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ZAPORIZHZHIA STATE MEDICAL
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DEPARTMENT OF PHARMACEUTICAL, ORGANIC
AND BIOORGANIC CHEMISTRY

PHARMACEUTICAL CHEMISTRY

Section 1.2

ANALYSIS OF MEDICINES OF THE VITAMIN GROUP

Study Guide for 4th year students
of the specialty"Pharmacy, Industrial Pharmacy"

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INTRODUCTION

Pharmaceutical chemistry is studied according to the Model curriculum for training specialists of the second (master's) level of higher education in the field of knowledge 22 "Health Protection" in higher educational institutions of the Ministry of Health of Ukraine in specialty 226 "Pharmacy" educational qualification "Master of Pharmacy" as of 26.07.2016.

Most of the drawings were developed by the authors of this study guide.

According to the order, pharmaceutical chemistry is studied in III, IV and V courses. In the fourth year (VII-VIII semesters) the discipline program is structured into 2 meaningful blocks:

Block 1 - "Pharmaceutical Analysis"

Block 2 - "Special Pharmaceutical Chemistry"

Block 1 consists of three sections:

Section 1 – "Analysis of cardiotonic and antiarrhythmic drugs. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application".

Section 2 - "Analysis of medicines of the vitamin group. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application".

Section 3 - "Analysis of medicines of the antibiotic group. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application".

The present Pharmaceutical chemistry guide for 4th year students of the specialty " Pharmacy, Industrial Pharmacy" complies with curriculum and cover most of topics of 7th semester.

Lecture plan

on pharmaceutical chemistry for 4th year students of the Faculty of Pharmacy (7 semester)

Sl. No.	Lecture topics	Number of hours
1	Cardiotonic and antiarrhythmic drugs. Characteristics, classification, relationship between structure and pharmacological action, mechanism of action, methods of preparation, methods of analysis, application in medicine.	2
2	Vitamins of aliphatic and alicyclic structure. Characteristics, classification, relationship between structure and pharmacological action, mechanism of action, methods of preparation, methods of analysis, application in medicine.	2
3	Vitamins of heterocyclic structure. Characteristics, classification, relationship between structure and pharmacological action, mechanism of action, methods of preparation, methods of analysis, application in medicine.	2
4	Antibiotics of aromatic and alicyclic structure. Characteristics, classification, relationship between structure and pharmacological action, mechanism of action, methods of preparation, methods of analysis, application in medicine.	2
5	Heterocyclic antibiotics: penicillins, cephalosporins. Characteristics, classification, relationship between structure and pharmacological action, mechanism of action, methods of preparation, methods of analysis, application in medicine.	2

PLAN

of laboratory practicals and seminar classes on pharmaceutical chemistry for 4th year students of the Faculty of Pharmacy (7th semester)

No. s/p	Lesson topics	**Class type**	Number hours **Lab., semin.**
1.	Analysis of drugs from the group of monosaccharides.	Labor.	3
2.	Analysis of drugs from the group of oligo-, polysaccharides and antiarrhythmic drugs.	Labor.	3
3.	Analysis of cardiotonic drugs. Cardiac glycosides.	Labor.	3
4.	Control lesson from the section.	Seminar	2
5.	Analysis of drugs from the group of vitamins of the aliphatic series.	Labor.	3
6.	Analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of chroman, pyridine.	Labor.	3
7.	Analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corin.	Labor.	3
8.	Analysis of drugs from the group of vitamins of the alicyclic and aromatic structure.	Labor.	3
9.	Control lesson from the section.	Seminar	2
10.	Analysis of drugs from the group of antibiotics of the aromatic series.	Labor.	3
11.	Analysis of drugs from the group of alicyclic antibiotics.	Labor.	3
12.	Analysis of drugs from the group of heterocyclic antibiotics.	Labor.	3
13.	Analysis of drugs from the group of glycoside antibiotics.	Labor.	3
14.	Control lesson from the section.	Seminar	3

SPECIFIC GOALS:

"Analysis of medicines of the vitamin group. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application»

- Learn the properties of drugs from the group of vitamins.
- Know the main sources and methods of obtaining drugs from the group of vitamins.
- To propose and carry out the selection of physical, physicochemical and chemical methods of quality analysis of drugs from the group of vitamins in accordance with the requirements of the SPhU and other regulatory documentation, as well as Quality Control Methods (QCM).
- Explain the peculiarities of the analysis of drugs from the group of vitamins using physical, physicochemical and chemical methods.
- Interpret the results of studies of the proposed drugs from the group of vitamins, obtained using physical, physico-chemical and chemical methods.
- Explain the peculiarities of storage of drugs from the group of vitamins, based on their physical and chemical properties.

LESSON No. 1

1. THEME: Analysis of drugs from the group of vitamins of the aliphatic series.

2.PURPOSE: Master the methods of analysis of drugs from the group of vitamins of the aliphatic series.

3.OBJECTIVES:

3.1.T o study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of vitamins of the aliphatic series and their synthetic derivatives.

3.2. To study the methods of analysis of the considered group of medicinal products according to the SPhU, QCM.

3.3. Propose and justify possible methods of identification and quantification, based on the structure of drugs of the studied group.

3.4. To study specific impurities, as well as testing methods for the purity of this group of substances.

3.5. Consider the peculiarities of the analysis of drugs from the group of vitamins of the aliphatic series and their synthetic analogues using physical, physicochemical and chemical methods.

3.6. To learn how to analyze the quality of the considered group of medicines using physical, physico-chemical and chemical methods.

3.7. Interpret and give a correct assessment of the received analysis results, draw a conclusion about the quality of the analyzed substances.

3.8. Explain the peculiarities of storage of medicines from the group of vitamins of the aliphatic series and their synthetic analogues, based on their physicochemical properties.

3.9.Learn and follow the rules of safe work in a chemical laboratory.

VITAMINS *is a group of low molecular weight organic compounds of relatively simple structures and diverse chemical nature, united by a sign of absolute necessity as a component of food for heterotrophic body.*

Vitamins are characterized by the following general properties:

1) vitamins are one of the key factors of normal metabolism in the human body;

2) the biosynthesis of vitamins occurs mainly outside the human body, so their deficiency must be replenished, mainly through a balanced diet;

3) violation of the intake and/or assimilation of vitamins leads to the appearance of a number of pathological processes in the body;

4) vitamins are neither a plastic (building, structural) material nor a source of energy for the body;

5) vitamins are highly active compounds: their biological activity is manifested in rather small amounts (milligrams, micrograms);

6) each vitamin has its own characteristics of participation in metabolism, however, there is a mutual influence between vitamins on the manifestation of each other's biological effects.

Table 1

Characteristics of some vitamins

Letter designation	**Name**	**Biochemical group, (solubility*)**
A_1 A_2	Retinol Dehydroretinol	Antioxidants, (F)
D_2 D_3	Ergocalciferol Cholecalciferol	Hormone vitamins, (F)
E	α-, β-, γ-Tocopherols	Antioxidants, (F)
K_1 K_2	Phylloquinone Farnoquinone	Hormone vitamins, enzyme vitamins, (F)
B_1	Thiamine	Enzyme vitamins, (W)
B_2	Riboflavin	Enzyme vitamins, (W)
B_6	Pyridoxine	Enzyme vitamins, (W)
Bc(B_3)	Niacin	Enzyme vitamins, (W)
B_5	Pantothenic acid	Enzyme vitamins, (W)
B_c (B_9)	Folic acid	Enzyme vitamins, (W)
B_{12}	Cobalamin	Enzyme vitamins, (W)
C	Ascorbic acid	Antioxidants, Enzyme vitamins, (W)
P	Bioflavonoids	Antioxidants, (W)
N	Lipoic acid	Enzyme vitamins, antioxidants, (F)

Note: * - F - fat-soluble; W - water soluble.

The characteristics of some vitamins are presented in the Table 1. *Enzyme vitamins* (B_1, B_2, PP, B_6, B_{12}, pantothenic acid, H, folic acid, etc.), *hormone vitamins* (A, D_2, D_3), as well as *antioxidant vitamins* are known today or *redox vitamins* (A, E, C, lipoic acid). Based on solubility, vitamins are divided into *fat-soluble* - A, D, E, K, and *water-soluble* - all others.

Chemical classification of vitamins

1. Compounds ***of the aliphatic*** range:

a) derivatives of lactones of unsaturated polyhydroxy and carboxylic acids - ascorbic acid (vitamin C);

b) derivatives of esters of gluconic acid - pangamic acid (vitamin B_{15});

c) β-amino acid derivatives - pantothenic acid (vitamin B_5).

2. Compounds ***of the alicyclic*** structure:

a) cyclohexenyl isoprenoid vitamins (cyclohexene vitamins with a polyene chain of isoprenoid character) - retinol and (vitamins of group A);

b) cyclohexanolethylenehydrindan vitamins - calciferols (vitamins of group D).

3. Compounds ***of the aromatic*** structure: derivatives of naphthoquinones - vitamins of the K group.

4. Compounds ***of the heterocyclic*** structure:

a) chroman vitamins - tocopherols (vitamins of group E);

b) phenylchroman vitamins - bioflavonoids (vitamins of group P);

c) pyridinecarbon vitamins - vitamins of the PP group;

d) β-oxymethylpyridine vitamins - vitamins of group $B_{6;}$

e) pyrimidine-thiazole vitamins - thiamine (vitamin B_1);

e) pteric vitamins - folic acid (vitamin B_c);

g) isoalloxazine vitamins - riboflavin (vitamin B_2);

h) corrin vitamins - cobalamins (vitamins of group B_{12}).

There are three main pathological conditions associated with a violation of the intake of vitamins in the body, which are caused by: vitamin deficiency - ***hypovitaminosis;*** an almost complete absence of the vitamin - ***avitaminosis*** (can be considered as the extreme degree of hypovitaminosis) and an excess of the vitamin - ***hypervitaminosis.*** It is important to note that fat-soluble vitamins accumulate in the body, and their depot is adipose tissue and the liver. Water-soluble vitamins are not deposited in significant quantities, and in excess - they are easily excreted. This explains the high prevalence of hypovitaminosis of water-soluble vitamins and hypervitaminosis of fat-soluble vitamins.

Certain interactions are observed between vitamins in the process of realizing their biological role. It was established that a single vitamin in the process of metabolism is not isolated from the influence of other vitamins on it, which, in turn, affects the manifestation of the final effect of each of the vitamins. The main manifestations of interaction between vitamins are considered below.

I. The influence of one vitamin on the catabolism of another. For example, vitamin E as an antioxidant prevents the peroxidation of vitamins A and F, increasing their biological activity. The vitamin C reduces the consumption of vitamins $B_{1,}$ $B_{2,}$

A, E, folic and pantothenic acids, reducing the body's need for them. It is also known that vitamin B_2 participates in the exchange of thiamine, pantothenic acid, choline, pyridoxine and folic acid.

II. The influence of one vitamin on the formation of coenzyme forms of another. At the same time, the interaction of some vitamins is synergistic, while others are antagonistic. Thus, derivatives of vitamin B_2 are a part of enzymes that catalyze the formation of pyridoxal phosphate from pyridoxine. Cobalamin and ascorbic acid contribute to the formation of the coenzyme form of folic acid. Thus, these interactions are positive (synergistic). An example of antagonism can be observed in the formation of coenzyme forms of thiamine and pyridoxine, which compete for adenosine triphosphate (ATP) molecules in the metabolic process. In addition, nicotinamide, riboflavin, and pantothenic acid compete in reactions of attachment to adenylic acid in the formation of dinucleotide coenzymes.

III. Joint participation of vitamins in a single biochemical process. Manifestations of this type of interactions are the most numerous. For example, the joint participation of vitamins A, B_2, B_6 and B_5 is noted in the formation and regeneration of rhodopsin, namely, in the biochemical act of vision. A classic example of the positive interaction of vitamins is also the participation of ascorbic acid and natural bioflavonoids (vitamin P) in the formation of connective tissue and the regulation of capillary permeability.

The given examples indicate the need to consider the interaction of individual vitamins in the case of their joint use. On the other hand, the accumulated material became the basis for the creation of effective ***multivitamin drugs*** - medicines containing two or more vitamins in one dose. Many drugs of this group also contain biologically important inorganic (trace elements) and organic substances. Of course, each person's needs for individual vitamins are strictly individual and depend on many factors: age, lifestyle, diet, state of health, conditions in which he lives, etc. Accordingly, the composition of multivitamin preparations in each specific case should be specific.

