

Cambridge IGCSE[™]

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

CHEMISTRY 0620/43

Paper 4 Theory (Extended)

October/November 2020

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 names of nine substances are shown.

aluminium oxide
ammonia
carbon monoxide
anhydrous cobalt(II) chloride
hydrated copper(II) sulfate
iron(III) oxide
nitrogen dioxide
silver
steel

Answer the following questions using these substances. Each substance may be used once, more than once or not at all.

Name the substance that is:

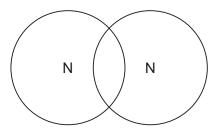
(a)	the main constituent of hematite	[1]
(b)	a gas produced in car engines which causes acid rain	[1]
(c)	an alkaline gas	[1]
(d)	an element	[1]
(e)	a gas formed by the incomplete combustion of fossil fuels	[1]
(f)	used to test for the presence of water.	[1]
	[Total	: 6]

2 The table gives information about five particles, **A**, **B**, **C**, **D** and **E**.

particle	number of electrons	number of neutrons	number of protons
Α	10	13	11
В	18	20	18
С	18	18	18
D	10	12	8
E	10	10	10

(a)	Sta	te the atomic number of A .	
			[1]
(b)	Sta	te the nucleon number of B .	
			[1]
(c)	Wri	te the electronic structure of C .	
			[1]
(d)	Giv	e the letters of all the particles which are:	
	(i)	atoms	[1]
	(ii)	positive ions	[1]
	(iii)	negative ions	[1]
	iv)	isotopes of each other.	[1]
		[Total	: 7]

- **3** This question is about nitrogen and some of its compounds.
 - (a) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of nitrogen, ${\rm N_2}$. Show the outer shell electrons only.



[2]

[5]

(b)	Nitr	rogen can be converted into ammonia by the Haber process.
	(i)	Describe how nitrogen is obtained for the Haber process.
		[2]
	(ii)	Give the essential reaction conditions and write a chemical equation for the reaction occurring in the Haber process.
		chemical equation:
		reaction conditions:

(c) Some of the ammonia made by the Haber process is converted into nitric acid	(c)	Some of the	ammonia ma	ade by th	e Haber	process is	converted	into	nitric acid
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The first stage of this process is the oxidation of ammonia to make nitrogen monoxide.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

The process is carried out at 900 °C and a pressure of 5 atmospheres using an alloy of platinum and rhodium as a catalyst.

The forward reaction is exothermic.

(i)	State the meaning of the	e term <i>catalyst</i> .		
				[2]
(ii)	State the meaning of the	e term <i>oxidation</i> .		
				[1]
(iii)	Complete the table using	g the words increase , decre	ase or no change.	
		effect on the rate of the forward reaction	effect on the equilibrium yield of NO(g)	
inc	reasing the temperature			
in	creasing the pressure			

[4]

(d) Nitrogen monoxide, NO, is converted into nitrogen dioxide, NO_2 .

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The nitrogen dioxide reacts with oxygen and water to produce nitric acid as the only product.

Write a chemical equation for this reaction.

.....[2

(e)	Ammonium nitrate, NH ₄ NO ₃ , is a fertiliser.
	Calculate the percentage by mass of nitrogen in ammonium nitrate.
	% [2]
	[Total: 20]

4

Zin ZnS		manufactured from zinc blende. Zinc blende is an ore which consists mainly of zinc sulfide
(a)	Zin	c blende is roasted in air. One of the products is zinc oxide.
	Nar	me the other product formed in this reaction.
		[1]
(b)	Zin	c oxide is then converted into zinc.
		c oxide and coke, a source of carbon, are heated in a furnace. Hot air is blown into the nace.
	(i)	Give two reasons why coke is needed.
		1
		2
	(ii)	Write a chemical equation for the formation of zinc in the furnace.
		[1]
((iii)	Zinc has a melting point of 420 $^{\circ}$ C and a boiling point of 907 $^{\circ}$ C. The temperature inside the furnace is 1200 $^{\circ}$ C.
		Explain how this information shows that the zinc produced inside the furnace is a gas.
		[1]
((iv)	The gaseous zinc is converted to molten zinc.
		Name this change of state.
		[1]

(c) 2	Zinc reacts v	with dilut	e sulfurio	acid to	produce ad	queous zind	: sulfate.
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$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Hydrated zinc sulfate crystals are made from aqueous zinc sulfate.

- **Step 1** Solid zinc is added to dilute sulfuric acid until zinc is in excess.
- **Step 2** Excess zinc is separated from aqueous zinc sulfate by filtration.
- **Step 3** Aqueous zinc sulfate is heated until the solution is saturated.

Ste	h 2	Aqueous zinc sunate is neated until the solution is saturated.	
Ste	p 4	The saturated solution is allowed to cool and crystallise.	
Ste	p 5	The crystals are removed and dried.	
(i)	Nan	ne the residue in step 2 .	
			[1]
(ii)	In s	tep 3, a saturated solution is produced.	
	Des	cribe what a saturated solution is.	
			[2]
iii)		ne two compounds each of which react with dilute sulfuric acid to produce aqueousulfate.	us
	1		
	2		
			[2]

(d)	When hydrated magnesium sulfate crystals, MgSO $_4$ •xH $_2$ O, are heated they give off water.

