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METHODICAL MANUAL
ON PHYSICAL AND COLLOIDAL CHEMISTRY
for preparation
FOR "KROK 1. PHARMACY"

METHODICAL MANUAL
ON PHYSICAL AND COLLOIDAL CHEMISTRY
for preparation
FOR "KROK 1. PHARMACY"
(field of knowledge 22 health care specialty
«Pharmacy. Industrial pharmacy»,
second master's level)

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   The methodological manual for students is intended for preparation for KROK-1, exams, tests, assessment in physical and colloid chemistry under the program on the discipline of training pharmacists at the educational and qualification level "master", which contains the necessary list of knowledge, skills and abilities taking into account international requirements for credit transfer system of international normative documents and standards regulating professional activity and training of masters of pharmacy.
The immediate need for such a methodical guide for students is due to the limited time students have to study the discipline and the wide implementation of a test form of students' knowledge control.
   The methodological manual consists of four chapters and eight topics.
   The "Thermodynamics" and "Kinetics" sections consider the possibilities and limits of the application of the laws of thermodynamics, kinetics, the importance of the laws for the course of processes in the creation of drugs and their application.
   In the sections "Solutions" and "Electrochemistry" attention is drawn to the comparison of the properties of solutions of non-electrolytes and electrolytes of different strengths, protolytes, buffer solutions; electrochemical methods of analysis in the creation of drugs are considered, the advantage of methods in modern pharmaceutical research is emphasized.
In the sections "Surface Phenomena" and "Dispersed Systems", the main regularities of surfaces are given, molecular-kinetic, electrokinetic, and optical properties of colloidal solutions are compared, attention is focused on the application of coarsely dispersed systems (suspensions, emulsions, aerosols) in pharmacy.
   Test tasks are systematized according to the theoretical provisions of the discipline and can be used for further study of the course by students.
   The methodological manual consists of appropriately structured modules, blocks of content modules and lesson topics.

TOPIC 1. CHEMICAL THERMODYNAMICS AND CHEMICAL KINETICS

Theoretical basis

1.1 .Chemical thermodynamics

Chemical thermodynamics is the science of the relationship between chemical energy and other types of energy, the conditions and possibilities of spontaneous chemical reactions.

Basic Concepts.

1.1. internal energy (U) - the sum of all types of energies of the system particles depending on temperature, volume, pressure, amount of substance and composition;

1.2. enthalpy (H, energy content) - the sum of internal energy and product of pressure on volume ($H = U + pV$);

1.3. entropy (S) - a measure of disorder, chaos or induced heat ($S = Q/T$);

1.4. Gibbs energy G (P = const, T = const) and **Helmholtz energy F** (V = const, T = const) -maximum work that the system is able to perform under certain conditions ($G = H - TS$, $F = U - TS$).

The main property of these parameters (physical quantities) is **the independence of the change of parameters from the path of change, but their dependence on the initial and final states**; the following parameters are called state functions:

$\Delta U = U_2 - U_1$; $\Delta H = H_2 - H_1$; $\Delta S = S_2 - S_1$; $\Delta G = G_2 - G_1$.

For simple substances (O_2, H_2, N_2) $\Delta H = 0$; $\Delta G = 0$; $\Delta F = 0$.

When the state is constant in time, the system is equilibrium:

$\Delta H = 0$; $\Delta G = 0$; $\Delta F = 0$; $\Delta S = 0$.

2. Standard thermodynamic parameters (ΔH^0_{298}, $\Delta^0 G_{298}$):

2.1. standard enthalpy of formation of matter (heat of formation) - heat of formation of matter (1 mol) from simple substances under standard conditions (st. cond.);

2.2. standard thermal effect of combustion of matter (heat of combustion) - heat of combustion of matter (1 mol) to higher stable oxides according to st. cond. in

3. Thermodynamic processes - processes carried out under the condition of constancy of the corresponding physical parameters:

3.1. isothermal (occurs in the thermostat) - the process at T = const;

3.2. isobaric (occurs when the system comes into contact with the atmosphere) - when P = const;

3.3. isochoric (occurs in a closed system, such as an autoclave) - when V = const;

3.4. isobaric - isothermal (occurs in an isolated system) - when P = const, T = const;

3.5. isochoric - isothermal (occurs in an isolated system) -when V = const, T = const.

3.6. adiabatic- (occurs under the condition Q = const).

4. Extensive parameters (derived from the main, intensive parameters: pressure, concentration, temperature) - internal energy **ΔU**, Gibbs energy **ΔG**, enthalpy **ΔH**, entropy **ΔS**, Helmholtz energy **ΔF**.

5. The criterion for the direction of a chemical reaction (straight, left to right) under **isobaric-isothermal conditions** (P and T = const) is **the Gibbs energy** (ΔG <0); the criterion of the direction of the chemical reaction (straight, left to right) in **isochoric-isothermal conditions** (V and T = const) is **the Helmholtz energy** (ΔF

<0); the criterion for the direction of the reaction in an **isolated system is entropy** ($\Delta S > 0$).

Basic laws and their connection with thermodynamic parameters

1. $Q = \Delta U + A$ - **equation of the first law of thermodynamics.**

2. $A = P\Delta V$ - **work of chemical process.**

3. $Q_v = \Delta U_v$ - **heat of isochoric process.**

4. $Q_p = \Delta H_p$ - **heat of isobaric process.**

5.1. $Q_p = \Delta H - P\Delta V$ - **equation of the first law of thermodynamics for isobaric processes.**

5.2. $Q_V = \Delta U - P\Delta V$ - **equation of the first law of thermodynamics for isochoric processes.**

6. Hess's law: the thermal effect of the reaction does not depend on the course of the reaction, but depends on the initial and final states (performed in isobaric and isochoric conditions (performed in an autoclave or calorimetric bomb).

6.1. $\Delta H = \sum_n \Delta H^0_{298 \text{ form. of reac. prod.}} - \sum_n \Delta H^0_{298 \text{ form of react.start mat.}}$ - **the first consequence of Hess's law.**

6.2. $\Delta H = \sum_n \Delta H^0_{298 \text{ burning of react.start mat.}} - \sum_n \Delta H^0_{298 \text{ burning of reac. prod.}}$ - **the second consequence of Hess's law.**

7. $Q = A$ – **equation of the first law of thermodynamics for biosystems.**

8. $\Delta S = \dfrac{Q}{T}$ - **entropy as a function of state or** $S = K \cdot \ln\dfrac{W2}{W1}$.

9. $\Delta S \geq 0$ - **equation of the second law of thermodynamics:** entropy does not change, $\Delta S = 0$, if the amount of substance (mol) before the reaction = the amount of substance (mol) after the reaction, for example $H_2 + Cl_2 \rightarrow 2HCl$, that is 2 mol (1 + 1 = 2 mol) before the reaction = 2 mol after the reaction.

10. $\Delta S = \sum_n S^0_{298 \text{ form. of reac. prod.}} - \sum_n S^0_{298 \text{ form of react.start mat}}$ – **calculation of reaction entropy.**

11. $\Delta G^0 = \Delta H^0 - T\Delta S^0$ - **Gibbs execution.**