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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.

2

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]

3

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]

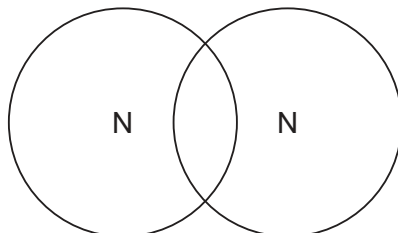
(iv) isotopes of each other. [1]

[Total: 7]

4

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:

.....

.....

.....

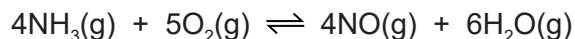
.....

[5]

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*.

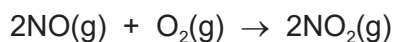
..... [1]

- (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]

7

- 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.

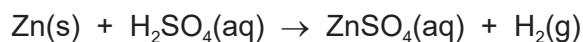
..... [1]

(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 $\text{H}_2\text{O} = \dots\dots\dots \text{ g}$

- 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.

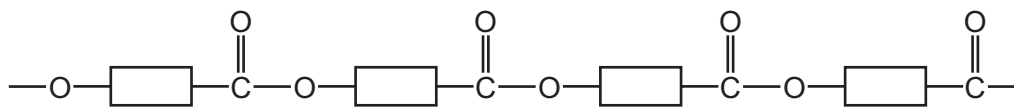
Name the carboxylic acid and the ester.

carboxylic acid	ester
name	name

[4]

13

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

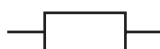


(i) On the diagram draw a ring around one unit of the polymer that is repeated. [1]

(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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Group

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	europlum	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
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 dm^3 at room temperature and pressure (r.t.p.).