

# **Cambridge IGCSE**<sup>™</sup>

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

CHEMISTRY 0620/43

Paper 4 Theory (Extended)

May/June 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.

Giv	e the name of the process that is used:	
(a)	to produce large molecules from monomers	
		[1]
(b)	to separate oxygen from liquid air	
		[1]
(c)	to make ethanol from glucose	
		[1]
(d)	to separate water from aqueous sodium chloride	
		[1]
(e)	to produce aluminium from aluminium oxide in molten cryolite	
		[1]
(f)	to separate the products of hydrolysis of long chain carbohydrates	
		[1]
(g)	to separate an aqueous solution from an undissolved solid.	
		[1]
	[Tota	l: 7]

## **2** Complete the table to:

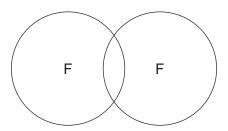
- deduce the number of protons, electrons and neutrons in the boron atom and chloride ion shown
- identify the atom or ion represented by the final row.

formula	number of protons	number of electrons	number of neutrons
<sup>11</sup> <sub>5</sub> B		5	
<sup>35</sup> C <i>l</i> <sup>-</sup>	17		
	24	21	30

[Total: 5]

Sodi	um reacts with fluorine to form sodium fluoride, NaF.
(a)	Write a chemical equation for this reaction.
	[2]
(b)	Sodium fluoride is an ionic compound.
	Complete the diagram to show the electron arrangement in the outer shells of the ions present n sodium fluoride.
	Give the charges on both ions.
	Na X Na X
	[3]
(0)	
	Aqueous sodium fluoride undergoes electrolysis.
	i) State what is meant by the term <i>electrolysis</i> .
	[2]
(	i) Name the products formed at the positive electrode (anode) and the negative electrode (cathode) when dilute aqueous sodium fluoride undergoes electrolysis.
	anode
	cathode
	[2]
(d)	Molten sodium fluoride undergoes electrolysis.
	<ul> <li>i) Name the products formed at the positive electrode (anode) and the negative electrode</li> </ul>
,	(cathode) when molten sodium fluoride undergoes electrolysis.
	anode
	cathode
	[2]
(	i) Write the ionic half-equation for the reaction at the negative electrode (cathode).
	[1]

(e)	Complete the d	lot-and-cross	diagram 1	to show	the	electron	arrangement	in a	molecule	of
	fluorine, F <sub>2</sub> .									
	Show the outer of	electrons only	<b>'</b> .							



[1]

(f) The melting points and boiling points of fluorine and sodium fluoride are shown.

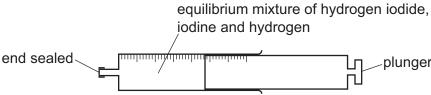
	melting point /°C	boiling point /°C
fluorine	-220	-188
sodium fluoride	993	1695

(1)	answer.	oui
	physical state	
	explanation	
		 [2]
(ii)	Explain, in terms of structure and bonding, why sodium fluoride has a much higher melt point than fluorine.	ing
	Your answer should refer to the:  types of particle held together by the forces of attraction types of forces of attraction between particles relative strength of the forces of attraction.	
		[3]

[Total: 18]

4 Hydrogen iodide, HI, decomposes into iodine and hydrogen. The reaction is reversib
--

A gas syringe containing a mixture of hydrogen iodide, iodine and hydrogen gases was sealed. After reaching equilibrium the mixture was a pale purple colour.



(a)	Stat	te what is meant by the term <i>equilibrium</i> .
		[2]
(b)		plunger of the gas syringe is pushed in. The position of equilibrium does not change. The our of the gaseous mixture turns darker purple.
	The	temperature remains constant.
		$2HI(g) \iff I_2(g) + H_2(g)$ colourless gas purple gas colourless gas
	(i)	Explain why the position of equilibrium does <b>not</b> change.
		[1]
	(ii)	Suggest why the colour of the gaseous mixture turns darker purple even though the position of equilibrium does not change.
		[1]
(c)	The	forward reaction is endothermic.
	(i)	State what happens to the position of equilibrium when the temperature is decreased.

(ii)	State what happens to the rate of the forward reaction and the rate of the backy reaction when the temperature of the mixture is decreased.	vard
	rate of the forward reaction	
	rate of the backward reaction	
		[2]

5 This question is about sal	5	This	auestion	is	about	salts
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(a)	Salts that are soluble in water can be made by the reaction between insoluble carbonates and
	dilute acids. Zinc sulfate is soluble in water.