 $MgSO_4 \cdot xH_2O(s) \rightarrow MgSO_4(s) + xH_2O(g)$

A student carries out an experiment to	determine the	value of x in	$MgSO_4 \cdot xH_2O$.
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- Step 1 Hydrated magnesium sulfate crystals were weighed.
- Step 2 Hydrated magnesium sulfate crystals were heated.
- **Step 3** The remaining solid was weighed.

(i)	Describe how the student can ensure that all the water is given off.

(ii) In an experiment, all the water was removed from 1.23g of $MgSO_4 \cdot xH_2O$. The mass of $MgSO_4$ remaining was 0.60g.

.....[2]

$$M_r$$
: MgSO₄ = 120; M_r : H₂O = 18

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

• Calculate the number of moles of MgSO₄ remaining.

moles of MgSO₄ =

Calculate the mass of H₂O given off.

mass of $H_2O = \dots g$

Calculate the moles of H₂O given off.

moles of $H_2O = \dots$

• Determine the value of x.

x =[4]

[Total: 17]

		elements, Group VII elements and transition elements are found in different parts of the Table.
(a)	Des	cribe the trend in the reactivity of Group I elements.
		[1
(b)	Whe	en potassium is added to water a chemical reaction occurs.
	(i)	State two observations that can be made when potassium is added to water.
		[2
((ii)	Write a chemical equation for the reaction of potassium with water.
		[2
(c)	Exc	ess aqueous potassium iodide is added to chlorine.
	(i)	Write a chemical equation for the reaction that occurs when aqueous potassium iodide is added to chlorine.
((ii)	State the final colour of the reaction mixture.
		[1
(d)	Sod	lium is extracted from sodium chloride by electrolysis.
	(i)	State the meaning of the term <i>electrolysis</i> .
((ii)	State what must be done to sodium chloride before it can be electrolysed to produce sodium.
		[1
(i	iii)	Write an ionic half-equation for the change that occurs at the cathode during this electrolysis
		[1

- (e) Chromium is a transition element.
 - Chromium has a high melting point.
 - Chromium is a good conductor of electricity.
 - Many chromium compounds are soluble in water.
 - Hydrated chromium(III) sulfate is green.

 - Chromium forms the chlorides ${\rm CrC} l_2$ and ${\rm CrC} l_3$. Oxides of chromium act as catalysts in the manufacture of poly(ethene).

Use this information to give two properties of chromium which are different from properties of Group I elements such as sodium.	(i)
1	
2[2]	
L— .	
Use this information to give two properties of chromium which are similar to properties of Group I elements such as sodium.	(ii)
1	
2	
[2]	
[Total: 16]	

(a) A c	arboxylic acid and an ester are structura	ai is	omers.
(i)	State the meaning of the term structur	al is	omers.
			[2
(ii)	atoms.		d and the ester which both contain two carbor
	Show all of the atoms and all of the bo	nds	
	Name the carboxylic acid and the este	r.	
	carboxylic acid		ester
na	ame		name

[4]

(b) Pa	art of a polyester chain is shown. This polyester is made from one monomer.	
	_o	
(i)	On the diagram draw a ring around one unit of the polymer that is repeated.	[1]
(ii)	Name the type of polymerisation that produces polyesters.	
		[1 ⁻
(iii)		
		[2]
(c) A	polyamide is made from the two monomers shown.	
	H ₂ N——NH ₂ HOOC——COOH	
	omplete the diagram to show a section of the polyamide made from the two monomers now all of the atoms and all of the bonds in the linkages.	i_
		[2]
(d) Na	aturally occurring polyamides are constituents of food.	
(i)	State the name given to naturally occurring polyamides.	
		[1]
(ii)	Name the monomers which form naturally occurring polyamides.	
		[1]
	[Tota	ıl: 14]

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The Periodic Table of Elements

	III	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	lO	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	Ф	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	ъ́	francium

						_	
71	Ρſ	lutetium	175	103	۲	lawrencium	ı
20	Υp	ytterbium	173	102	9 N	nobelium	ı
69	Η	thulium	169	101	Md	mendelevium	ı
89	щ	erbinm	167	100	Fm	ferminm	I
29	웃	holmium	165	66	Es	einsteinium	ı
99	ò	dysprosium	163	86	ర్	californium	ı
99	Д	terbium	159	26	Æ	berkelium	1
64	gg	gadolinium	157	96	Cm	curium	ı
63	En	europium	152	92	Am	americium	ı
62	Sm	samarium	150	94	Pa	plutonium	ı
61	Pm	promethium	ı	93	ď	neptunium	1
09	βN	neodymium	144	92	\supset	uranium	238
59	Ā	praseodymium	141	91	Ра	protactinium	231
28	Ce	cerium	140	06	Ч	thorium	232
22	Га	lanthanum	139	89	Ac	actinium	ı

lanthanoids

actinoids

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