Cambridge Assessment International Education

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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.

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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:

View solution

(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]

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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**.

View solution

..... [1]

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

View solution

..... [1]

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

View solution

..... [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]

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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.

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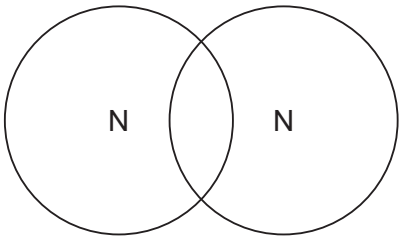

[2]

View solution

(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]

View solution

(c) Some of the ammonia made by the 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 term *catalyst*.

.....

..... [2]

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

View solution

..... [1]

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

View solution

	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, NO_2.

View solution

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

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_4NO_3, is a fertiliser.

Calculate the percentage by mass of nitrogen in ammonium nitrate.

View solution

..... % [2]

[Total: 20]

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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.

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

..... [1]

(b) Zinc oxide is then converted into zinc.

View solution

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.

View solution

..... [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.

View solution

..... [1]

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

View solution

Name this change of state.

..... [1]

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

View solution

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

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.

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.

View solution

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]

View solution

(d) When hydrated magnesium sulfate crystals, $MgSO_4 \cdot xH_2O$, are heated they give off water.

View solution

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

A student carries out an experiment to determine the value of x in $MgSO_4 \cdot xH_2O$.

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 $MgSO_4 \cdot xH_2O$. The mass of $MgSO_4$ remaining was 0.60 g.

View solution

M_r: $MgSO_4$ = 120; M_r: H_2O = 18

Determine the value of x using the following steps.

- Calculate the number of moles of $MgSO_4$ remaining.

moles of $MgSO_4$ = ...

- Calculate the mass of H_2O given off.

mass of H_2O = ... g

- Calculate the moles of H_2O given off.

moles of H_2O = ...

- Determine the value of x.

x = ...
[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.

View solution

.....

..... [1]

(b) When potassium is added to water a chemical reaction occurs.

View solution

(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.

View solution

..... [2]

(c) Excess aqueous potassium iodide is added to chlorine.

View solution

(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.

View solution

..... [1]

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

View solution

(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.

View solution

- 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]

View solution

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

View solution

(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.

View solution

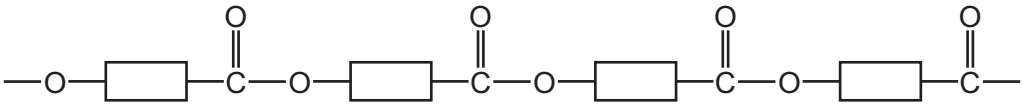
Name the carboxylic acid and the ester.

carboxylic acid	ester
name	name .....

[4]

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

View solution



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

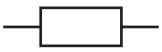
(ii) Name the type of polymerisation that produces polyesters.

View solution

..... [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.

View solution



[2]

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

View solution



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.

View solution

(i) State the name given to naturally occurring polyamides.

..... [1]

(ii) Name the monomers which form naturally occurring polyamides.

..... [1]

[Total: 14]

View solution

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

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