MINISTRY OF PUBLIC HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY

Educational degree *master* (level of educational degree) Training area *22 – PUBLIC HEALTH* (code number and title of training area)

Speciality *226 – PHARMACY, INDUSTRIAL PHARMACY* (code number and title of speciality) Educational program *PHARMACY* (Фм(5,0)англ) (title of educational program)

Semester *autumn semester*, 2019/2020 *academic year* Subject *ANALYTICAL CHEMISTRY* (title of academic subject)

FINAL MODULE CONTROL
MODULE 1. QUALITATIVE ANALYSIS. BASIC OF QUANTITATIVE ANALYSIS

QUESTION CARD (EXAMPLE)

1. **Carry out qualitative analysis of the certain salt. Write the equations of the reactions of cation and anion detection and reactions of cation and anion with the respective group reagents; specify the conditions of their carrying out.**
2. **Carry out determination of $KHCO_3$ ($M(KHCO_3)$ = 100.115 g/mole) by the method of acid-base titration (the pipetting method). Write the equation of reaction. Calculate the stoichiometrical ratio *s* and the factor of equivalence *f* for the substance to be determined. Calculate the sample mass of the substance to be determined, which is necessary for reliable determination carrying out, in two ways – according to the molar mass of equivalent and according to the molar mass ($c(HCl)$ = 0.1 mole/dm^3, $\omega(KHCO_3) \approx 90\%$, $V_{m.f}$ = 200.00 cm^3, V_p = 10.00 cm^3).**
3. **Carry out determination of NaOH ($M(NaOH)$ = 39.9971 g/mole) by the method of acid-base titration (the method of separate samples). Write the equation of reaction. Calculate the stoichiometrical ratio *s* and the factor of equivalence *f* for the substance to be determined. Calculate the percentage of the substance to be determined in three ways – according to the molar mass of equivalent, according to the molar mass and according to the titre of the titrant by the substances to be determined ($c(HCl)$ = 0.1005 mole/dm^3, $V(HCl)$ = 20.56 cm^3, $m(NaOH)$ = 0.1234 g).**
4. **Answer the tests.**

POINTS DISTRIBUTION

question 1	**10 points**
question 2	**8 points**
question 3	**12 points**
question 4	**10 points**
in all	**40 points**

Estimation scale: national and ECTS

Points in all	ECTS mark	Mark by national scale
36 – 40	**A**	**5**
34 – 35	**B**	**4**
30 – 33	**C**	
26 – 29	**D**	**3**
24 – 25	**E**	
0 – 23	**F**	**2**

It has been approved at the meeting of the Analytical Chemistry Department.
The minutes №1 from 29. 08. 2019 year.

Head of the Analytical Chemistry Department, prof. _____ (sign) I. S. Grytsenko

Examiner, as. prof. _____ (sign) O. Ye. Mykytenko

performed by as. prof. Klimenko L. Yu., as. prof. Mykytenko O. Ye., as. prof. Kostina T. A.

FINAL CONTROL №1

1. Carry out qualitative analysis of $CoCl_2$. Write the equations of the reactions of cation and anion detection and reactions of cation and anion with the respective group reagents; specify the conditions of their carrying out.

$$CoCl_2 \rightarrow Co^{2+} + 2\ Cl^-$$

1. Action of the group reagent for Co^{2+}-cations – ammonia solution:

$$Co^{2+} + NH_3 \cdot H_2O + Cl^- \rightarrow \underset{\text{dark-blue}}{Co(OH)Cl\downarrow} + NH_4^+$$

$$Co(OH)Cl\downarrow + 6\ NH_3 \cdot H_2O \rightarrow \underset{\substack{\text{orange}\\ \text{solution}}}{[Co(NH_3)_6]^{2+}} + Cl^- + OH^- + 6\ H_2O$$

2. Identification of Co^{2+}-cations:

2.1. Action of ammonium thiocyanate solution:

$$2\ NH_4^+ + Co^{2+} + 4\ SCN^- \rightarrow \underset{\text{dark blue solution}}{(NH_4)_2[Co(SCN)_4]}$$

3. Soda extraction:

$$2\ Co^{2+} + 2\ CO_3^{2-} + H_2O \rightarrow (CoOH)_2CO_3\downarrow + CO_2\uparrow$$

4. Action of the group reagent for Cl^--anions – silver nitrate solution:

$$Cl^- + Ag^+ \rightarrow \underset{\text{white}}{AgCl\downarrow}$$

5. Identification of Cl^--anions:

5.1. Formation of AgCl caseous precipitate and its dissolution in $NH_3 \cdot H_2O$:

$$Cl^- + Ag^+ \rightarrow \underset{\text{white}}{AgCl\downarrow}$$

$$AgCl\downarrow + 2\ NH_3 \cdot H_2O \rightarrow [Ag(NH_3)_2]^+ + Cl^- + 2\ H_2O$$

5.2. Action of potassium dichromate:

The reaction is carried out in a dry way. Chloride-ions interact with $K_2Cr_2O_7$ in the presence of H_2SO_4 and form the volatile substance CrO_2Cl_2:

$$4\ CaCl_2 + K_2Cr_2O_7 + 3\ H_2SO_4 \rightarrow 2\ CrO_2Cl_2\uparrow + 2\ CaSO_4 + K_2SO_4 + 3\ H_2O$$

Gaseous CrO_2Cl_2 is identified by appearance of a red-violet colour of filter paper impregnated with diphenylcarbazide solution.

performed by as. prof. Klimenko L. Yu., as. prof. Mykytenko O. Ye., as. prof. Kostina T. A.

