

## Entering exams – 2021 Part 1 (20 min)

### Task 1

Find the ions from the listed below, these have the same electron configuration as a  $Na^+$ :

- 1)  $Li^+$       2)  $Cl^-$       3)  $Mg^{2+}$       4)  $N^{-3}$       5)  $S^{+4}$       6)  $P^{+5}$

### Task 2

Find the chemical substances from the listed below, these have at least one donor-acceptor bond:

- 1)  $SOCl_2$       2)  $O_2$       3)  $O_3$       4)  $[(CH_3)_2NH_2]Cl$       5)  $NH_3$       6)  $BF_4$

### Task 3

Find the chemical substances from the listed below, these able to react with water at room temperature:

- 1)  $CuO$       2)  $CaO$       3)  $Zn$       4)  $Ca$       5)  $NO_2$       6)  $Al_2S_3$

### Task 4

Find the substances from the listed below, these able to react with ammonia solution:

- 1)  $CuO$       2)  $NaCl_{(p-p)}$       3)  $Be(OH)_2$       4)  $AlCl_{3(p-p)}$       5)  $CuSO_{4(p-p)}$       6)  $Al(OH)_3$

### Task 5

Find the substances from the listed below, these able to form geometric isomers:

- 1) butene-1; 2) butene-2; 3) butyne-1; 4) butyne-2; 5) 1,3-dichlorocyclobutane; 6) 1,1-dimethylcyclobutane.

### Task 6

Find the main products in the second column (numbered list with numbers), these formed by reactions listed in the first column (numbered list with letters)

Reactions	Main product
A) $C_6H_6 + Cl_2 (hv)$	1. $C_6H_5CH_2Cl$
B) $C_6H_5CH_3 + Cl_2 (hv)$	2. $C_6H_6Cl_6$
C) $CH_3CH=CH_2 + HCl$	3. $C_6H_5Cl$
D) $CH_3Cl + C_6H_6 (catalyst)$	4. $CH_3CH(Cl)CH_3$
	5. $C_6H_5CH_3$
	6. $CH_3CH_2CH_2Cl$

Fill up the second row in the table below. Put the correct numbers of main products below the letters of reactions.

A	B	C	D

### Task 7

Find the main products in the second column (numbered list with numbers), these formed by reactions listed in the first column (numbered list with letters)

Reactions	Main product
A) $CH_3COONa + NaOH (melting)$	1. $C_2H_5OH$
B) $CH_3COOH + Cu(OH)_2$	2. $(CH_3COO)_2Cu$
C) $CH_3CHO + Cu(OH)_2$	3. $CH_3OH$
D) $CH_3CHO + H_2$	4. $CH_4$
	5. $CH_3COOH$

	6. C <sub>2</sub> H <sub>6</sub>
--	----------------------------------

Fill up the second row in the table below. Put the correct numbers of main products below the letters of reactions.

A	B	C	D

### Task 8

Find the reagent in the second column, that allows to distinguish two gases from the first column.

Gases	Reagent
A) CO and CO <sub>2</sub>	1. phenolphthaleine
B) HI and HCl	2. H <sub>3</sub> PO <sub>4</sub>
C) H <sub>2</sub> and N <sub>2</sub>	3. CuO
D) CH <sub>4</sub> and C <sub>2</sub> H <sub>4</sub>	4. Br <sub>2</sub> (aq.)
	5. KCl

Fill up the second row in the table below. Put the correct numbers of reagents below the letters of gas.

A	B	C	D

### Task 9

Find the products of the electrolysis in the second column (numbered list with numbers), these formed by electrolysis of aqueous solution of salts from the first column (numbered list with letters) on inert electrodes.

Salt	Products
A) Na <sub>2</sub> CO <sub>3</sub>	1. Metall and chlorine
B) MgSO <sub>4</sub>	2. Hydrogen and oxygen
C) Cu(NO <sub>3</sub> ) <sub>2</sub>	3. Metall and oxygen
D) CuCl <sub>2</sub>	4. Hydrogen and chlorine
	5. Hydrogen, metall and oxygen
	6. Hydrogen, metall and chlorine

Fill up the second row in the table below. Put the correct numbers of products below the letters of salts.

A	B	C	D

### Task 10

Find the mass of aluminium that should be dissolved in excess of sodium hydroxide solution, in order to get the sufficient amount of hydrogen gas for the complete reduction of 24 g copper oxide. Molecular weight of copper is 64 g/mol.

### Part 2 (40 min)

#### Task 1

Chromium oxide (III) and sodium carbonate were melted together in oxygen atmosphere. Evolved gas was passed through limewater (Ca(OH)<sub>2</sub>). The remaining solid was dissolved in water. Barium hydroxide solution was added to the resulted solution and bright yellow precipitate was formed. This precipitate was dissolved in nitric acid forming an orange solution.

Write down four chemical reactions described above.

#### Task 2

Mixture of neutral and basic carbonates of unknown bivalent metal with mass of 36.2 g was thermally decomposed. Volume of evolved gases was 15.3 l at 350 °C and 1 atm. By cooling the mixture of gases to room temperature at 1 atm the total volume reduced up to 5.6 l.

Determine the unknown metal and salts thereof.