It should be noted that by the seventies of the 20^{th} century, several substances that belonged to vitamins, but did not meet the above criteria, became known. So, for example, choline («vitamin B_4»), is formed in sufficient quantity in the presence of methionine, and performs plastic functions as a component of phospholipids. According to the same criteria and the absence of coenzymatic function, orotic acid («vitamin B_{13}») was excluded from the number of vitamins. Polyunsaturated fatty acids («vitamin F») are plastic components of a few lipids. «Vitamin U» - S-methylmethionine sulfonium - («methylvane derivative of the essential amino acid methionine. Inositol alcohol vitamin B_8»), although indispensable for animals, plays a plastic role in inositol phosphatides. Carnitine («vitamin vib») is synthesized in the

human body from the amino acid lysine. Para-aminobenzoic acid («vitamin $B_{10,}$ or H_1») is not a vitamin for humans, but is a component of folacin («vitamin $B_{c,}$ or B_9») and a necessary growth factor for intestinal microflora. Given the above-mentioned features, these substances are called vitamin-like.

Vitamin-like substances *are irreplaceable food biologically active substances of organic nature, the deficiency of which, unlike vitamins, does not lead to an expresssed clinical picture of hypo- or vitamin deficiency.*

Also, such concepts as «vitamers», «provitamins» and «antivitamins» should be considered.

Vitamers *(vitamins + Greek meros – part) are different chemical forms of one vitamin.* For example, vitamin E is represented by a group of 8 vitamers with varying degrees of biological activity; the most important are α-, β- and γ-tocopherols.

Provitamins *are organic substances that are converted into vitamins in the human body.* For example, plants contain provitamins of vitamin A - yellow pigments α-, β- and γ-carotenes. The most active provitamin is β-carotene, when hydrolyzed in the wall of the small intestine and human liver, two molecules of vitamin A are formed. When α- and γ-carotenes are splited, one molecule of vitamin A is formed.

Antivitamins *are a group of organic compounds that inhibit the biological activity of vitamins.* It is customary to divide antivitamins into two groups: 1) antivitamins that have a structure like the structure of the target vitamin, and which have an effect based on competitive antagonism with it; 2) antivitamins that make absorption, transport or metabolism of vitamins difficult. In medical practice, antivitamins are widely used as medicines (methotrexate, isoniazid, sulfonamides, vitamin K antagonists, etc.).

Methods of biological standardization occupy a special place in the analysis of the quality of vitamins. The result of evaluating the pharmacological action of vitamins is expressed in international units (IU). ***International unit*** - a unit of measurement of the dose of a substance, based on its biological activity. It is also used for hormones, vaccines, blood components and similar biologically active substances. Despite the name, IU is not part of the international system of measuring IMS.

The amounts of a substance in 1 IU for different classes of substances are completely different: the exact definition of one IU differs for different substances and is established by international agreement. The Committee for Biological Standardization at the World Health Organization provides reference blanks of certain substances, establishes the number of IU units contained in them, and defines biological procedures for comparing other blanks with reference blanks. The purpose of such procedures is that different preparations having the same biological activity

contain the same number of IU units. For some substances, over time, mass equivalents of one IU were established, and measurement in these units was officially abandoned. However, the IU unit may remain in widespread use due to convenience. For example, to estimate the vitamin activity of the tocopherol vitamer (vitamin E), it is convenient to convert to the activity of a certain amount of α -tocopherol and express it in IU, assuming that 1 IU of vitamin E is equal to the activity of 1 milligram of synthetic d,l- α-tocopherol acetate taken orally. Then, instead of specifying the exact type and weight of the vitamer in the preparation, you can simply indicate the amount of vitamin E in international units.

Mass equivalents of 1 IU for some vitamins: 1 IU of vitamin A is the biological equivalent of 0.3 microgram of retinol or 0.6 microgram of β-carotene; 1 IU of vitamin C - 50 micrograms of ascorbic acid; 1 IU of vitamin D is the biological equivalent of 0.025 microgram of chole- or ergocalciferol; 1 IU of vitamin E is the biological equivalent of 0.67 milligram of d-α-tocopherol or 1 milligram of d,l-α-tocopherol acetate.

4. TASKS FOR STUDENT SELF-TRAINING:

4.1. Repeat the theoretical material from organic and analytical chemistry courses on this topic.

4.2. Study the program material on the subject of the lesson according to the questions below.

Educational questions for self-training of students

1. Vitamins. General characteristics, distribution in nature, role in human life. Pathological conditions associated with a violation of the intake of vitamins in the human body.
2. Classification of vitamins: principles, examples, characteristics of individual groups. Names and synonyms of vitamins.
3. Definition of terms: "vitamers", "provitamins", "antivitamins", "vitamin-like substances". To substantiate the possibility of using the specified groups of substances for medical purposes.
4. Vitamins as medicines. Sources of extraction, chemical structure, nomenclature, physicochemical properties of medicinal substances from the group of vitamins. The concept of multivitamin preparations.
5. Vitamins of aliphatic structure. Medicinal products from the group of vitamins of the aliphatic series, sources and methods of extraction.
   - **5.1.** Lactone derivatives of unsaturated polyhydroxycarboxylic acids - ascorbic acid (vitamin C). Structure, nomenclature, properties, analysis, storage, application.

5.2. Derivatives of esters of gluconic acid - pangamic acid (vitamin B15). Calcium pangamate. Structure, nomenclature, properties, analysis, storage, application.

5.3. Derivatives of β-amino acids -pantothenic acid (vitamin B5). Calcium pantothenate. Structure, nomenclature, properties, analysis, storage, application.

6. To characterize the use of chemical, physical and physicochemical methods for quality analysis (identification, testing, quantitative determination) of medicines from the group of vitamins of aliphatic structure.

7. Establishing the biological activity of vitamins. The concept of an international unit (IU). Disadvantages of the biological method of vitamin analysis.

8. The relationship between the chemical structure and the biological effect on the example of drugs from the group of vitamins of aliphatic structure.

9. Features of storage of medicines from the group of vitamins of aliphatic structure, based on their physicochemical properties.

4.3.Work out test tasks

1) Which of the following drugs according to their chemical structure belongs to the derivatives of the aliphatic series?
   1. Ascorbic acid
   2. Nicotinic acid
   3. Riboflavin
   4. Pyridoxine hydrochloride
   5. Thiamine hydrobromide

2) What is the name of the group of organic compounds that inhibit the biological activity of vitamins?
   1. Antivitamine
   2. Antioxidants
   3. Provitamins
   4. Vitamers
   5. Vitamin-like substances

3) What is the name of a group of low-molecular organic compounds of a relatively simple structure and diverse chemical nature, united by the sign of absolute necessity for a heterotrophic organism as a component of food?

1. Vitamers
2. Vitamins
3. Provitamins

4. Antivitamins
5. Vitamin-like substances

4) What are the names of organic substances that turn into vitamins in the human body?

1. Antivitamins
2. Antioxidants
3. Vitamers
4. Provitamins
5. Vitamin-like substances

5) How are the different chemical forms of one vitamin called?

1. Antivitamins
2. Antioxidants
3. Vitamers
4. Provitamins
5. Vitamin-like substances

6) What is the name of food irreplaceable biologically active substances of organic nature, the deficiency of which, unlike vitamins, does not lead to a pronounced clinical picture of hypo- or vitamin deficiency?

1. Antivitamins
2. Antioxidants
3. Vitamers
4. Provitamins
5. Vitamin-like substances

7) To identify ascorbic acid [Acidum ascorbicum], a reaction with what solution is not used:

1. Iron(II) sulfate
2. Silver nitrate
3. Potassium permanganate
4. Ammonia
5. 2,6-Dichlorophenolindophenol

8) In accordance with the requirements of the The State Pharmacopoeia of Ukraine (SPhU), the quantitative determination of ascorbic acid is carried out by the following method:

1. Nitritometry

2. Acidimetry
3. Bromatometry
4. Iodometry
5. Complexonometry

9) Which of the following reagents cannot be used to confirm the reducing properties of ascorbic acid?

1. Iron(III) chloride solution
2. Silver nitrate solution
3. Potassium iodate solution
4. Iodine solution
5. Potassium iodide solution

10) Which excipient should be used according to the SPhU to increase the stability of the ascorbic acid solution for injection in concentration 50 milligram per milliliter?

1. Oxalic acid
2. Sodium sulfite
3. Sodium chloride
4. Glucose monohydrate
5. Ammonium oxalate

11) Choose the incorrect statement about ascorbic acid:

1. Easily soluble in water
2. Optically active
3. The manifestation of reducing properties
4. The manifestation of amphoteric properties
5. It darkens under the influence of air and moisture

12) Specify the starting substance used for the synthesis of ascorbic acid:

1. Fructose
2. Rhamnose
3. Lactose
4. Glucose
5. Glycerin

13) What chemical process occurs in the quantitative determination of ascorbic acid by the method of direct alkalimetric titration?

1. Complex formation

2. Salt formation
3. Hydrolysis
4. Oxidation
5. Reduction

14) Which one of the listed medicinal substances corresponds to the chemical name (5*R*)-5-[(1*S*)-1,2-dihydroxyethyl]-3,4-dihydroxyfuran-2(5*H*)-one?
1. Pantothenic acid
2. Pangamic acid
3. Ascorbic acid
4. Folic acid
5. Methylmethionine sulfonium chloride

15) What functional group determines the acidic properties of ascorbic acid?
1. Enolic hydroxyl
2. Imid group
3. Amino group
4. Amide group
5. Alcoholic hydroxyl

16) According to the chemical classification, ascorbic acid belongs to the following vitamins:
1. Aromatic series
2. Alicyclic series
3. Aliphatic series
4. Heterocyclic series (pyridine derivative)
5. Heterocyclic series (isoalloxazine derivative)

17) During the identification of ascorbic acid, according to the requirements of the Federal State Administration of Ukraine, a reaction was carried out, which resulted in the formation of a gray precipitate in the medium of dilute nitric acid. What reagent was used in the performance of the indicated reaction?
1. Ammonium oxalate solution
2. Sodium edetate solution
3. Copper(II) sulfate solution
4. Silver nitrate solution
5. Potassium pyroantimonate solution

18) What chemical properties does ascorbic acid show due to the presence of an enediol group in its structure?

1. Acidic and reducing
2. Basic and oxidizing
3. Amphoteric and Red/Ox - duality
4. Acidic and oxidizing
5. Basic and restorative

19) Which drug according to its chemical structure is a derivative of unsaturated polyhydroxy lactones and carboxylic acids?

1. Riboflavin
2. Nicotinic acid
3. Calcium pangamate
4. Ascorbic acid
5. Calcium pantothenate

20) When determining the quantitative content of ascorbic acid in the dosage form, the pharmacist-analyst used the alkalimetric method. What are the properties of ascorbic acid based on this definition?

1. acidic
2. basic
3. amphoteric
4. oxidizing
5. reducing

21) The reducing properties of ascorbic acid are the basis of quantitative determination by all the listed methods, except:

1. Iodometry
2. Cerimetry
3. Iodometry
4. Bromatometry
5. Alkalimetry

22) Given the presence of a double bond in the ascorbic acid molecule, the existence of geometric *cis*- and *trans*-isomers is possible. Physiologically active vitamin C has the following configuration:

1. *cis* isomer
2. *trans* isomer

23) Which auxiliary substance, which is a part of the ascorbic acid solution for injections of 50 mg/ml, determines the possibility of its subcutaneous administration due to the reduction of the irritating effect on tissues?

1. Oxalic acid
2. Sodium metabisulfite
3. Sodium bicarbonate
4. Glucose monohydrate
5. Ammonium oxalate

24) The acidic properties of ascorbic acid (γ-lactone of 2,3-dehydro-L-gulonic acid) are more expressed in hydroxyls:

1. In the 2nd position
2. In the 3rd position
3. In the 4th position
4. In the 5th position
5. In the 6th position

25) When extracting ascorbic acid from natural sources, it is most rational to use as raw materials:

1. Rosehip fruits
2. Buckwheat leaves
3. Sea fish liver
4. Rice bran
5. Foxglove leaves

26) Ascorbic acid when titrated with alkali behaves as:

1. Monobasic acid
2. Dibasic acid
3. Tribasic acid
4. Tetrabasic acid
5. Does not interact with alkali

27) When strong oxidizing agents are added to ascorbic acid, it is irreversibly oxidized, which leads to the formation of:

1. Dehydroascorbic acid
2. Ascorbic acid
3. Gulonic acid
4. Furfural
5. Glucose

28) The pharmacist-analyst conducts the reaction of ascorbic acid and iron(II) sulfate in the presence of sodium bicarbonate. The appearance of the purple color of the solution is due to the presence of ascorbic acid:

1. Oxidizing properties
2. Reducing properties
3. Acidic properties
4. Basic properties
5. Amphoteric properties

29) The pharmacist-analyst performs quantitative determination of ascorbic acid by direct iodometric titration. What indicator should analytics use?

