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

THEMATIC CONTROL №3

QUESTION CARD (EXAMPLE)

1. **Prepare the solution of the titrant of $AgNO_3$ with the concentration of 0.1 mole/dm^3. Calculate the sample mass of $AgNO_3$ ($M(AgNO_3)$ = 169.873 g/mole) for preparation of 5 dm^3 of the titrant solution in two ways – according to the molar mass of equivalent and according to the molar mass.**
2. **Carry out determination of $CaCl_2$ ($M(CaCl_2)$ = 110.99 g/mole) by the method of mercurometry (the pippeting method). Write the equation of reaction. Calculate the stoichiometrical ratio *s*, the factor of equivalence *f* for the substance to be determined and its molar mass of equivalent *E*. 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 ($c(1/2Hg_2(NO_3)_2)$ = 0.1 mole/dm^3, $\omega(CaCl_2) \approx 80\%$, $V_{m.f}$ = 100.00 cm^3, V_p = 10.00 cm^3).**
3. **Carry out determination of $Na_2C_2O_4$ ($M(Na_2C_2O_4)$ = 134.000 g/mole) by the method of permanganatometry (the method of separate samples). Write the equation of reaction. Calculate the stoichiometrical ratio *s*, the factor of equivalence *f* for the substance to be determined and its molar mass of equivalent *E*. 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 ($c(1/5KMnO_4)$ = 0.1015 mole/dm^3, $V(KMnO_4)$ = 25.18 cm^3, $m(Na_2C_2O_4)$ = 0.2458 g).**
4. **Answer the tests.**

POINTS DISTRIBUTION

question 1	**1.5 points**
question 2	**2.5 points**
question 3	**4 points**
question 4	**1 points**
in all	**9 points**

Estimation scale: national and ECTS

Points in all	ECTS mark	Mark by national scale
8.1 – 9.0	**A**	**5**
7.3 – 8.0	**B**	**4**
6.9 – 7.3	**C**	
6.0 – 6.8	**D**	**3**
5.0 – 5.9	**E**	
0 – 4.9	**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) L. Yu. Klimenko

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

THEMATIC CONTROL №3

1. Prepare the solution of the titrant of $AgNO_3$ with the concentration of 0.1 mole/dm³. Calculate the sample mass of $AgNO_3$ ($M(AgNO_3)$ = 169.873 g/mole) for preparation of 5 dm³ of the titrant solution in two ways – according to the molar mass of equivalent and according to the molar mass.

Given:

$V(AgNO_3)$ = 5 dm³
$c(AgNO_3)$ = 0.1 mole/dm³
$E(AgNO_3)$ = 169.873 g/mole
$M(AgNO_3)$ = 169.873 g/mole

$m(AgNO_3)$ – ?

$$m(AgNO_3) = c(AgNO_3) \cdot V(AgNO_3) \cdot E(AgNO_3) =$$
$$= 0.1 \cdot 5 \cdot 169.873 = 84.94 \text{ g}$$

$$m(AgNO_3) = c(AgNO_3) \cdot V(AgNO_3) \cdot M(AgNO_3) =$$
$$= 0.1 \cdot 5 \cdot 169.873 = 84.94 \text{ g}$$

2. Carry out determination of $CaCl_2$ ($M(CaCl_2)$ = 110.99 g/mole) by the method of mercurometry (the pippeting method). Write the equation of reaction. Calculate the stoichiometrical ratio *s*, the factor of equivalence *f* for the substance to be determined and its molar mass of equivalent *E*. 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 ($c(1/2Hg_2(NO_3)_2)$ = 0.1 mole/dm³, $\omega(CaCl_2) \approx 80\%$, $V_{m.f}$ = 100.00 cm³, V_p = 10.00 cm³).

$CaCl_2 + Hg_2(NO_3)_2 \rightarrow Hg_2Cl_2\downarrow + Ca(NO_3)_2$
indicator *– diphenylcarbazone*
s = 1; $f(CaCl_2)$ = 1/2; $f(Hg_2(NO_3)_2)$ = 1/2;
$E(CaCl_2) = M(CaCl_2) \cdot f(CaCl_2)$ = 110.99·1/2 = 55.495 g/mole

Given:

$c(1/2Hg_2(NO_3)_2)$ = 0.1 mole/dm³
$V(Hg_2(NO_3)_2)$ = 20 cm³
$E(CaCl_2)$ = 55.495 g/mole
$M(CaCl_2)$ = 110.99 g/mole
$\omega(CaCl_2) \approx 80\%$
$V_{m.f}$ = 100.00 cm³
V_p = 10.00 cm³

$m(CaCl_2)$ – ?