You are provided with solid zinc carbonate, ZnCO<sub>3</sub>, and dilute sulfuric acid, H<sub>2</sub>SO<sub>4</sub>.

Describe how you would make a pure sample of zinc sulfate crystals.

Your answer should include:

a chemical equation for the reaction.

- practical details
- how you would make sure that all the dilute sulfuric acid has reacted


(b) Some sulfates decompose when heated.

When hydrated iron(II) sulfate is heated strongly, sulfur dioxide gas is given off.

(i) Describe a test for sulfur dioxide.

observations .....

(ii) Complete the equation for the decomposition of hydrated iron(II) sulfate.

....FeSO<sub>4</sub>•7H<sub>2</sub>O 
$$\rightarrow$$
 Fe<sub>2</sub>O<sub>3</sub> + SO<sub>2</sub> + SO<sub>3</sub> + ....H<sub>2</sub>O [2]

[2]

When hydrated barium chloride crystals, BaC $l_2 \cdot xH_2O$ , are heated they give off water.

$$BaCl_2 \cdot xH_2O(s) \rightarrow BaCl_2(s) + xH_2O(g)$$

A student carries out an experiment to determine the value of x in BaC $l_2 \cdot xH_2O$ .

- step 1 Hydrated barium chloride crystals are weighed.
- **step 2** The hydrated barium chloride crystals are then heated.
- **step 3** The remaining solid is weighed.

)	Describe now the student can be sure that all the water is given off.								
	(2)								

(ii) In an experiment, 4.88 g of  $BaCl_2 \cdot xH_2O$  is heated until all the water is given off. The mass of  $BaCl_2$  remaining is 4.16 g.

 $[M_r: BaCl_2, 208; H_2O, 18]$ 

Determine the value of **x** using the following steps.

Calculate the number of moles of BaCl<sub>2</sub> remaining.

..... mol

Calculate the mass of H<sub>2</sub>O given off.

..... g

• Calculate the number of moles of H<sub>2</sub>O given off.

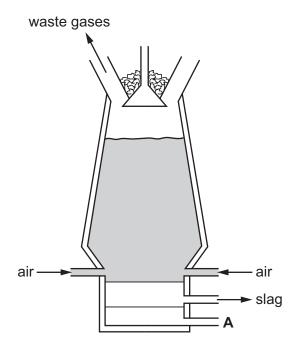
..... mol

• Determine the value of x.

**x** = .....[4]

[Total: 15]

- 6 This question is about metals.
  - (a) Iron is extracted from its main ore in a blast furnace.



(i)	Coke and iron ore are added at the top of the blast furnace.
	Name one <b>other</b> substance that is added at the top of the blast furnace.
	[1]
(ii)	Name the substance that leaves the blast furnace at <b>A</b> .
	[1]
(iii)	Iron ore is mainly iron(III) oxide, Fe <sub>2</sub> O <sub>3</sub> .
	Name a substance that reduces iron(III) oxide to iron in the blast furnace.
	[1]
(iv)	Temperatures inside a blast furnace can reach 2000 °C.
	Name <b>two</b> substances that react together, in the blast furnace, to produce this high temperature.
	[1]
(v)	Name <b>two</b> waste gases that leave the blast furnace.
	1
	2
	[2]

(b)	Zino	c is extracted from zinc blende.	
	(i)	Name the main zinc compound that is present in zinc blende.	[1]
	(ii)	When zinc is extracted, it is formed as a gas.	[1]
		The gaseous zinc is then converted into molten zinc.	
		State the name of this physical change.	[41
(c)	Nar	me the alloy that contains zinc and copper only.	
(d)	Сор	oper has the following properties.	
	•	It has a high melting point. It has a high density. It is a good conductor of electricity. It has variable oxidation states. It forms a basic oxide. It forms soluble salts.	
	(i)	Give <b>two</b> properties from the list in which copper differs from Group I elements	
		1     2	
	(ii)	Give <b>two</b> properties from the list in which copper is similar to Group I elements	
		1	
		2	[2]
			[Total: 13]