2. Carry out determination of $KHCO_3$ ($M(KHCO_3)$ = 100.115 g/mole) by the method of acid-base titration (the pipetting method). Write the equation of reaction. Calculate the stoichiometrical ratio *s* and the factor of equivalence *f* for the substance to be determined. Calculate the sample mass of the substance to be determined, which is necessary for reliable determination carrying out, in two ways – according to the molar mass of equivalent and according to the molar mass ($c(HCl)$ = 0.1 mole/dm³, $\omega(KHCO_3) \approx 90\%$, $V_{m.f}$ = 200.00 cm³, V_p = 10.00 cm³).

$KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2$
indicator *– methyl orange*
$s = 1$; $f(KHCO_3) = 1$; $f(HCl) = 1$;
$E(KHCO_3) = M(KHCO_3) \cdot f(KHCO_3) = 100.115 \cdot 1 = 100.115$ g/mole

Given:

$c(HCl)$ = 0.1 mole/dm³
$V_{min}(HCl)$ = 20 cm³
$\omega(KHCO_3) \approx 90\%$
$E(KHCO_3)$ = 100.115 g/mole
$M(KHCO_3)$ = 100.115 g/mole
$V_{m.f}$ = 200.00 cm³
V_p = 10.00 cm³

$m(KHCO_3)$ – ?

calculation of $m(KHCO_3)$ according to $E(KHCO_3)$

$$m(KHCO_3) = \frac{c(HCl) \cdot V(HCl) \cdot E(KHCO_3) \cdot 100 \cdot V_{m.f}}{1000 \cdot \omega(KHCO_3) \cdot V_p} =$$

$$= \frac{0{,}1 \cdot 20 \cdot 100.115 \cdot 100 \cdot 200.00}{1000 \cdot 90 \cdot 10.00} = 4.45 \text{ g}$$

calculation of $m(KHCO_3)$ according to $M(KHCO_3)$ and *s*

$$m(KHCO_3) = \frac{c(HCl) \cdot V(HCl) \cdot s \cdot M(KHCO_3) \cdot 100 \cdot V_{m.f}}{1000 \cdot \omega(KHCO_3) \cdot V_p} =$$

$$= \frac{0{,}1 \cdot 20 \cdot 1 \cdot 100.115 \cdot 100 \cdot 200.00}{1000 \cdot 90 \cdot 10.00} = 4.45 \text{ g}$$

3. Carry out determination of NaOH (*M*(NaOH) = 39.9971 g/mole) by the method of acid-base titration (the method of separate samples). Write the equation of reaction. Calculate the stoichiometrical ratio *s* and the factor of equivalence *f* for the substance to be determined. Calculate the percentage of the substance to be determined in three ways – according to the molar mass of equivalent, according to the molar mass and according to the titre of the titrant by the substances to be determined (*c*(HCl) = 0.1005 mole/dm³, *V*(HCl) = 20.56 cm³, *m*(NaOH) = 0.1234 g).

$NaOH + HCl \rightarrow NaCl + H_2O$
indicator *– phenolphthalein*
s = 1; *f*(NaOH) = 1; *f*(HCl) = 1;
$E(NaOH) = M(NaOH) \cdot f(NaOH) = 39.9997 \cdot 1 = 39.9997$ g/mole

Given:

$m(NaOH) = 0.1234$ g $c(HCl) = 0.1005$ mole/dm³ $V(HCl) = 20.56$ cm³ $E(NaOH) = 39.9997$ g/mole $M(NaOH) = 39.9997$ g/mole	**calculation of ω(NaOH) according to *E*(NaOH)** $\omega(NaOH) = \frac{c(HCl) \cdot V(HCl) \cdot E(NaOH) \cdot 100}{1000 \cdot m(NaOH)} =$
ω(NaOH) – ?	$= \frac{0.1005 \cdot 20.56 \cdot 39.9997 \cdot 100}{1000 \cdot 0.1234} = 65.15\%$

calculation of ω(NaOH) according to *M*(NaOH) and *s*

$$\omega(NaOH) = \frac{c(HCl) \cdot V(HCl) \cdot s \cdot M(NaOH) \cdot 100}{1000 \cdot m(NaOH)} = \frac{0.1005 \cdot 20.56 \cdot 1 \cdot 39.9997 \cdot 100}{1000 \cdot 0.1234} = 65.15\%$$

calculation of ω(NaOH) according to *T*(HCl/NaOH)

$$T(HCl/NaOH) = \frac{c(HCl)_{theor} \cdot E(NaOH)}{1000} = \frac{0.1000 \cdot 39.9997}{1000} = 0.004000 \text{ g/cm}^3$$

$$T(HCl/NaOH) = \frac{c(HCl)_{theor} \cdot s \cdot M(NaOH)}{1000} = \frac{0.1000 \cdot 1 \cdot 39.9997}{1000} = 0.004000 \text{ g/cm}^3$$

$$K(HCl) = \frac{c(HCl)_{pract}}{c(HCl)_{theor}} = \frac{0.1005}{0.1000} = 1.005$$

$$\omega(NaOH) = \frac{K(HCl) \cdot V(HCl) \cdot T(HCl/NaOH) \cdot 100}{m(NaOH)} = \frac{1.005 \cdot 20.56 \cdot 0.004000 \cdot 100}{0.1234} = 65.15\%$$