1. Phenolphthalein
2. Sodium eosinate
3. Thymolphthalein
4. Ferroin
5. Starch

30) The presence of oxalic acid (impurity E) in the substance of ascorbic acid, in accordance with the requirements of the SPhU is determined by the reaction:

1. With calcium chloride in an acetic acid medium
2. From iron(III) chloride in a sulfuric acid medium
3. With cobalt nitrate in a nitric acid medium
4. With sodium edetate in an ammonia buffer medium
5. With ammonium oxalate in a hydrochloric acid medium

31) In the iodatometric method of quantitative determination of ascorbic acid in injection solutions, to bind antioxidants-stabilizers into the compounds that do not react with the titrant, it is necessary to add:

1. A few crystals of potassium bromide
2. Glycerin
3. Acetic acid
4. Sodium edetate solution
5. Formaldehyde solution

32) Identification of ascorbic acid, in accordance with the requirements of the SPhU, is carried out using a solution of:

1. Ammonium oxalate
2. Calcium carbonate

3. Ammonium thiocyanate
4. Silver nitrate
5. Iron(III) chloride

33) The sedimentation of a shiny precipitate of metallic silver is observed during the identification of ascorbic acid by reaction with:
1. Nesler's reagent
2. Fehling's reagent
3. Tolens reagent
4. Dragendorf's reagent
5. Mark's reagent

34) A powder containing ascorbic and glutamic acids is made in the pharmacy store. What method should the pharmacist-analyst use for the quantitative determination of ascorbic acid in the presence of glutamic acid?
1. Alkalimetry
2. Acidimetry
3. Iodometry
4. Nitritometry
5. Complexonometry

35) Ascorbic acid can be quantitatively determined in a mixture with glucose without preliminary separation by:
1. Mercurimetry
2. Alkalimetry
3. Nitritometry
4. Acidimetry
5. Complexonometry

36) In the practice of control and analytical laboratories, a solution of 2,6-dichlorophenolindophenol is used, the blue color of which disappears under the action of reducing agents. What medicine can be identified using this solution?
1. Ascorbic acid
2. Calcium pantothenate
3. Nicotinic acid
4. Calcium pangamate
5. Pyridoxine hydrochloride

37) The pharmacist-analyst identifies the substance of ascorbic acid using diluted nitric acid and a solution of silver nitrate. The positive effect of the reaction is:

1. Appearance of blue color
2. Appearance of green color
3. Appearance of purple color
4. Fallout of a yellow precipitate
5. Formation of gray precipitate

38) Calcium pantothenate is identified by a complexation reaction, which results in a blue color. What reagent should be used to carry out the specified reaction?

1. Potassium pyroantimonate
2. Sodium edetate
3. Copper(II) sulfate
4. Ammonium oxalate
5. Hydrochloric acid

39) Which of the listed methods is not used during the quantitative analysis of the calcium pangamate?

1. Acidimetry in a non-aqueous medium
2. Complexonometry
3. Argentometry
4. Ion exchange chromatography
5. Nitritometry

40) To identify ascorbic acid, you should use:

1. Potassium chloride and potassium hydroxide solution
2. Iron(II) sulfate in the presence of sodium bicarbonate
3. Dragendorff's reagent (rosin of bismuth iodide in potassium iodide)
4. Glyoxalhydroxyanil in the presence of sodium hydroxide
5. The tannin solution is freshly prepared

41) Specify the starting substance used for the synthesis of pangamic acid:

1. Fructose
2. Rhamnose
3. Lactose
4. Glucose
5. Glycerin

42) The ester bond in the calcium pangamate molecule can be proven by the reaction:
1. Alkaline hydrolysis when heated (the smell of dimethylamine)
2. Formation of azo dye when combined with diazonium salts
3. With general alkaloid reagents
4. With Fehling's reagent
5. With iodine solution (discoloration of the solution)

43) The possibility of quantitative determination of ascorbic acid by the method of iodometry is due to the presence in the structure of this medicinal substance:
1. Lactone fragment
2. Endiol group
3. Alcohol hydroxyls
4. Carboxylic group
5. Oxymethyl group

44) Ascorbic acid (vitamin C) chemically belongs to:
1. Derivatives of polyhydroxy-γ-lactones
2. Derivatives of the alicyclic series
3. Derivatives of β-amino acids
4. Polyatomic alcohols
5. Derivatives of γ-amino acids

45) Pangamic acid (vitamin B_{15}) chemically belongs to:
1. Derivatives of polyhydroxy-γ-lactones
2. Derivatives of gluconic acid esters
3. Derivatives of β-amino acids
4. Polyatomic alcohols
5. Derivatives of γ-amino acids

46) Pantothenic acid (vitamin B_5) chemically belongs to:
1. Derivatives of polyhydroxy-γ-lactones
2. Derivatives of gluconic acid esters
3. Derivatives of β-amino acids
4. Polyatomic alcohols
5. Derivatives of γ-amino acids

47) The medicinal substance of calcium pangamate, in addition to the main substance, also contains 25% of calcium gluconate and 6% of calcium chloride.

When analyzing this medicinal product by the complexonometry method, the next content is determined:

1. Calcium
2. Nitrogen
3. Chlorides
4. Sums of carboxyl groups
5. Crystallization water

48) The medicinal substance of calcium pangamate, in addition to the main substance, also contains 25% of calcium gluconate and 6% of calcium chloride. When analyzing this medicinal product by the method of acidimetry in a non-aqueous medium, the next content is determined:

1. Calcium
2. Nitrogen
3. Chlorides
4. Sums of carboxyl groups
5. Crystallization water

49) The pharmacist-analyst performs the quantitative determination of ascorbic acid by the method of iodometry. What properties of ascorbic acid the mentioned method of analysis is based on?

1. Acidic
2. The basic ones
3. Amphoteric
4. Oxidizing
5. Reducing

50) The pharmacist-analyst of the central factory laboratory of the chemical-pharmaceutical factory determines the quantitative content of the produced substance of ascorbic acid by the iodatometric method. Specialist must perform the titration in the presence of:

1. Sodium acetate
2. Potassium iodide
3. Calcium sulfate
4. Magnesium chloride
5. Ammonium nitrate

51) Calcium cations in the composition of calcium pantothenate can be identified by the reaction with:

1. Copper sulfate
2. Silver nitrate
3. Ammonia oxalate
4. Sodium nitrate
5. Barium sulfate

52) Identification of calcium pangamate is carried out by the reaction of alkaline hydrolysis in the presence of hydroxylamine hydrochloride with subsequent increase in the solution of iron(III) chloride during acidification. The appearance of a red-brown color confirms the presence of calcium pangamate in the structure:
1. Calcium cations
2. Complex ether bond
3. Phenolic hydroxyl
4. Pyridine cycle
5. Primary aromatic amino group

4.4. Situational tasks:

1. Describe the acid-base properties of ascorbic acid. What features of the chemical structure of ascorbic acid are they related to? Give the equation and describe the conditions for the identification reaction of ascorbic acid, based on its acid-base properties.
2. Justify the possibility of using acid-base titration as a method of quantitative determination of ascorbic acid. Describe the titration conditions and give the reaction equation underlying this method.
3. Describe the redox properties of ascorbic acid. What features of the chemical structure of ascorbic acid are they related to? What is called reversible and irreversible oxidation of ascorbic acid? Which of these processes is the basis of its biological action?
4. Justify the possibility of using the reaction with silver nitrate solution to identify ascorbic acid. Give the equation and describe the conditions for this reaction.
5. What is the basis for using the reaction with a solution of 2,6-dichlorophenolindophenol to identify ascorbic acid? Give the equation and describe the conditions for this reaction.
6. Explain how its optical activity is used in the analysis of ascorbic acid. Describe the relevant quality indicator and the method of its determination.
7. Justify the possibility of using direct iodometric titration for the quantitative determination of ascorbic acid. Describe the titration conditions and give the corresponding chemistry.

8. Describe the method of direct iodatometric determination of ascorbic acid. What is it based on? Give the corresponding reaction equations.
9. Justify the necessity of introducing sodium sulfite and sodium bicarbonate into the composition of the ascorbic acid solution for injections of 50 mg/ml. Why do these auxiliary substances not interfere with the reaction with silver nitrate solution when identifying the active substance by the DFU method? Give the corresponding reaction equations.
10. Describe the iodatometric method of quantitative determination of ascorbic acid in a solution for injections of 50 mg/ml. What causes the need to add formaldehyde solution in this case? Give the corresponding reaction equations.
11. Justify the possibility of using cerimetric titration for the quantitative determination of ascorbic acid. Describe the titration conditions and give the corresponding reaction equations.
12. What structural fragment determines the possibility of using a hydroxam test to identify calcium pangamate? Describe the conditions for conducting this test and give the corresponding reaction equations.
13. What is the peculiarity of the quantitative determination of the substance calcium pangamate? What quality indicators are evaluated in this case? Describe the appropriate methods of analysis, give the necessary reaction equations.
14. Justify the possibility of using a reaction with a solution of copper(II) sulfate in an alkaline medium to identify calcium pantothenate. Give the equation of the corresponding reaction.
15. An acid hydrolysis reaction is used to identify calcium pantothenate. One of the products of this reaction is substance X, for the detection of which the hydroxam test is used. Define substance X and write the equations of all mentioned reactions.
16. Explain the basis of the use of the complexonometry method in the quantitative determination of calcium pantothenate. Describe the titration conditions and give the corresponding reaction equations.

4.5.Tasks:

1. Calculate the volume of 0.05 M potassium iodate solution (Kp = 0.9915), which is spent on the titration of 0.4974 g of ascorbic acid (M.m. 176.13), if the content of the active substance in the substance is 99.43% .
2. Calculate the percentage content of ascorbic acid (M.m. 176.13), if 14.0 ml of 0.1 M sodium hydroxide solution was spent on the titration of 0.2530 g of the substance (Kp = 1.0030).

3. Calculate the mass of the test of ascorbic acid (M.m. 176.13), if 20.10 ml of 0.05 M iodine solution (Kp = 1.0000) was spent on its titration, and the percentage content in the substance was 99.0%.
4. Calculate the percentage content of ascorbic acid (M.m. 176.13), if 14.55 ml of 0.1 M sodium hydroxide solution was spent on the titration of 0.2589 g of the substance (Kp = 1.0084).
5. Calculate the volume of 0.0167 M potassium iodate solution (Kp = 1.0010), which is spent on the titration of 0.4520 g of ascorbic acid (M.m. 176.13), if its percentage content in the substance is 98.70% , the volume of the used volumetric flask is 50.0 ml, and the volume of the pipette is 10.00 ml.
6. Calculate the specific rotation of a 2% solution of ascorbic acid if the angle of rotation is +0.95 and the length of the cuvette used is 19.0 cm.
7. For two aqueous solutions of ascorbic acid with a content of 4.44% and 6.36%, the refractive indices were determined, which are equal to 1.3400 and 1.3430, respectively, and for the studied solution - 1.3420. Calculate the concentration of ascorbic acid in the already mentioned solution, if it is known that in the considered interval there is a linear dependence of n - C%, and the refractive index of purified water under the same conditions is 1.3330.
8. Calculate the concentration of the ascorbic acid solution if the angle of rotation for this solution is +2.20 °, the thickness of the layer is 1 dm, and the specific rotation is +23.0 °.
9. Calculate the concentration (%) of a solution of ascorbic acid if it is known that the refractive index of this solution is 1.3346, F = 0.00160, and the refractive index of the solvent is 1.3330.
10. Calculate the volume of a 0.05 M solution of sodium edetate (Kp = 1.0015), which was spent on the titration of 0.2037 g of calcium pantothenate in the quantitative determination of calcium cations (M.m. 40.08), if their content was 8, 52%, and the loss in mass during drying is 4.12%.

