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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]

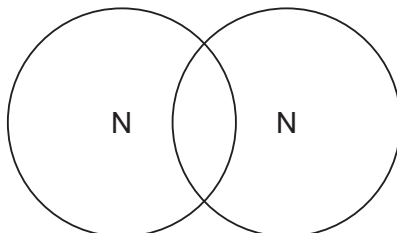
(iii) negative ions [1]

(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:

.....

.....

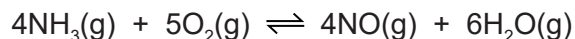
.....

.....

[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*.

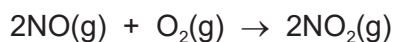
..... [1]

(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]

6

(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.

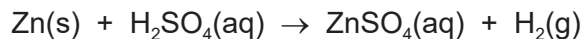
..... [1]

(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.

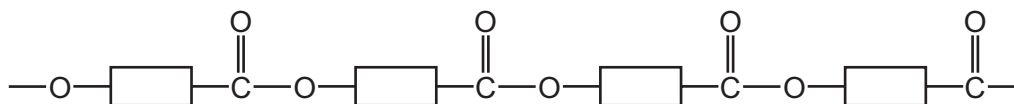
Name the carboxylic acid and the ester.

carboxylic acid
name

ester
name

[4]

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

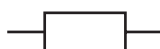


(i) **On the diagram** draw a ring around one unit of the polymer that is repeated. [1]

(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]

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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	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20										
11	12	13	14	15	16	17	18										
Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40										
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs caesium 133	Ba barium 137	lanthanoids	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 —	At astatine —	Rn radon —
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Lv livermorium —	Ts tennessine —	Og oganeson —	—

Key

atomic number

atomic symbol

name

relative atomic mass

1

H

hydrogen

1

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

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