



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.

This document has **16** pages. Blank pages are indicated.



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
A	10	13	11
B	18	20	18
C	18	18	18
D	10	12	8
E	10	10	10

(a) State the atomic number of **A**.

..... [1]

(b) State the nucleon number of **B**.

..... [1]

(c) Write the electronic structure of **C**.

..... [1]

(d) Give the letters of all the particles which are:

(i) atoms [1]

(ii) positive ions [1]

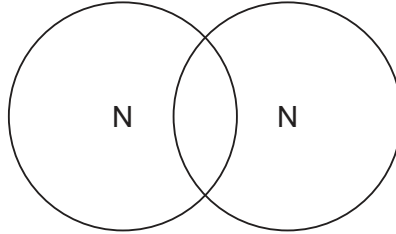
(iii) negative ions [1]

(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, N_2 .
Show the outer shell electrons only.



[2]

(b) Nitrogen 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:

.....

.....

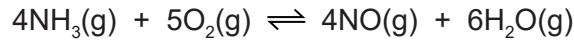
.....

.....

[5]

- (c) Some of the ammonia made by the Haber process is converted into nitric acid.

The first stage of this process is the oxidation of ammonia to make nitrogen monoxide.



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 term *catalyst*.

.....
 [2]

- (ii) State the meaning of the term *oxidation*.

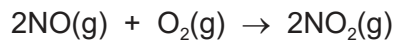
..... [1]

- (iii) Complete the table using the words **increase**, **decrease** or **no change**.

	effect on the rate of the forward reaction	effect on the equilibrium yield of NO(g)
increasing the temperature		
increasing the pressure		

[4]

- (d) Nitrogen monoxide, NO, is converted into nitrogen dioxide, NO₂.



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_4NO_3 , is a fertiliser.

Calculate the percentage by mass of nitrogen in ammonium nitrate.

..... % [2]

[Total: 20]

4 Zinc is manufactured from zinc blende. Zinc blende is an ore which consists mainly of zinc sulfide, ZnS.

(a) Zinc blende is roasted in air. One of the products is zinc oxide.

Name the **other** product formed in this reaction.

..... [1]

(b) Zinc oxide is then converted into zinc.

Zinc oxide and coke, a source of carbon, are heated in a furnace. Hot air is blown into the furnace.

(i) Give **two** reasons why coke is needed.

1

2 [2]

(ii) Write a chemical equation for the formation of zinc in the furnace.

..... [1]

(iii) Zinc has a melting point of 420°C and a boiling point of 907°C . The temperature inside the furnace is 1200°C .

Explain how this information shows that the zinc produced inside the furnace is a gas.

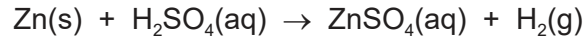
..... [1]

(iv) The gaseous zinc is converted to molten zinc.

Name this change of state.

..... [1]

(c) Zinc reacts with dilute sulfuric acid to produce aqueous zinc sulfate.



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.

Step 4 The saturated solution is allowed to cool and crystallise.

Step 5 The crystals are removed and dried.

(i) Name the residue in **step 2**.

..... [1]

(ii) In **step 3**, a saturated solution is produced.

Describe what a saturated solution is.

.....

 [2]

(iii) Name **two** compounds each of which react with dilute sulfuric acid to produce aqueous zinc sulfate.

1

2 [2]

(d) When hydrated magnesium sulfate crystals, $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$, are heated they give off water.



A student carries out an experiment to determine the value of x in $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$.

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.

.....

 [2]

(ii) In an experiment, all the water was removed from 1.23 g of $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$. The mass of MgSO_4 remaining was 0.60 g.

M_r : $\text{MgSO}_4 = 120$; M_r : $\text{H}_2\text{O} = 18$

Determine the value of x using the following steps.

- Calculate the number of moles of MgSO_4 remaining.

moles of $\text{MgSO}_4 = \dots\dots\dots$

- Calculate the mass of H_2O given off.

mass of $\text{H}_2\text{O} = \dots\dots\dots$ g

- Calculate the moles of H_2O given off.

moles of $\text{H}_2\text{O} = \dots\dots\dots$

- Determine the value of x .