5. LABORATORY WORK

During laboratory work it is necessary to strictly follow the safety rules in the chemical laboratory.

Each student individually carries out reactions of identification of samples of drug substances under the instruction of the teacher and draws up the test report.

LESSON No. 2

1.THEME: Analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of chroman, pyridine.

2.PURPOSE: Master the methods of analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of chroman, pyridine.

3.OBJECTIVES:

3.1.To study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of vitamins of the heterocyclic series, derivatives of chroman, pyridine and their synthetic analogues.

3.2.To study the methods of analysis of the considered group of medicinal products according to the SPhU, QCM.

3.3.Propose and justify possible methods of identification and quantification, based on the structure of drugs of the studied group.

3.4.To study specific impurities, as well as testing methods for the purity of this group of substances.

3.5.Consider the peculiarities of the analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of chroman, pyridine and their synthetic analogues using physical, physicochemical and chemical methods.

3.6.To learn how to analyze the quality of the considered group of medicines using physical, physico-chemical and chemical methods.

3.7.Interpret and give a correct assessment of the received analysis results, draw a conclusion about the quality of the analyzed substances.

3.8.Explain the peculiarities of storage of medicines from the group of vitamins of the heterocyclic series, derivatives of chroman, pyridine and their synthetic analogues, based on their physicochemical properties.

3.9.Learn and follow the rules of safe work in a chemical laboratory.

4. TASKS FOR STUDENT SELF-TRAINING:

4.1. Repeat the theoretical material from organic and analytical chemistry courses on this topic.

4.2. Study the program material on the subject of the lesson according to the questions below.

Educational questions for self-training of students

1. Vitamins: general characteristics, classification. Names and synonyms of vitamins.

2. Definition of terms: «vitamers», «provitamins», «antivitamins», «vitamin-like substances». To substantiate the possibility of using the indicated groups of substances for medical purposes.

3. Vitamins as medicines. Sources of extraction, chemical structure, nomenclature, physicochemical properties of medicinal substances from the group of vitamins. The concept of multivitamin preparations.

4. Vitamins of heterocyclic structure. Characteristics of heterocyclic systems underlying the structure of this group of substances. Medicines from the group of heterocyclic vitamins (chroman, pyridine derivatives), sources and methods of extraction.

5. Medicinal products from the group of vitamins, chroman derivatives.

5.1. Tocopherols (vitamins of group E). Tocopherol acetate. Structure, nomenclature, properties, analysis, storage, application.

5.2. Phenylchroman vitamins - bioflavonoids (vitamins of group P). Quercetin. routine Troxevasin (Venoruton). Structure, nomenclature, properties, analysis, storage, application.

6. Medicines from the group of vitamins, pyridine derivatives.

6.1. Pyridinecarbon vitamins - vitamins of the PP group. Nicotinic acid. Nicotinamide. Structure, nomenclature, properties, analysis, storage, application.

6.2. β-Oxymethylpyridine vitamins - vitamins of group $B_{6.}$ Pyridoxine hydrochloride. Pyridoxal phosphate. Structure, nomenclature, properties, analysis, storage, application.

7. To characterize the usage of the chemical, physical and physicochemical methods for quality analysis (identification, testing, quantitative determination) of medicines from the group of vitamins of heterocyclic structure (chroman, pyridine derivatives).

8. Establishing the biological activity of vitamins. The concept of an international unit (IU). Disadvantages of the biological method of vitamins analysis.

9. The relationship between chemical structure and biological acttivity on the example of drugs from the group of heterocyclic vitamins (chroman, pyridine derivatives).

10. Features of drugs storage from the group of vitamins of heterocyclic structure (chroman, pyridine derivatives), based on their physical and chemical properties.

4.3. Work out test tasks

1) Which of the following statements incorrectly characterizes pyridoxine hydrochloride?

1. Easily dissolves in water
2. Gives an azo coupling reaction with diazonium salts
3. Forms complexes with boric acid
4. Hydrolyzed under the treatment of hydrochloric acid
5. Quantitatively determined by the method of acid-base titration in non-aqueous media

2) According to the requirements of the SPhU, to detect the amide group in the structure of nicotinamide, a sample of the substance should be heated with a diluted solution of:
   1. Sodium hydroxide
   2. Hydrochloric acid
   3. Cyan bromide reagent
   4. Ammonium chloride
   5. Potassium ferricyanide

3) Which of the proposed reagents can be used to identify pyridoxine hydrochloride?
   1. 2-Chloro-4-methoxybenzene
   2. 2,6-Dichloroquinone chloride
   3. 2,4,6-Trinitrophenol
   4. 2,4-Dichloro-4-oxybenzene
   5. 2,4,6-Tribromophenol

4) Pyridoxine hydrochloride and pyridoxal phosphate cannot be distinguished based on:
   1. External view
   2. Solubility in purified water
   3. Reactions with iron(III) chloride
   4. Reactions of azo dye formation
   5. Reactions with phenylhydrazine

5) To identify pyridoxal phosphate, reactions with a copper-tartrate reagent (Fehling's reagent) and with an ammonia solution of silver nitrate (Tolens' reagent) are used. What properties of pyridoxal phosphate are the basis of these tests?
   1. Acidic
   2. Basic
   3. Amphoteric

4. Oxidizing
5. Reducing

6) What heterocycle is the basis of the structure of pyridoxal phosphate?
1. Pyridine
2. Pyrimidine
3. Furane
4. Chromane
5. Pyrane

7) The formation of an indophenol dye is an identification reaction for:
1. Tocopherol acetate
2. Nicotinic acid
3. Nicotinamide
4. Pyridoxine hydrochloride
5. Ascorbic acid

8) The presence of which functional group in the structure of pyridoxine hydrochloride determines the possibility of reaction with iron(III) chloride?
1. Phenolic hydroxyl
2. Pyridine cycle
3. Alcoholic hydroxyl
4. Oxymethyl group
5. Methyl group

9) The following method cannot be used for the quantitative determination of pyridoxine hydrochloride:
1. Acidimetry in a non-aqueous medium
2. Alkalimetry (in the presence of chloroform)
3. Gravimetry
4. Argentometry
5. Complexonometry

10) Identification of pyridoxal phosphate is carried out by the reaction of the formation of a yellow precipitate of phenylhydrazone. What this reaction confirms in the structure of pyridoxal phosphate:
1. Phenolic hydroxyl
2. Pyridine cycle
3. Phosphate ions

4. Aldehyde group
5. Methyl group

11) Indicate the acid-base properties of nicotinic acid:
1. Acidic and
2. Basic
3. Amphoteric

12) What reagent is used in pharmaceutical analysis to prove the presence of a pyridine heterocycle in the structure of medicinal substances?
1. 2,4-Dichlorobenzene
2. 2,4-Dinitrochlorobenzene
3. 2,6-Dichloroquinone chloride
4. Sodium 2,6-Dichlorophenolindophenolate
5. 2,4,6-Trinitrophenol

13) In order to identify the substance rutin, the pharmacist-analyst conducted a reaction with metallic magnesium in the presence of concentrated hydrochloric acid and observed the appearance of a red color. In pharmaceutical analysis, the indicated reaction is known as:
1. Hydroxam test
2. Cyanine test
3. Thiochrome test
4. Murexide test
5. Taleiochin test

14) What heterocyclic system is the basis of the chemical structure of nicotinic acid?
1. Pyrimidine
2. Pyrazole
3. Pyrrol
4. Pyridine
5. Pyrazine

15) Indicate which method should be used according to the SPhU for the quantitative determination of nicotinamide:
1. Acid-base titration
2. Acid-base titration in non-aqueous solvents
3. Determination of nitrogen by Kjeldahl

4. Cerimetry
5. Argentometry

16) The pharmacist-analyst performs the identification of nicotinic acid by reaction with solutions of cyanobromide and aniline. Due to what fragment in the nicotine acid structure the yellow colour appears:
1. Carboxylic group
2. Aldehyde group
3. Pyridine cycle
4. Amide group
5. Primary aromatic amino group

17) Indicate which method should be used according to the SPhU for the quantitative determination of nicotinic acid:
1. Determination of nitrogen by Kjeldahl
2. Acid-base titration in non-aqueous solvents
3. Acid-base titration
4. Iodometric
5. Cuprimetric

18) Which of the following substances is the starting point for the synthesis of nicotinic acid?
1. Benzene
2. Phenol
3. Benzoic acid
4. γ-Picoline
5. β-Picoline

19) Choose the incorrect statement about nicotinic acid:
1. Forms complexes with copper ions
2. Moderately soluble in water
3. It is a pyrimidine derivative
4. It is decarboxylated to form pyridine
5. Quantitatively determined by the method of neutralization

20) According to the IUPAC nomenclature, nicotinic acid is called:
1. Pyridine-2-carboxylic acid
2. Pyridine-3-carboxylic acid
3. Pyridine-4-carboxylic acid

4. β-Picolinic acid
5. 2-Carboxypyridine

21) When identifying the substance of nicotinic acid, a reaction was carried out, and as a a result of it a blue color appeared. What reagent was used?
1. Nesler's reagent
2. Sodium hydroxide solution
3. Sodium carbonate anhydrous
4. Copper(II) sulfate solution
5. Cyan bromide reagent

22) Indicate which reagent is used to identify the tocopherol acetate:
1. Concentrated ammonia solution
2. Concentrated nitric acid
3. Ammonium thiocyanate solution
4. Sodium edetate solution
5. Copper sulfate solution

23) Indicate which of the following medicines belongs to the antioxidant vitamins:
1. Tocopherol acetate
2. Riboflavin
3. Thiamine hydrochloride
4. Pyridoxine hydrochloride
5. Nicotinic acid

24) Indicate which of the methods is used for quantitative determination of tocopherol acetate:
1. Complexonometry
2. Cerimetry
3. Mercurimetry
4. Acidimetry
5. Argentometry

25) Which of the following indicators is used in cerimetric determination of the tocopherol acetate?
1. Phenolphthalein
2. Diphenylamine
3. Bromophenol blue
4. Thymolphthalein

5. Fluorescein

26) Tocopherol acetate is identified by the appearance of a red-orange color when heated with nitric acid, which fumes. What chemical process is the basis of this reaction?
1. Oxidation
2. Azo compound
3. Dianitrogenation
4. Complex formation
5. Hydration

27) The possibility of the formation of azo dyes during the identification of pyridoxine hydrochloride by reaction with diazonium salts is due to the presence in its structure of:
1. Alcoholic hydroxyl
2. Phenolic hydroxyl
3. Primary aromatic amino group
4. Methyl group
5. Crystallization water

28) The application of the cerimetry method for the quantitative determination of tocopherol acetate is based on its ability to:
1. Reducing
2. Salt formation
3. Oxidation
4. Complex formation
5. Sedimentation

29) When boiling nicotinamide with alkali, the smell is felt:
1. Ammonia
2. Pyridine
3. Benzaldehyde
4. Formaldehyde
5. Ethyl acetate

30) To identify the nicotinamide substance, a reaction was carried out with 2,4-dinitrochlorobenzene. The formation of a yellow color confirms the presence of nicotinamide in the structure of:
1. Amide group

2. Aldehyde group
3. Pyridine cycle
4. Primary aromatic amino group
5. Carboxylic group

31) The reaction of alkaline hydrolysis in the presence of ethanol and concentrated sulfuric acid is used to confirm the presence of tocopherol acetate in the structure:
1. Chromane cycle
2. Acetyl radical
3. A phytol fragment
4. Methyl groups
5. Crystallization water

32) When identifying and quantifying the tocopherol acetate, a reaction with a solution of cerium(IV) sulfate is used. The basis of this reaction is the ability of tocopherol acetate to:
1. Complex formation
2. Sedimentation
3. Reduction
4. Oxidation
5. Salt formation

33) According to the requirements of the SPhU, the method of thin-layer chromatography is used for the identification of pyridoxine hydrochloride. The use of 2,6-dichloroquinone chloride solution as a developer is based on the formation of:
1. Azo dye
2. Azomethine dye
3. Aurine dye
4. Indophenol dye
5. Pyrazolone dye

34) To identify rutin, a reaction was carried out with metallic magnesium in the presence of concentrated hydrochloric acid. At the same time, the appearance of a red color is due to the formation of:
1. Khalkon
2. Pyrylium salt
3. Diazonium salt
4. Azo dye