Ma	ny organic compounds contain carbon, hydrogen and oxygen only.
(a)	An organic compound <b>R</b> has the following composition by mass.
	C, 69.77%; H, 11.63%; O, 18.60%
	Calculate the empirical formula of compound <b>R</b> .
	empirical formula = [2]
(b)	Compound <b>S</b> has the empirical formula CH <sub>2</sub> O and a relative molecular mass of 60.
	Calculate the molecular formula of compound <b>S</b> .
	molecular formula = [2]
(c)	Compounds <b>T</b> and <b>V</b> have the same molecular formula, $C_3H_6O_2$ .
	<ul> <li>Compound <b>T</b> is an ester.</li> <li>Compound <b>V</b> contains a –COOH functional group.</li> </ul>
	(i) State the name given to compounds with the same molecular formula but different structures.
	[1]
	(ii) Name the homologous series that <b>V</b> is a member of.
	[1]

(	(iii)	Draw a structure of compound <b>T</b> . Show all of the atoms and all of the bonds.	
		Name compound <b>T</b> .	
		name	[3]
(	(iv)	Draw the structure of compound <b>V</b> . Show all of the atoms and all of the bonds.	
		Name compound <b>V</b> .	
		name	[2]
(d)		anol can be produced from long chain alkanes such as decane, $\mathrm{C}_{10}\mathrm{H}_{22}$ , in a cess.	two-step
		step 1 step 2	
		decane → ethene → ethanol	
	For •	each of the two steps: name the type of chemical reaction that occurs write a chemical equation.	
	ste	p 1: decane to ethene	
	type	e of reaction	
	che	emical equation	
	ste	p 2: ethene to ethanol	
	type	e of reaction	
	che	emical equation	
			[4]
			[Total: 15]

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The Periodic Table of Elements

	<b>III</b>	2 He	helium 4	10	Ne	neon 20	18	Ā	argon 40	36	궃	krypton 84	54	Xe	xenon 131	98	R	radon			
	=			6	ш	fluorine 19	17	ľ	chlorine 35.5	35	Ŗ	bromine 80	53	Н	iodine 127	85	¥	astatine -			
	5			8	0	oxygen 16	16	ഗ	sulfur 32	34	Se	selenium 79	52	<u>e</u>	tellurium 128	84	Ъ	molod –	116	^	livemorium –
	>			7	z	nitrogen 14	15	₾	phosphorus 31	33	As	arsenic 75	51	Sb	antimony 122	83	<u>.</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	Δ	boron 11	13	Αſ	aluminium 27	31	Ga	gallium 70	49	In	indium 115	81	11	thallium 204			
										30	Zn	zinc 65	48	පි	cadmium 112	80	Нg	mercury 201	112	S	copernicium -
										59	J.	copper 64	47	Ag	silver 108	79	Αn	gold 197	111	Rg	roentgenium -
Group										28	Z	nickel 59	46	Pd	palladium 106	78	£	platinum 195	110	Ds	darmstadtium -
ğ				,						27	ပိ	cobalt 59	45	몬	rhodium 103	77	i	iridium 192	109	Μ̈́	meitnerium -
		- I	hydrogen 1							26	Pe	iron 56	44	Ru	ruthenium 101	9/	Os	osmium 190	108	Hs	hassium -
							1			25	Mn	manganese 55	43	ပ	technetium -	75	Re	rhenium 186			bohrium –
				_	loq	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	niobium 93	73	<u>n</u>	tantalum 181	105	В	dubnium –
					atc	ler 				22	F	titanium 48	40	Zr	zirconium 91	72	Ξ	hafnium 178	104	꿆	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	ഗ്	strontium 88	26	Ba	barium 137	88	Ra	radium
	_			8	=	lithium 7	11	Na	sodium 23	19	×	potassium 39	37	&	rubidium 85	92	CS	caesium 133	87	ъ.	francium

71	Ρn	lutetium	175	103	ב	lawrencium	ı
70	Υp	ytterbium	173	102	%	nobelium	ı
69	Tm	thulium	169	101	Md	mendelevium	1
89	Щ	erbinm	167	100	Fm	ferminm	I
29	웃	holmium	165	66	Es	einsteinium	ı
99	۵	dysprosium	163	86	ర్	californium	ı
9	Tp	terbium	159	26	崙	berkelium	ı
64	В	gadolinium	157	96	Cm	curium	ı
63	En	europium	152	92	Am	americium	ı
62	Sm	samarium	150	94	Pn	plutonium	ı
61	Pm	promethium	I	93	ď	neptunium	I
09	pN	neodymium	144	92	$\supset$	uranium	238
59	Ā	praseodymium	141	91	Ра	protactinium	231
28	Ce	cerium	140	06	H	thorium	232
22	Га	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.).