calculation of $m(CaCl_2)$ according to $E(CaCl_2)$

$$m(CaCl_2) = \frac{c(1/2Hg_2(NO_3)_2) \cdot V(Hg_2(NO_3)_2) \cdot E(CaCl_2) \cdot 100 \cdot V_{m.f}}{1000 \cdot \omega(CaCl_2) \cdot V_p} =$$
$$= \frac{0.1 \cdot 20 \cdot 55.495 \cdot 100 \cdot 100.00}{1000 \cdot 80 \cdot 10.00} = 1.39 \text{ g}$$

calculation of $m(CaCl_2)$ according to $M(CaCl_2)$ and *s*

$$c(Hg_2(NO_3)_2) = c(1/2Hg_2(NO_3)_2) \cdot f(Hg_2(NO_3)_2) =$$
$$= 0.1 \cdot 1/2 = 0.05 \text{ mole/dm}^3$$

$$m(CaCl_2) = \frac{c(Hg_2(NO_3)_2) \cdot V(Hg_2(NO_3)_2) \cdot s \cdot M(CaCl_2) \cdot 100 \cdot V_{m.f}}{1000 \cdot \omega(CaCl_2) \cdot V_p} =$$
$$= \frac{0{,}05 \cdot 20 \cdot 1 \cdot 110.99 \cdot 100 \cdot 100.00}{1000 \cdot 80 \cdot 10.00} = 1.39 \text{ g}$$

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

3. Carry out determination of $Na_2C_2O_4$ ($M(Na_2C_2O_4)$ = 134.000 g/mole) by the method of permanganatometry (the method of separate samples). Write the equation of reaction. Calculate the stoichiometrical ratio *s*, the factor of equivalence *f* for the substance to be determined and its molar mass of equivalent *E*. 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 ($c(1/5KMnO_4)$ = 0.1015 mole/dm³, $V(KMnO_4)$ = 25.18 cm³, $m(Na_2C_2O_4)$ = 0.2458 g).

$-2\ e + C_2O_4^{2-} \rightarrow 2\ CO_2$	5
$+5\ e + MnO_4^- + 8\ H^+ \rightarrow Mn^{2+} + 4\ H_2O$	2

$$5\ C_2O_4^{2-} + 2\ MnO_4^- + 16\ H^+ \rightarrow 10\ CO_2 + 2\ Mn^{2+} + 8\ H_2O$$

$s = 5/2$; $f(Na_2C_2O_4) = 1/2$; $f(KMnO_4) = 1/5$;

$E(Na_2C_2O_4) = M(Na_2C_2O_4) \cdot f(Na_2C_2O_4) = 134.000 \cdot 1/2 = 67.000$ g/mole

Given:

$c(1/5KMnO_4) = 0.1015$ mole/dm³
$V(KMnO_4) = 25.18$ cm³
$m(Na_2C_2O_4) = 0.2458$ g
$E(Na_2C_2O_4) = 67.000$ g/mole
$M(Na_2C_2O_4) = 134.000$ g/mole

$\omega(Na_2C_2O_4)$ – ?

calculation of $\omega(Na_2C_2O_4)$ according to $E(Na_2C_2O_4)$

$$\omega(Na_2C_2O_4) = \frac{c(1/5KMnO_4) \cdot V(KMnO_4) \cdot E(Na_2C_2O_4) \cdot 100}{1000 \cdot m(Na_2C_2O_4)} =$$

$$= \frac{0.1015 \cdot 25.18 \cdot 67.000 \cdot 100}{1000 \cdot 0.2458} = 69.70\%$$

$$c(KMnO_4) = c(1/5KMnO_4) \cdot f(KMnO_4) = 0.1015 \cdot 1/5 = 0.02030 \text{ mole/dm}^3$$

calculation of $\omega(Na_2C_2O_4)$ according to $M(Na_2C_2O_4)$ and *s*

$$\omega(Na_2C_2O_4) = \frac{c(KMnO_4) \cdot V(KMnO_4) \cdot s \cdot M(Na_2C_2O_4) \cdot 100}{1000 \cdot m(Na_2C_2O_4)} =$$

$$= \frac{0.02030 \cdot 25.18 \cdot 5/2 \cdot 134.000 \cdot 100}{1000 \cdot 0.2458} = 69.70\%$$

calculation of $\omega(Na_2C_2O_4)$ according to $T(KMnO_4/Na_2C_2O_4)$

$$T(KMnO_4/Na_2C_2O_4) = \frac{c(1/5KMnO_4)_{theor} \cdot E(Na_2C_2O_4)}{1000} = \frac{0.1000 \cdot 67.000}{1000} = 0.006700 \text{ g/cm}^3$$

$$T(KMnO_4/Na_2C_2O_4) = \frac{c(KMnO_4)_{theor} \cdot s \cdot M(Na_2C_2O_4)}{1000} = \frac{0.02000 \cdot 5/2 \cdot 134.000}{1000} = 0.006700 \text{ g/cm}^3$$

$$K(KMnO_4) = \frac{c(1/5KMnO_4)_{pract}}{c(1/5KMnO_4)_{theor}} = \frac{0.1015}{0.1000} = 1.015$$

$$\omega(Na_2C_2O_4) = \frac{K(KMnO_4) \cdot V(KMnO_4) \cdot T(KMnO_4/Na_2C_2O_4) \cdot 100}{m(Na_2C_2O_4)} =$$

$$= \frac{1.015 \cdot 25.18 \cdot 0.006700 \cdot 100}{0.2458} = 69.70\%$$