5. Thiochrome

35) A natural source of rutin extraction is:
1. Cinnamon rosehip fruits
2. Yeast
3. Unrefined cereal grains
4. Leaves of digitalis purple
5. Buds of Japanese sophora

36) Which of the listed medicines is identified using the cyanine reaction?
1. Pyridoxine hydrochloride
2. Retinol acetate
3. Tocopherol acetate
4. Rutin
5. Nicotinic acid

37) Rutin can be distinguished from quercetin using the following reaction:
1. With sodium hydroxide solution
2. Production of azo dye
3. Cyanine sample
4. With Fehling's reagent
5. With a solution of iron(III) chloride

38) The reaction product of an alkaline solution of rutin with a diazonium salt is:
1. Pyryllium salt
2. Thiochrome
3. Azo dye
4. Murexid
5. Shif's base

39) It is possible to detect a specific admixture of quercetin in the substance rutin with the help of:
1. Fehling's reagent
2. Cyanine sample
3. Sodium hydroxide solution
4. UV spectrophotometry
5. Iron(III) chloride solution

40) To identify rutin, a reaction is carried out with a solution of iron(III) chloride, which is accompanied by the appearance of a dark green color. This reaction makes it possible to detect a routine in the structure:

1. Piran cycle
2. D-glucose
3. Phenolic hydroxyl
4. Alcoholic hydroxyl
5. Chrome cycle

41) The chemist of department of technical control identifies the substance rutin. He confirms the presence of a sugar component using Fehling's reagent by the formation of:

1. Brick-red sediment
2. Yellow-green sediment
3. Blue-violet sediment
4. Dark gray sediment
5. White sediment

42) Rutin as a glycoside contains the disaccharide rutinose as a sugar part, consisting of:

1. Glucose and fructose
2. Galactose and glucose
3. Glucose and rhamnose
4. Fructose and galactose
5. Fructose and rhamnose

43) For routine identification, a sample of the substance was dissolved in a 1 M sodium hydroxide solution. The appearance of the yellow-orange color is due to the formation of:

1. Pyrylium salt
2. Diazonium salt
3. Azo dye
4. Chalconoids
5. Thiochrome

44) Which drug from the group of vitamins is identified by the reaction of the formation of ethyl ester of acetic acid, which has a characteristic smell?

1. Rutin
2. Nicotinamide

3. Nicotinic acid
4. Pyridoxine hydrochloride
5. Tocopherol acetate

45) Quantitative determination of tocopherol acetate is carried out after preliminary acid hydrolysis by redox titration. What titrimetric method is used for this?
1. Mercurimetry
2. Cerimetry
3. Argentometry
4. Alkalimetry
5. Acidimetry

4.4. Situational tasks

1. Describe the redox properties of tocopherol acetate. What features of the chemical structure of tocopherol acetate are they related to? How does the structure of oxidation products depend on the nature of the oxidizing agent?
2. What is the basis of the formation of ethyl acetate reaction used in the tocopherol acetate identification? Describe the test conditions and give the corresponding reaction equations.
3. Substance **X** is a reaction product of tocopherol acetate with concentrated nitric acid. When substance **X interacts** with *o*-phenylenediamine, substance **Y is formed.** Identify the substances **X and Y,** write the equations of all the mentioned reactions. What characteristic optical property of substance **Y** is used for its detection?
4. Describe the cerimetric method of quantitative determination of tocopherol acetate. What is it based on? Give the corresponding reaction equations.
5. Describe the usage of a reaction with 1 M sodium hydroxide solution to identify rutin. The appearance of a yellow-orange color is associated with the formation of which product? Give the appropriate reaction equation.
6. Justify the possibility of identifying rutin by the reaction of the cyanine sample. What is this reaction based on? How do the colored reaction products are called? Give the corresponding reaction equations.
7. Explain whether the cyanine test can be used to distinguish the substances rutin and quercetin. Give the corresponding reaction equations.
8. Explain whether it is possible to use the reaction with the copper-tartrate reagent to distinguish the substances rutin and quercetin. Give the corresponding reaction equations.

9. Justify the possibility of using the reaction with copper(II) salts to identify nicotinic acid. What is the advantage of using copper(II) acetate in comparison with copper(II) sulfate when performing the mentioned reaction? Give the corresponding reaction equations.
10. When identifying nicotinic acid, a reaction with 2,4-dinitrochlorobenzene is carried out followed by the addition of sodium hydroxide solution. What structural fragment of nicotinic acid is detected in this test? Give the corresponding reaction equations and analytical effects that are observed.
11. Justify the possibility of using a reaction with a solution of cyanobromide (with the subsequent addition of aniline) to identify nicotinic acid. What type of organic dye is formed in this test? Give the corresponding reaction equations.
12. Justify the possibility of using acid-base titration for the quantitative determination of nicotinic acid. Describe the titration conditions and give the corresponding reaction equations.
13. Describe the cupriiodmetric method of quantitative determination of nicotinic acid in a 1% injection solution. Give the corresponding reaction equations.
14. Describe the decomposition reactions of nicotinamide that occur when heated with sodium hydroxide solution and when mixed with anhydrous sodium carbonate. How do you detect the products that have formed? Give the corresponding reaction equations.
15. Justify the possibility of quantitative determination of nicotinamide based on ammonia release as a result of hydrolysis. Give the corresponding reaction equations.
16. Describe the method of acid-base titration of medicinal substances in aqueous media using the example of nicotinamide. Give the corresponding reaction equations.
17. Justify the possibility of identifying pyridoxine hydrochloride by reaction with 2,6-dichloroquinone chloride. What is the reason of the change in the analytical effect when this reaction is carried out in the presence of boric acid? Give the corresponding reaction equations.
18. Explain the purpose of using 2,6-dichloroquinone chloride in the identification of pyridoxine hydrochloride by thin-layer chromatography. What type of organic dye is formed in this test? Give the corresponding reaction equations.
19. Justify the possibility of using the azo coupling reaction to identify and quantify pyridoxine hydrochloride. For what purpose are heavy metal salts introduced into the reaction medium? Give the corresponding reaction equations.
20. Explain the necessity of adding mercury(II) acetate in the quantitative determination of pyridoxine hydrochloride by the acid-base titration method in a non-aqueous medium. Give the corresponding reaction equations.

21. Describe the quantitative determination of pyridoxine hydrochloride by the method of acidimetry in a mixture of anhydrous formic acid and acetic anhydride. Why is mercury(II) acetate not added in this case? Give the corresponding reaction equations.
22. Describe the quantitative determination of pyridoxine hydrochloride by the method of acidimetry in a mixture of anhydrous formic acid and acetic anhydride. What is the reason for the need for constant stirring during titration and its termination immediately after reaching the equivalence point? Give the corresponding reaction equations.
23. Justify the possibility of quantitative determination of pyridoxine hydrochloride by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.
24. Justify the possibility of using the reaction with phenylhydrazine hydrochloride to identify pyridoxal phosphate. Give the corresponding reaction equations.

4.5. Tasks

1. Calculate the volume of 0.1 M sodium hydroxide solution (Cc = 1.0030), which is used on the titration of 0.3010 g of nicotinic acid (M.w. 123.11 g/mol), if its percentage content in the substance is 99.5%, and the loss in mass during drying is 0.4%.
2. Calculate the initial weight of the nicotinic acid (M.w. 123.11 g/mol), if 19.88 ml of 0.1 M sodium hydroxide solution (Cc = 1.0030) was spent on its titration, the percentage content in the substance is 99.6%, and the loss in mass during drying is 0.5%.
3. Calculate the percentage content of nicotinamide (M.w. 122.13), if 11.80 ml of a 0.1 M solution of perchloric acid (Cc = 1.0000) was spent on the titration of 0.1520 g of the substance, the loss in mass during drying was 0.4%, and the volume of titrant in the control experiment is 0.3 ml.
4. Calculate the volume of 0.1 M perchloric acid solution (Cc = 1.0000), which is spent on the titration of 0.1450 g of pyridoxine hydrochloride (M.w. 205.64 g/mol), if its percentage content in the substance is 98.7%, the loss in mass during drying is 0.45%, and the titrant volume in the control experiment is 0.3 ml.
5. Calculate the percentage content of chloride ions (M.w. 35.45 g/mol) in the substance of pyridoxine hydrochloride, if 1.80 ml of 0.1 M sodium hydroxide solution (Cc = 1.0863) was spent on the titration of a weighing 0.1015 g, the loss in mass during drying was 0.6%, the volume of the measuring flask was 50 ml, and the volume of the pipette was 20 ml.
6. Calculate the weight of the tocopherol acetate test (M.w. 472.8 g/mol), if 19.2 ml of a 0.1 M solution of cerium sulfate (Cc = 1.0000) was spent on its titration, the

percentage content of the active substance in the substance was 94.9%, and the titrant volume in the control experiment was 0.4 ml.

7. Estimate the quality of tocopherol acetate (M.w. 472.8 g/mol) according to its quantitative content, if 21.10 ml of 0.01 M cerium sulfate solution (Cc = 0.9900) was used for the titration of 0.1203 g of the substance, and for the control experiment - 1.1 ml of the same titrant. The volume of the used volumetric flask is 50.0 ml, and the volume of the pipette is 20.0 ml. According to QCM, the content of tocopherol acetate in the substance should be from 95.0% to 100.5%.
8. Calculate the quantitative content of rutin if 0.7730 g of the substance was dissolved in ethanol in a 50 ml volumetric flask, 2 ml of this solution was transferred to a 50 ml volumetric flask and adjusted to the mark with ethanol. 0.5 ml of 0.1 M sodium hydroxide solution was added to 1.6 ml of the resulting solution and diluted to 10 ml with ethanol. The optical density measured in a cuvette with a thickness of 10 mm at 400 nm is 0.612. In parallel, the reaction was carried out with 0.5 ml of a 0.02% standard solution of rutin, the optical density of which was 0.624.
9. Estimate the quality of tocopherol acetate (M.w. 472.8 g/mol) by the specific absorption index of a 0.01% alcohol solution, if its optical density is 0.45, the measurement is made at 285 nm, and the thickness of the used cuvette is 10 mm. According to QCM, the specific absorption index should have a value from 42 to 47.
10. Calculate the percentage content of pyridoxine hydrochloride (M.w. 205.64 g/mol) if, during the potentiometric titration of 0.1515 g of the substance, the volume of 0.1 M sodium hydroxide solution (Cc = 1.0030), which corresponds to the first potential jump on the curve titration is 0.42 ml, the second jump is 7.77 ml, and the loss in mass during drying is 0.48%.

5. LABORATORY WORK

During laboratory work it is necessary to strictly follow the safety rules in the chemical laboratory.

Each student individually carries out reactions of identification of samples of drug substances under the instruction of the teacher and writes the test report.

LESSON No. 3

1.THEME: Analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corin.

2.PURPOSE: Master the methods of analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corin.

3.OBJECTIVES:

3.1.To study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of vitamins of the heterocyclic series, derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corin and their synthetic analogues.

3.2.To study the methods of analysis of the considered group of medicinal products according to the SPhU, QCM.

3.3.Propose and justify possible methods of identification and quantification, based on the structure of drugs of the studied group.

3.4.To study specific impurities, as well as testing methods for the purity of this group of substances.

3.5.Consider the peculiarities of the analysis of drugs from the group of vitamins of the heterocyclic series, derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corin and their synthetic analogues using physical, physicochemical and chemical methods.

3.6.To learn how to analyze the quality of the considered group of medicines using physical, physico-chemical and chemical methods.

3.7.Interpret and give a correct assessment of the received analysis results, draw a conclusion about the quality of the analyzed substances.

3.8.Explain the peculiarities of storage of medicines from the group of vitamins of the heterocyclic series, derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corin and their synthetic analogues, based on their physicochemical properties.

3.9.Learn and follow the rules of safe work in a chemical laboratory.

4. TASKS FOR STUDENT SELF-TRAINING:

4.1. Repeat the theoretical material from organic and analytical chemistry courses on this topic.

4.2. Study the program material on the subject of the lesson according to the questions below.

Educational questions for self-training of students

1. Vitamins: general characteristics, classification. Names and synonyms of vitamins.

2. Definition of terms: "vitamers", "provitamins", "antivitamins", "vitamin-like substances". To substantiate the possibility of using the specified groups of substances for medical purposes.

3. Vitamins as medicines. Sources of extraction, chemical structure, nomenclature, physicochemical properties. The concept of multivitamin drugs.

