MINISTRY OF PUBLIC HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY

Educational degree *master* Training area 22 – *PUBLIC HEALTH*
(level of educational degree) (code number and title of training area)
Speciality *226 – PHARMACY, INDUSTRIAL PHARMACY* Educational program *PHARMACY* (Фм(5,0)англ)
(code number and title of speciality) (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. ________________ I. S. Grytsenko
(sign)

Examiner, as. prof. ________________ L. Yu. Klimenko
(sign)

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

$m(AgNO_3)$ – ?

$$m(\text{AgNO}_3) = c(\text{AgNO}_3)\cdot V(\text{AgNO}_3)\cdot E(\text{AgNO}_3) = 0.1\cdot 5\cdot 169.873 = 84.94 \text{ g}$$

$$m(\text{AgNO}_3) = c(\text{AgNO}_3)\cdot V(\text{AgNO}_3)\cdot M(\text{AgNO}_3) = 0.1\cdot 5\cdot 169.873 = 84.94 \text{ g}$$

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, ω($CaCl_2$) ≈ 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*
$s = 1$; $f(CaCl_2) = 1/2$; $f(Hg_2(NO_3)_2) = 1/2$;
$E(CaCl_2) = M(CaCl_2)\cdot f(CaCl_2) = 110.99\cdot 1/2 = 55.495$ 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
ω($CaCl_2$) ≈ 80%
$V_{m.f}$ = 100.00 cm³
V_p = 10.00 cm³

$m(CaCl_2)$ – ?

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

$$m(\text{CaCl}_2) = \frac{c(1/2\text{Hg}_2(\text{NO}_3)_2)\cdot V(\text{Hg}_2(\text{NO}_3)_2)\cdot E(\text{CaCl}_2)\cdot 100\cdot V_{m.f}}{1000\cdot \omega(\text{CaCl}_2)\cdot V_p} =$$

$$= \frac{0.1\cdot 20\cdot 55.495\cdot 100\cdot 100.00}{1000\cdot 80\cdot 10.00} = 1.39 \text{ g}$$

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

$$c(\text{Hg}_2(\text{NO}_3)_2) = c(1/2\text{Hg}_2(\text{NO}_3)_2)\cdot f(\text{Hg}_2(\text{NO}_3)_2) = 0.1\cdot 1/2 = 0.05 \text{ mole/dm}^3$$

$$m(\text{CaCl}_2) = \frac{c(\text{Hg}_2(\text{NO}_3)_2)\cdot V(\text{Hg}_2(\text{NO}_3)_2)\cdot s\cdot M(\text{CaCl}_2)\cdot 100\cdot V_{m.f}}{1000\cdot \omega(\text{CaCl}_2)\cdot V_p} =$$

$$= \frac{0{,}05\cdot 20\cdot 1\cdot 110.99\cdot 100\cdot 100.00}{1000\cdot 80\cdot 10.00} = 1.39 \text{ g}$$

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).

$$-2e + C_2O_4^{2-} \rightarrow 2CO_2 \quad | \; 5$$
$$+5e + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O \quad | \; 2$$
$$5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \rightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$$

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

$E(Na_2C_2O_4) = M(Na_2C_2O_4)\cdot f(Na_2C_2O_4) = 134.000\cdot 1/2 = 67.000$ 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 $T(KMnO_4/Na_2C_2O_4)$

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

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

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

$$\omega(Na_2C_2O_4) = \frac{K(KMnO_4)\cdot V(KMnO_4)\cdot T(KMnO_4/Na_2C_2O_4)\cdot 100}{m(Na_2C_2O_4)} = \frac{1.015\cdot 25.18\cdot 0.006700\cdot 100}{0.2458} = 69.70\%$$

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