$x = \dots\dots\dots$
 [4]

[Total: 17]

5 Group I elements, Group VII elements and transition elements are found in different parts of the Periodic Table.

(a) Describe the trend in the reactivity of Group I elements.

.....
 [1]

(b) When 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) Excess 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.

..... [2]

(ii) State the final colour of the reaction mixture.

..... [1]

(d) Sodium is extracted from sodium chloride by electrolysis.

(i) State the meaning of the term *electrolysis*.

.....
 [2]

(ii) State what must be done to sodium chloride before it can be electrolysed to produce sodium.

..... [1]

(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 CrCl_2 and CrCl_3 .
- Oxides of chromium act as catalysts in the manufacture of poly(ethene).

(i) Use this information to give **two** properties of chromium which are different from properties of Group I elements such as sodium.

1

2

[2]

(ii) Use this information to give **two** properties of chromium which are similar to properties of Group I elements such as sodium.

1

2

[2]

[Total: 16]

6 (a) A carboxylic acid and an ester are structural isomers.

(i) State the meaning of the term *structural isomers*.

.....
.....
..... [2]

(ii) Draw the structures of the carboxylic acid and the ester which both contain two carbon atoms.

Show all of the atoms and all of the bonds.

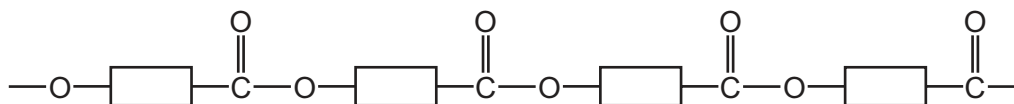
Name the carboxylic acid and the ester.

carboxylic acid
name

ester
name

[4]

(b) Part of a polyester chain is shown. This polyester is made from one monomer.

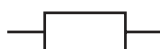


(i) **On the diagram** draw a ring around one unit of the polymer that is repeated. [1]

(ii) Name the type of polymerisation that produces polyesters.

..... [1]

(iii) Complete the diagram to show the structure of the monomer used to produce this polyester. Show all of the atoms and all of the bonds in the functional groups.



[2]

(c) A polyamide is made from the two monomers shown.



Complete the diagram to show a section of the polyamide made from the two monomers. Show all of the atoms and all of the bonds in the linkages.



[2]

(d) Naturally 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]

[Total: 14]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

The Periodic Table of Elements

		Group																																			
I	II	III	IV	V	VI	VII	VIII																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																				
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18	K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36										
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 90	Nb niobium 91	Mo molybdenum 92	Tc technetium 93	Ru ruthenium 94	Rh rhodium 95	Pd palladium 96	Ag silver 97	Cd cadmium 98	In indium 99	Sn tin 100	Sb antimony 101	Te tellurium 102	I iodine 103	Xe xenon 104	Cs caesium 133	Ba barium 137	La lanthanum 139	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium 210	At astatine 210	Rn radon 222		
87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Fr francium —	Ra radium —	Ac actinium —	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Fl flerovium —	Lv livermorium —	Uu ununoctium —	Uub unubium —	Uut ununtrium —	Uuq ununquadium —	Uup ununpentium —	Uuq ununhexium —	Uuh ununheptium —	Uuo ununoctium —	Uuq ununnonium —	Uuq unundecium —	Uuq ununtridecium —	Uuq ununpentadecium —	Uuq ununseptendecium —	Uuq ununnonadecium —	Uuq ununvigintiium —	Uuq ununtriacontium —	Uuq ununquadragintaium —	Uuq ununquinquagintaium —	Uuq ununsexagintaium —	Uuq ununseptuagintaium —	Uuq ununoctogintaium —	Uuq ununnonagintaium —		

Key

atomic number
atomic symbol
name
relative atomic mass

1
H
hydrogen
1

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

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