4. Vitamins of heterocyclic structure. Characteristics of heterocyclic systems underlying the structure of this group of substances. Medicines from the group of heterocyclic vitamins, sources, and methods of extraction.

4.1. Pyrimidine-thiazole derivatives - vitamin B_1. Thiamine hydrobromide. Thiamine hydrochloride. Coenzyme preparations: phosphothiamine, cocarboxylase, benfotiamine. Structure, nomenclature, properties, analysis, storage, application.

4.2. Derivatives of pteridine - vitamin B (B_9). Folic acid. Methotrexate is an antagonist of folic acid. Structure, nomenclature, properties, analysis, storage, application.

4.3. Derivatives of isoalloxazine - vitamin B_2. Riboflavin. Riboflavin mononucleotide. Structure, nomenclature, properties, analysis, storage, application.

4.4. Corrin derivatives - cobalamins (vitamins of group B_{12}). Cyanocobalamin. Vitohepatum. Structure, nomenclature, properties, analysis, storage, application.

5. Describe the use of chemical, physical, and physicochemical methods for quality analysis (identification, testing, quantification) of drugs from the group of heterocyclic vitamins (pyrimidine-thiazole derivatives, pterin, isoalloxazine, corrin).

6. Establishing the biological activity of vitamins. The concept of an international unit (IU). Disadvantages of the biological method of vitamin analysis.

7. Relation of chemical structure with biological effect on the example of drugs from the group of vitamins of heterocyclic structure (derivatives of pyrimidine-thiazole, pterin, isoalloxazine, corrin).

8. Features of storage of medicines from the group of vitamins of heterocyclic structure (pyrimidine-thiazole derivatives, pterin, isoalloxazine, corrin), based on their physicochemical properties.

4.3. Work out test tasks

1) Which drug from the group of vitamins according to its chemical structure

belongs to pterin derivatives?

1. Riboflavin
2. Folic acid
3. Tocopherol acetate
4. Cyanocobalamin

2) Cleavage of the thiazole nucleus, which leads to the formation of the open thiol form of thiamine, occurs when:

1. pH > 7
2. pH = 7
3. pH < 7

3) The chemical structure of cocarboxylase is a semi-synthetic derivative:

1. Pyridoxine (vitamin B_6)
2. Thiamine (vitamin B_1)
3. Riboflavin (vitamin B_2)
4. Folic acid (vitamin B)
5. Cobalamin (vitamin B_{12})

4) Which of the following heterocyclic systems are included in the structure of thiamine hydrobromide?

1. Pyridine and furan
2. Pyrazole and chroman
3. Pyrimidine and thiazole
4. Thiophene and corrin
5. Pterin and corrin

5) Indicate which method should be used according to the SPhU for the quantitative determination of thiamine hydrobromide:

1. Acid-base titration
2. Acid-base titration in non-aqueous solvents
3. Gravimetric
4. Spectrophotometric
5. Argentometric

6) Indicate which method should be used according to the SPhU for the quantitative determination of thiamine hydrochloride:

1. Acid-base titration
2. Argentometric

3. Mercurimetric
4. Gravimetric
5. Spectrophotometric

7) To identify thiamine hydrobromide, the pharmacist-analyst conducts a thiochrome formation reaction. What reagent should the analyst use for this test?
1. Calcium chloride
2. Ammonium thiocyanate
3. Potassium ferricyanide
4. Sodium acetate
5. Iron(II) sulfate

8) Name the medicinal product which, when identified by reaction with a solution of silver nitrate, forms a yellow precipitate insoluble in dilute nitric acid:
1. Pyridoxine hydrochloride
2. Thiamine hydrobromide
3. Retinol acetate
4. Ascorbic acid
5. Cyanocobalamin

9) The chemical structure of folic acid is based on a condensed heterocyclic system consisting of pyrimidine and pyrazine rings. What is the name of the specified heterocyclic system?
1. Corrin
2. Pyridine
3. Pteridine
4. Purine
5. Phenothiazine

10) According to the chemical structure, the phosphorylated derivative of thiamine is:
1. Cocarboxylase
2. Lumiflavin
3. Riboflavin
4. Folic acid
5. Cyanocobalamin

11) Due to its acidic properties, riboflavin is identified by reaction with salts of heavy metals to form colored complex compounds. The presence of which functional group in the structure of riboflavin confirms this test?

1. Amino group
2. Methyl group
3. Imide group
4. Heterocyclic nitrogen
5. Benzene cycle

12) Indicate to what heterocyclic compound do riboflavin belongs to:

1. Quinoline
2. Pterin
3. Pyridine
4. Pyrimidine
5. Isoalloxazine

13) What specific impurity can appear in riboflavin preparations during improper storage (effect of light, alkalinity of the medium)?

1. Ergosterol
2. 2-Methyl-1,4-naphthoquinone
3. Lumiflavin
4. 4-Methyl-5β-oxyethylthiazole
5. Oxalic acid

14) The doctor prescribed vitamin B_2 eye drops to the patient. When taking a prescription, the pharmacist must check the availability of the substance in the pharmacy:

1. Riboflavin
2. Thiamine hydrochloride
3. Folic acid
4. Nicotinic acid
5. Retinol acetate

15) Choose the statement that incorrectly characterizes folic acid:

1. It is a yellowish crystalline powder
2. A fragment of sulfanilic acid is present in the structure
3. Easily soluble in alkali metal hydroxide solutions
4. Enters into a complex formation reaction with copper(II) sulfate
5. Decomposes under the influence of light, hygroscopic

16) According to the SPhU, the aqueous solution of which of the listed substances has a pale greenish-yellow color in transmitted light, and in reflected light it exhibits an intense yellowish-green fluorescence that disappears when mineral acids or alkalis are added?

1. Thiamine hydrobromide
2. Folic acid
3. Pyridoxine hydrochloride
4. Riboflavin
5. Cyanocobalamin

17) The chemical name "3-[(4-amino-2-methylpyrimidin-5-yl)methyl]-5-(2-hydroxyethyl)-4-methylthiazolium bromide hydrobromide" corresponds to the medicinal product:

1. Thiamine hydrobromide
2. Bromisoval
3. Scopolamine hydrobromide
4. Bromcamphora
5. Homatropin hydrobromide

18) Which medicinal product from the group of vitamins, according to its chemical structure, is a nucleotide connected to the main system by a peptide bond?

1. Riboflavin
2. Cyanocobalamin
3. Folic acid
4. Cocarboxylase
5. Thiamine hydrochloride

19) When identifying cyanocobalamin, a sample of the substance is treated with potassium hydrosulfate. The specified manipulation is performed for the purpose of further detection:

1. D-ribose residue
2. Corrin cycle
3. Cobalt(III) ions
4. 5,6-Dimethylbenzimidazole
5. Amide groups

20) The pharmacist-analyst identifies the substance “Thiamine hydrobromide” by reaction with a solution of potassium ferricyanide in an alkaline medium with the

subsequent addition of butanol. At the same time, he observes the light blue fluorescence of the alcohol layer in UV light. What product is formed during this reaction?

1. Murexid
2. Ninhydrin
3. Thiochrome
4. Hinonymin
5. Taleiochin

21) Which of the proposed tests is not used to identify the cyanocobalamin substance?

1. Disappearance of color of aqueous solution during acidification
2. Determination of absorption maxima of an aqueous solution
3. Complexation reaction after mineralization
4. Calculation of optical density relations of an aqueous solution at different wavelengths
5. According to the results of thin-layer chromatography

22) Indicate which method is used for the quantitative determination of cyanocobalamin (vitamin B_{12}):

1. Bromatometry
2. Alkalimetry
3. Spectrophotometry
4. Refractometry
5. Nitritometry

23) Which medicinal substance from the group of vitamins contains a corrin heterocycle in its structure?

1. Folic acid
2. Thiamine hydrobromide
3. Cyanocobalamin
4. Riboflavin
5. Rutin

24) The color of cyanocobalamin is associated with the presence in its structure:

1. Cobalt(III) atom
2. 6,7-Dimethylbenzimidazole
3. The rest of hydrocyanic acid
4. Azomethine group

5. D-ribose residue

25) A feature of the chemical structure of vitamin B_{12} is the macrocyclic planar corrine system. Hydrogenated rings of which heterocycle are the basis of the corrin system?

1. Pyrazole
2. Imidazole
3. Pyrrol
4. Thiazole
5. Oxazole

26) Indicate what heterocyclic system the derivatives of folic acid belong to:

1. Pterin
2. Isoalloxazine
3. Lame
4. Thiazolidine
5. Pyrimidine

27) Quantitative determination of the riboflavin substance, according to the SPhU, is carried out by the following method:

1. Refractometry
2. Spectrophotometry
3. Complexonometry
4. Ion exchange chromatography
5. Gas chromatography

28) Indicate which method should be used according to the SPhU for the quantitative determination of folic acid:

1. Photoelectrocolorimetry
2. Acid-base titration
3. Liquid chromatography
4. Permanganatometry
5. Iodometry

29) The quantitative content of thiamine hydrochloride in powders can be determined by a pharmacist-analyst by the following method:

1. Alkalimetry
2. Nitritometry
3. Bromatometry

4. Permanganatometry
5. Complexonometry

30) Medicines with anti-vitamin activity include:
1. Cocarboxylase
2. Benfotiamine
3. Riboflavin mononucleotide
4. Methotrexate
5. Vitohepatum

31) To identify thiamine hydrochloride, the pharmacist-analyst conducts the formation reaction of:
1. Azo dye
2. Murexida
3. Taleiochin
4. Thiochrome
5. Indophenol

32) Oxidation-reduction properties of folic acid are the basis of its quantitative determination by the method:
1. Polarimetry
2. Complexonometry
3. Polarography
4. Alkalimetry
5. Refractometry

33) According to the SPhU, riboflavin as an optically active substance is identified by:
1. Refractive index
2. Melting point
3. pH of freshly prepared aqueous solution
4. Specific optical rotation
5. Molar absorption index

34) Which method is not used for the quantitative determination of thiamine hydrobromide in a substance?
1. Alkalimetry, direct titration
2. Bromatometry, reverse titration
3. Argentometry according to the Fayance method

4. Argentometry after alkali neutralization
5. Gravimetry

35) When identifying cyanocobalamin, cobalt (III) ions are detected by reaction with sodium 1-nitroso-2-naphthol-3,6-disulfonate. Before performing the specified test, the medicinal substance should be subjected to:

1. Decarboxylation
2. Sulfation
3. Hydrolysis
4. Mineralization
5. Esterification

36) The structure of cyanocobalamin includes a cobalt (III) atom, which, upon identification, is converted into an ionogenic state. The formed Co^{3+} ions are detected by reaction with sodium 1-nitroso-2-naphthol-3,6-disulfonate. What chemical process is the basis of this reaction?

1. Decarboxylation
2. Dianitrogenation
3. Complex formation
4. Hydrolysis
5. Esterification

37) A pharmacist-analyst observed a bright greenish-yellow fluorescence when examining a sample of vitamin eye drops in UV light. What component this confirms in the composition of eye drops:

1. Riboflavin
2. Thiamine hydrochloride
3. Ascorbic acid
4. Folic acid
5. Cyanocobalamin

38) To detect the imide group in the structure of riboflavin, the complex formation reaction is used of orange-red color. What reagent is used in the specified reaction?

1. Potassium permanganate solution
2. Sodium edetate solution
3. Sodium hydrosulfite solution
4. Silver nitrate solution
5. Ammonium oxalate solution

4.4. Situational tasks

1. Explain what is associated with the instability of thiamine hydrochloride in an alkaline medium. Describe the stages of transformation of thiamine preparations that occur under the influence of sodium hydroxide solution.
2. Describe the thiochrome test as a reaction for the identification of thiamine preparations. Explain its essence, conditions of implementation, specificity. Give the corresponding reaction equations using the example of thiamine hydrobromide.
3. Justify the possibility of using a reaction with a solution of potassium ferricyanide in an alkaline medium to identify thiamine hydrochloride. Describe the test conditions and give the corresponding reaction equations.
4. Explain whether the thiochrome test can be used to distinguish the substances of thiamine hydrobromide and benfotiamine. Describe the test conditions and give the corresponding reaction equations.
5. Explain whether the reaction with chloramine solution can be used to distinguish the substances of thiamine hydrochloride and thiamine hydrobromide. Describe the test conditions and give the corresponding reaction equations.
6. Explain the necessity of adding mercury(II) acetate in the quantitative determination of thiamine hydrobromide by the method of acid-base titration in a non-aqueous medium. Give the corresponding reaction equations.
7. Describe the quantitative determination of thiamine hydrochloride by the method of acidimetry in a mixture of anhydrous formic acid and acetic anhydride. Why is mercury(II) acetate not added in this case? Give the corresponding reaction equations.
8. Describe the quantitative determination of thiamine hydrobromide by the argentometric method after neutralization with alkali. Give the corresponding reaction equations.
9. Justify the possibility of quantitative determination of thiamine hydrobromide by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.
10. Justify the possibility of quantitative determination of thiamine hydrobromide by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.
11. Justify the possibility of quantitative determination of cocarboxylase by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.

