]
(c)	Eth	ene can be produced by cracking hydrocarbons.	
	(i)	State the meaning of the term <i>cracking</i> .	
			[1]
	(ii)	Give the conditions required for cracking.	
		1	
		2	

[Total: 12]

(d)	Ethene can be polymerised.	
	Complete these sentences about the polymerisation of ethene using words from the list.	
	addition decomposition neutralisation poly(ethene)	
	poly(ethane) reduction <i>Terylene</i>	
	When ethene polymerises, it produces a molecule called	
	The type of reaction which occurs is	[2]
(e)	Describe one pollution problem caused by non-biodegradable plastics.	[1]
		ניו

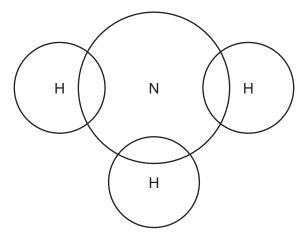
[4]

7

Sodiu	m is manufactured by electrolysis.
(a) E	xplain why sodium is manufactured by electrolysis and not by reduction with carbon.
	[1]
(b) T	he diagram shows the equipment for the production of sodium.
	molten sodium chloride power supply
(i) The anode is inert.
	Suggest a suitable substance that can be used for the anode.
	[1]
(ii) Label the anode on the diagram. [1]
(iii	Describe, by reference to the diagram, how you know that sodium is less dense than molten sodium chloride.
	[1]
	When concentrated aqueous sodium chloride is electrolysed, gases are produced at each lectrode.
S	tate the names of the products and give the observations at each electrode.
р	roduct at the negative electrode
0	bservations at the negative electrode
р	roduct at the positive electrode
0	bservations at the positive electrode

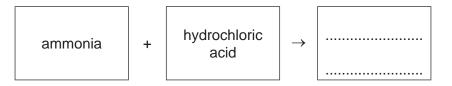
(d)	Give two ways in which the physical properties of sodium are different from the phys properties of transition elements.	ical
	1	
	2	
		[2]
(e)	The symbol equation for the production of sodium hydride is shown.	
	2Na + $H_2 \rightarrow 2NaH$	
	(i) Write a word equation for this reaction.	
		[1]
	ii) Suggest why the hydrogen must be dry.	
		[1]
(ii) Sodium hydride reduces iron(III) oxide to iron.	
	$Fe_2O_3 + 3NaH \rightarrow 2Fe + 3NaOH$	
	Explain how this equation shows that iron(III) oxide is reduced.	
		[1]
(f)	State the colour observed in the flame test for sodium.	
		[1]
	[Total:	14]

- 8 Aqueous ammonia is an alkali.
 - (a) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ammonia.



[2]

(b) Complete the word equation for the reaction of aqueous ammonia with dilute hydrochloric acid.



[1]

(c) Describe the colour change when excess aqueous ammonia is added to an acidified solution of methyl orange.

from to [1]

[2]

[Total: 7]

(d) Aqueous ammonia reacts with aqueous copper(II) ions to produce compound B.

The formula of compound **B** is CuN₄H₁₆O₂.

Complete the table to calculate the relative molecular mass of compound B.

type of atom	number of atoms	relative atomic mass	
copper	1	64	1 × 64 = 64
nitrogen	4	14	4 × 14 = 56
hydrogen		1	
oxygen		16	

(e)	Ammonia is used in the production of fertilisers.	
	State why farmers put fertilisers on the soil where crops are to be grown.	
		[1]

relative molecular mass =

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The Periodic Table of Elements

	=	_ 0	שַׁ שַּ)	Φ	nc C	~	_	on C	23		ton +	4	Φ	e –	.0	_	uo .			
	=	r I	helium 4	7	Z	7 Je	7	⋖	arg 4(3		kryp 8	2	×	xen 13	8	2	rad			
	₹			6	Щ	fluorine 19	17	Cl	chlorine 35.5	35	ğ	bromine 80	53	Н	iodine 127	85	Αt	astatine -			
	5			80	0	oxygen 16	16	ഗ	sulfur 32	34	Se	selenium 79	52	<u>a</u>	tellurium 128	84	Ъ	polonium	116	_	livermorium -
	>			7	z	nitrogen 14	15	₾	phosphorus 31	33	As	arsenic 75	51	Sp	antimony 122	83	<u>B</u>	bismuth 209			
	≥			9	ပ	carbon 12	14	:S	silicon 28	32	Ge	germanium 73	20	Sn	tin 119	82	Pp	lead 207	114	Fl	flerovium
	≡			5	В	boron 11	13	Αl	aluminium 27	31	Ga	gallium 70	49	In	indium 115	18	11	thallium 204			
										30	Zu	zinc 65	48	В	cadmium 112	80	Hg	mercury 201	112	S	copernicium
										59	Cn	copper 64	47	Ag	silver 108	79	Au	gold 197	111	Rg	roentgenium
Group										28	Ë	nickel 59	46	Pd	palladium 106	78	₹	platinum 195	110	Ds	darmstadtium -
Group										27	ဝိ	cobalt 59	45	Rh	rhodium 103	11	'n	iridium 192	109	¥	meitnerium -
		- ⊐	hydrogen 1							26	Ь	iron 56	44	Ru	ruthenium 101	92	SO	osmium 190	108	Hs	hassium
				J						25	Mn	manganese 55	43	ပ	technetium -	75	Re	rhenium 186	107	В	bohrium
					ГО	ss				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	14	q	niobium 93	73	<u>n</u>	tantalum 181	105	op O	dubnium -
				ğ	ator	relat				22	i=	titanium 48	40	Zr	zirconium 91	72	茔	hafnium 178	104	፟ጟ	rutherfordium -
							J			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	ഗ്	strontium 88	56	Ba	barium 137	88	Ra	radium
	_	•		3	:=	lithium 7	1	Na	sodium 23	19	¥	potassium 39	37	Rb	rubidium 85	55	S	caesium 133	87	Ē.	francium -

Lu Lu	lutetium 175	103	ت	lawrencium	ı
oz Yb	ytterbium 173	102	2	nobelium	ı
₆₉	thulium 169	101	Md	mendelevium	ı
es Er	erbium 167	100	Fm	fermium	I
67 Ho	holmium 165	66	Es	einsteinium	I
°° Dy	dysprosium 163	86	ర	californium	ı
e5 Tb	terbium 159	97	Ř	berkelium	ı
Gd	gadolinium 157	96	Cm	curium	ı
e3 Eu	europium 152	92	Am	americium	ı
ss Sm	samarium 150	94	Pn	plutonium	ı
Pm	promethium -	93	ď	neptunium	ı
° PN	neodymium 144	92	\supset	uranium	238
59 Pr	praseodymium 141	91	Ра	protactinium	231
Se Ce	cerium 140	06	┖	thorium	232
57 La	lanthanum 139	88	Ac	actinium	ı

lanthanoids

actinoids

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