12. Describe the chemical structure of folic acid. What fragments (parts) are distinguished in the structure of folic acid? Explain why drugs from the group of sulfonamides are antivitamins of folic acid.

13. Describe the acid-base properties of folic acid. What features of the chemical structure of folic acid are they related to? How are the acid-base properties of folic acid used when assessing the quality of the substance according to the ”Solubility” indicator?

14. Explain how its optical activity is used in the analysis of folic acid. Describe the corresponding quality indicator and the method of its determination.

15. Justify the possibility of using the reaction with potassium permanganate solution to identify folic acid. For what purpose a solution of hydrogen peroxide is added to the reaction medium? Describe the test conditions and give the corresponding reaction equations.

16. Justify the possibility of quantitative determination of folic acid by the photocolorimetric method based on the reaction of the formation of an azo dye. Describe the test conditions and give the corresponding reaction equations.

17. Justify the possibility of quantitative determination of folic acid by the polarographic method. Describe the conditions of the test and give the corresponding chemistry.

18. Explain whether it is possible to use the reaction with a solution of potassium permanganate to distinguish the substances of folic acid and methotrexate. Give the corresponding reaction equations.

19. Explain how light affects the stability of riboflavin. What changes can occur in the structure of riboflavin under the influence of light (considering the pH of the medium)? How should these changes be considered when evaluating the purity and storage of the riboflavin substance?

20. Justify the possibility of using the reaction with sodium hydrosulfite to identify riboflavin. Give the corresponding reaction equations.

21. Explain how its optical activity is used in the analysis of riboflavin. Describe the corresponding quality indicator and the method of its determination.

22. Justify the possibility of using a reaction with a solution of sodium 1-nitroso-2-naphthol-3,6-disulfonate to identify cyanocobalamin. Describe the conditions of the test and write the corresponding reaction.

4.5. Tasks

1. Calculate the volume of 0.1 M solution of perchloric acid (Cc = 1.0100), which is used on the titration of 0.0988 g of thiamine hydrochloride (M.w. 337.27 g/mol), if its content in the substance is 95.8%, the loss in mass during drying is 5.0%, and the titrant volume in the control experiment is 0.25 ml.

2. The following dosage form is analyzed at the pharmaceutical enterprise:

Riboflavin tablets in 0.005 g

Calculate the content of riboflavin in one tablet, if for determination by QCM 0.8200 g of powder of crushed tablets was dissolved in water in a volumetric flask with a capacity of 500 ml, 10 ml of the resulting solution was transferred to a volumetric flask with a capacity of 50 ml and the volume of the solution was brought to the mark with purified water. The value of the optical density of the obtained solution was 0.510 with a layer thickness of 10 mm. The specific index of absorption of riboflavin is 850, and the average weight of the tablets is 0.3050 g.

3. Calculate the specific rotation of riboflavin and conclude about the quality, if the angle of rotation of a 0.5% solution in a 0.05 M solution of sodium hydroxide was -1.2°, and the length of the used polarimeter tube was 19.96 cm. According to QCM, the specific rotation of riboflavin should be from -115° to -135°.

4. The pharmacy has prepared a dosage form with the following composition:

Thiamine hydrobromide 0.01
Nicotinic acid 0.02
Glucose 0.1

A weight of powder weighing 0.1000 g was dissolved in 3 ml of purified water and titrated with a solution of sodium hydroxide (0.02 M, Cc = 1.0000) until an orange color (indicator - phenolphthalein). 1 ml of diluted nitric acid, 1 ml of ferric ammonium alum solution, 0.20 ml of ammonium thiocyanate solution (0.02 M, Cc = 1.0000) were added to the titrated liquid and titrated with silver nitrate solution (0.02 M, Cc = 1.0000), until the orange color changes to yellow. Calculate the volume of titrants used for the determination of thiamine hydrobromide (M.w. 435.2 g/mol) and nicotinic acid (M.w. 123.1 g/mol).

5. Calculate the value of the specific rotation of methotrexate and conclude about its quality, if the angle of rotation of a 1% solution in sodium carbonate solution was +0.48°, and the length of the used polarimeter tube was 190 mm. According to QCM, the specific rotation of methotrexate should be from +19° to +24°.

6. Calculate the percentage content of riboflavin in the composition of eye drops, if for analysis 5.0 ml of the test solution was taken with a pipette, placed in a measuring flask with a capacity of 50 ml, brought to the mark with purified water and thoroughly mixed. The optical density of the resulting solution, measured in a cuvette with a layer thickness of 10 mm at a wavelength of 445 nm, is 0.24. In parallel, the optical density of a standard solution containing 0.00002 g of riboflavin in 1 ml was measured. It was 0.22.

7. Calculate the measured angle of rotation of a 0.5% alkaline solution of riboflavin if the specific rotation is -120° and the thickness of the cuvette is 10 cm.

8. Calculate the percentage content of thiamine hydrobromide (M.w. anhydrous 426.2 g/mol), if 7.61 ml of a 0.1 M perchloric acid solution (Cc = 1.0000) was spent on the titration of 0.1529 g of the substance, the titrant volume in the control experiment was 0.63 ml, and the loss in mass during drying was 3.17%.

9. Calculate the mass of thiamine hydrochloride (M.w. 337.27 g/mol), if 6.73 ml of 0.1 M perchloric acid solution (Cc = 1.0000) was spent on its titration, the content of the active substance in the substance was 98.12%, the volume of the titrant in the control experiment was 0.41 ml, and the mass loss during drying was 3.48%.

10. Calculate the percentage content of thiamine hydrochloride (M.w. 337.27 g/mol), if 8.30 ml of a 0.1 M perchloric acid solution (Cc = 1.0601) was spent on the titration of 0.1503 g of the substance, the volume of the titrant in the control experiment was 0.32 ml, and the mass loss during drying was 4.5%.

11. Calculate the percentage content of cyanocobalamin, if 25.0 mg of the substance was placed in a volumetric flask, dissolved in purified water and 1000.0 ml of the tested solution were obtained. The optical density of the tested solution, measured at a wavelength of 361 nm in a cuvette with a layer thickness of 10 mm, is 0.520. The specific absorption index of cyanocobalamin at 361 nm is 207.

5. LABORATORY WORK

During laboratory work it is necessary to strictly follow the safety rules in the chemical laboratory.

Each student individually carries out reactions of identification of samples of drug substances under the instruction of the teacher and draws up the test report.

LESSON No. 4

1.THEME: Analysis of drugs from the group of vitamins of the alicyclic and aromatic structure.

2.PURPOSE: Master the methods of analysis of drugs from the group of vitamins of the alicyclic and aromatic structure.

3.OBJECTIVES:

3.1.To study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of vitamins of the alicyclic and aromatic series and their synthetic analogues.

3.2.To study the methods of analysis of the considered group of medicinal products according to the SPhU, QCM.

3.3.Propose and justify possible methods of identification and quantification, based on the structure of drugs of the studied group.

3.4.To study specific impurities, as well as testing methods for the purity of this group of substances.

3.5.Consider the peculiarities of the analysis of drugs from the group of vitamins of the alicyclic and aromatic series and their synthetic analogues using physical, physicochemical and chemical methods.

3.6.To learn how to analyze the quality of the considered group of medicines using physical, physico-chemical and chemical methods.

3.7.Interpret and give a correct assessment of the received analysis results, draw a conclusion about the quality of the analyzed substances.

3.8.Explain the peculiarities of storage of medicines from the group of vitamins of the alicyclic and aromatic series and their synthetic analogues, based on their physicochemical properties.

3.9.Learn and follow the rules of safe work in a chemical laboratory.

4. TASKS FOR STUDENT SELF-TRAINING:

4.1. Repeat the theoretical material from organic and analytical chemistry courses on this topic.

4.2. Study the program material on the subject of the lesson according to the questions below.

Educational questions for self-training of students

1. Vitamins: general characteristics, classification. Names and synonyms of vitamins.

2. Definition of terms: "vitamers", "provitamins", "antivitamins", "vitamin-like substances". To substantiate the possibility of using the specified groups of substances for medical purposes.

3. Vitamins as medicines. Sources of extraction, chemical structure, nomenclature, physicochemical properties of medicinal substances from the group of vitamins. The concept of multivitamin preparations.

4. Medicinal products from the group of vitamins of the alicyclic series.

4.1. Cyclohexenylisoprenoid vitamins (cyclohexene vitamins with a polyene chain of isoprenoid character) - retinols (vitamins of group A). Retinol acetate. Structure, nomenclature, properties, analysis, storage, application.

4.2. Cyclohexanolethylenehydrindan vitamins - calciferols (vitamins of group D). Ergocalciferol. Cholecalciferol. Structure, nomenclature, properties, analysis, storage, application.

5. Medicinal products from the group of vitamins of the aromatic series.

5.1. Derivatives of naphthoquinones are vitamins of group K: phylloquinone (K_1), menaquinones (K_2). Phytomenadione. Vikasol. Structure, nomenclature, properties, analysis, storage, application.

5.2. Antagonists of vitamins of group K: neodicumarin, Phenindione. Structure, nomenclature, properties, analysis, storage, application.

6. To characterize the usage of chemical, physical and physicochemical methods for quality analysis (qualitative and quantitative determination) of medicines from the group of vitamins of alicyclic and aromatic structure.

7. Establishing the biological activity of vitamins. The concept of an international unit (IU). Disadvantages of the biological method of vitamin analysis.

8. The relationship between the chemical structure and the biological effect on the example of drugs from the group of vitamins of alicyclic and aromatic structure.

9. Features of storage of medicines from the group of vitamins of alicyclic and aromatic structure, based on their physicochemical properties.

4.3.Work out test tasks

1) According to the chemical structure, the derivatives of the alicyclic series include:

1. Phytomenadione
2. Tocopherol acetate
3. Retinol acetate
4. Riboflavin
5. Neodicumarin

2) An injection solution of Vikasol 1% in ampoules was sent to the Control Analytical Laboratory for analysis. One of the reactions for identifying the active substance in the drug is the interaction with concentrated sulfuric acid. What is the analytical effect of the indicated reaction?

1. The solution acquires a purple color
2. The smell of sulfur gas
3. A dark brown precipitate falls out
4. Brown gas is released
5. A transparent gelatinous mass is formed

3) Which substance from the group of vitamins according to its chemical structure belongs to the derivatives of the alicyclic series?

1. Phytomenadione
2. Tocopherol acetate
3. Routine
4. Riboflavin
5. Ergocalciferol

4) What substance is used as a starting material in the synthesis of retinol acetate?

1. Pyridine
2. Pyrimidine
3. Glycerin
4. Citral
5. γ-Picoline

5) Indicate which of the following medicines belongs to antioxidant vitamins:

1. Ergocalciferol
2. Folic acid
3. Retinol acetate
4. Riboflavin
5. Thiamine hydrochloride

6) Specify the reagent, the interaction of which with retinol acetate in a chloroform medium leads to the appearance of a blue color:

1. Ammonium oxalate
2. Potassium ferricyanide
3. Iron(II) oxide
4. Stibium(III) chloride
5. Acetic acid

7) The presence of enol hydroxyls in the structure of neodicumarin allows its quantitative determination by the acetylation method. This method of analysis is based on the following reaction:

1. Hydration
2. Oxidation
3. Esterification
4. Dianitrogenation
5. Complex formation

8) The retinol acetate substance should be stored in sealed ampoules at a temperature not higher than +5°C, protected from light. Managing such conditions is due to the fact that the substance is easily susceptible to:

1. Oxidation
2. Weathering
3. Hydrolysis
4. Weaning
5. Evaporation

9) According to the chemical structure, retinol acetate belongs to:

1. Monocyclic terpenoids
2. Bicyclic terpenoids
3. Tetraterpenoids
4. Polyterpenoids
5. Sesquiterpenes

10) The substances ergocalciferol and retinol acetate can be distinguished based on the reaction:

1. Formation of azo dye
2. With ammonium oxalate
3. With stibium(III) chloride
4. Cyanine sample
5. Murexide sample

11) Indicate which method should be used according to the SPhU for the quantitative determination of ergocalciferol:

1. Permanganatometry
2. Liquid chromatography
3. Complexonometry

4. Refractometry
5. Acid-base titration in non-aqueous media

12) The starting material for the synthesis of ergocalciferol (vitamin D_2) is ergosterol obtained by extraction from yeast. The basis of the transformation of ergosterol into ergocalciferol is:
1. Ion exchange reaction
2. Electrochemical reaction
3. Photochemical reaction
4. Complexation reaction
5. Exothermic reaction

13) Quantitative determination of vikasol is carried out by the cerimetric method. What indicator is used in this case?
1. Starch
2. Phenolphthalein
3. Ferroin
4. Sodium eosinate
5. Potassium chromate

14) Specify the reagent whose interaction with ergocalciferol in a chloroform medium (in the presence of acetyl chloride) leads to the appearance of an orange-pink color:
1. Ammonium oxalate
2. Potassium ferricyanide
3. Iron(II) oxide
4. Stibium(III) chloride
5. Acetic acid

15) The drug ”Vikasol” is a synthetic analogue of which group of vitamins?
1. Vitamins of group A
2. Vitamins of group B
3. Vitamins of group D
4. Vitamins of group K
5. Vitamins of group E

16) Which of the following drugs is an antagonist of vitamins of group K?
1. Retinol acetate
2. Neodicumarin

3. Quercetin
4. Venoruton
5. Calcium pangamate

17) Which of the following vitamins corresponds to the medicine under the international non-proprietary name “Phytomenadione”?

1. Vitamin E
2. Vitamin K_1
3. Vitamin A_1
4. Vitamin D_2
5. Vitamin R

18) When Vikasol interacts with concentrated sulfuric acid, the following is formed:

1. Sodium hydrosulphite
2. Elementary gray
3. Sulfur dioxide
4. Hydrogen sulfide
5. Ammonia

19) Which of the following medicines belongs to the derivatives of the aromatic series according to their chemical structure?

1. Retinol acetate
2. Phytomenadione
3. Ergocalciferol
4. Cholecalciferol
5. Calcium pantothenate

20) The drug, whose active ingredient is sodium 2,3-dihydro-2-methyl-1,4-naphthoquinone-2-sulfonate, has been delivered to the pharmacy. What active substance is part of the drug?

1. Neodicumarin
2. Routine
3. Riboflavin
4. Vikasol
5. Ergocalciferol

21) What medicine is identified by the formation of sulfur(IV) oxide in the process of reaction with concentrated sulfuric acid?

1. Retinol acetate
2. Vikasol
3. Ergocalciferol
4. Neodicumarin
5. Retinol acetate

22) The quantitative content of the active substance of the 0.125% solution of ergocalciferol in oil is determined by a pharmacist-analyst by a physicochemical method, having previously performed a staining reaction with stibium(III) chloride. What method of analysis requires such a preliminary procedure?

1. Refractometry
2. Polarimetry
3. Polarography
4. Potentiometry
5. Photocolorimetry

23) When Vikasol interacts with a solution of sodium hydroxide, a precipitate of 2-methyl-1,4-naphthoquinone falls out, which is extracted with chloroform, purified and the melting point is determined. What functional group is cleaved from the Vikasol molecule?

1. $-SO_3Na$
2. $-CH_3$
3. =O
4. $-NO_2$
5. Benzene cycle

24) A specific impurity in the Vikasol substance is sodium hydrosulfite. What method is used to determine the content of the indicated admixture?

1. Complexonometry
2. Alkalimetry
3. Iodometry
4. Polarimetry
5. Refractometry

25) To identify Vikasol, the pharmacist-analyst conducted a flame coloration reaction. During this test, the colorless flame of the gas burner is colored in the following color:

1. Green
2. Yellow

3. Violet
4. Brick red
5. Blue

26) Quantitative determination of Vikasol includes precipitation, extraction and recovery procedures, as well as subsequent titration with a standard solution:
1. Cerium(IV) sulfate
2. Hydrochloric acid
3. Sodium hydroxide
4. Chloric acid
5. Sodium edetate

27) The presence of an ester group and lactone cycles in the structure of neodicumarin makes it possible to use it for its identification:
1. Thiochrome test
2. Cyanine test
3. Hydroxamic test
4. Murexide test
5. Taleiochin test

28) What method should be used according to the SPhU to detect the impurity of ergosterol in the ergocalciferol substance?
1. Iodometry
2. Thin-layer chromatography
3. Potentiometry
4. Ion exchange chromatography
5. Refractometry

29) For the quantitative determination of neodicumarin by the method of acid-base titration in a non-aqueous medium, the following should be used as a solvent:
1. Acetone
2. Butylamine
3. Chloric acid
4. Lithium hydroxide
5. Glacial acetic acid

30) During the esterification of neodicumarin with acetic anhydride, the corresponding diacetate is formed, which is identified by its melting point. The

indicated reaction takes place due to the presence of neodicumarin in the structure:

1. Keto groups
2. Complex ether group
3. Enolic hydroxyls
4. The rest of the ethyl alcohol
5. The rest of the acetic acid

31) What method is used for the quantitative determination of neodicumarin?

1. Iodometry
2. Complexonometry
3. Permanganatometry
4. Acidimetry
5. Alkalimetry

32) To identify neodicumarin, a substance sample is alloyed with potassium hydroxide. What reagent should be used to detect salicylate ions formed in this case?

1. Ammonium oxalate
2. Sodium edetate
3. Potassium pyroantimonate
4. Iron(III) chloride
5. Glyoxalhydroxyanil

33) The quantitative determination of neodicumarin by the method of alkalimetry in an acetone medium is based on its:

1. Acidic properties
2. Basic properties
3. Amphoteric properties
4. Oxidizing properties
5. Restorative properties

34) For the quantitative determination of neodicumarin by the method of acid-base titration in a non-aqueous medium, what titrant should be used:

1. Acetone
2. Butylamine
3. Chloric acid
4. Lithium hydroxide
5. Glacial acetic acid

35) The presence of two enol hydroxyls in the structure of neodicumarin determines the possibility of all the listed chemical processes, except:

1. Acetylation
2. Reaction with sodium bicarbonate solution
3. Neutralization with alkali solution
4. Reaction with a solution of iron(III) chloride
5. Hydroxam test

36) What reaction is used to identify the product of hydrolytic decomposition of neodicumarin with a 10% solution of sodium hydroxide, carried out during heating?

1. Dianitrogenation
2. Formation of indophenol dye
3. Precipitation with general alkaloid reagents
4. Hydroxam test
5. Formation of hydrazones

37) Atlantic cod liver can serve as a natural source of which vitamin?

1. Ascorbic acid (vitamin C)
2. Thiamine (vitamin B_1)
3. Retinol (vitamin A)
4. Nicotinic acid (vitamin PP)
5. Phylloquinone (vitamin K_1)

38) The following international non-proprietary name corresponds to the drug ”Vikasol”:

1. Menadione sodium bisulfite
2. Metamizole sodium
3. Sodium hexobarbital
4. Caffeine sodium benzoate
5. Kanamycin sulfate

39) Neodicumarin contains two enol hydroxyls in its structure, which allow its quantitative determination by the following method:

1. Nitritometry
2. Acidimetry
3. Alkalimetry
4. Complexonometry

5. Permanganatometry

40) What reaction is used to identify the product of hydrolytic decomposition of neodicumarin with a 10% solution of sodium hydroxide, carried out during heating?

1. Dianitrogenation
2. Hydroxam test
3. Thiochrome test
4. Formation of azo dye
5. Formation of hydrazones

4.4. Situational tasks

1. Explain whether it is possible to use the reaction with a solution of stibium(III) chloride to distinguish the substances retinol acetate and ergocalciferol.

2. Justify the possibility of using the reaction with 3,5-dinitrobenzoyl chloride to identify ergocalciferol. Describe the test conditions and give the corresponding reaction equations.

3. Explain how optical activity is used in the analysis of ergocalciferol. Describe the corresponding quality indicator and the method of its determination.

4. Explain how you can distinguish the retinol acetate and ergocalciferol based on their structure and physicochemical properties. Describe the test conditions and give the corresponding reaction equations.

5. Justify the possibility of using a reaction with sodium hydroxide solution to identify Vikasol. Describe the test conditions and give the corresponding reaction equations.

6. Justify the possibility of using a reaction with concentrated sulfuric acid to identify Vikasol. Describe the conditions of the test and give the corresponding reaction equation.

7. Describe the cerimetric method of quantitative determination of Vikasol. Describe the titration conditions and give the corresponding reaction equations.

8. Explain what causes the color change of the ferroin indicator at the equivalence point in the quantitative determination of Vikasol by the cerimetric method. Why do titrations lead to the appearance of a green color, although the complex of 1.10-phenanthroline with the Fe^{3+} cation is colored blue? Give the corresponding reaction equation.

9. Justify the possibility of using the reaction of an alloy with potassium hydroxide to identify Neodicoumarin. Describe the test conditions and give the corresponding reaction equations.

10. Justify the possibility of carrying out reactions of the formation of azo and indophenol dyes after heating Neodicoumarin with a 10% solution of sodium

hydroxide. Describe the test conditions and give the corresponding reaction equations.

11. Justify the possibility of using an iodoform test for the identification of Neodicoumarin. Describe the test conditions and give the corresponding reaction equations.

12. Justify the possibility of using the acetylation reaction for the identification and quantification of Neodicoumarin. Describe the test conditions and give the corresponding reaction equations.

13. Justify the possibility of quantitative determination of Neodicoumarin by direct alkalimetric titration in acetone. What is the role of methylene blue in the composition of the used mixed indicator? Describe the titration conditions and give the corresponding reaction equations.

14. Justify the possibility of quantitative determination of Neodicoumarin by acid-base titration in a non-aqueous medium. Describe the titration conditions and give the corresponding reaction equation.

15. Explain the reasons for the differences in the behavior of Neodicoumarin during acid-base titration in an acetone medium and in a non-aqueous medium. Describe the titration conditions and give the corresponding reaction equations.

16. Justify the possibility of using the reaction with sodium hydroxide solution to identify and quantify the Phenindione. Describe the test conditions and give the corresponding reaction equations.

17. Describe the method of quantitative determination of Phenindione, based on the formation of the 2-bromo derivative of this medicinal substance. For what purpose is β-naphthol added to the reaction medium? Describe the titration conditions and give the corresponding reaction equations.

4.5. Tasks

1. Calculate the percentage content of retinol acetate, if 0.0287 g of the substance was dissolved in ethanol and 100 ml of the original solution were obtained. Then 1.0 ml of this solution was transferred to a volumetric flask, brought up to the mark with ethanol, and 100 ml of the tested solution were obtained. The optical density of the tested solution, measured at a wavelength of 326 nm in a cuvette with a layer thickness of 10 mm, is 0.443. The specific absorption index of an alcoholic solution of retinol acetate at 326 nm is 1550.
2. Calculate the percentage content of retinol acetate (M.w. = 328.5 g/mol), if 0.0300 g of the substance was dissolved in ethanol and 100 ml of the original solution were obtained. Then 1.0 ml of this solution was transferred to a volumetric flask, brought up to the mark with ethanol, and 100 ml of the tested solution were obtained. The optical density of the tested solution, measured at a wavelength of 326 nm in a cuvette with a layer thickness of 1 cm, is 0.456. The molar absorptivity of an alcoholic solution of retinol acetate at 326 nm is 50900.

3. Calculate the specific rotation and evaluate the quality of ergocalciferol, if the angle of rotation of a 15% solution of the substance in anhydrous ethanol is equal to +15.28°, and the length of the used cuvette is 10 cm. According to QCM, the specific rotation should be from +103° to +108°.
4. Calculate the percentage content of Vikasol (M.w. 330.29 g/mol), if 18.04 ml of 0.1 M solution of cerium sulfate (Cc = 0.9968) was spent on the titration of 0.2877 g of the substance, and the volume of the titrant in the control experiment was 0.62 ml.
5. Calculate the volume of 0.1 M solution of cerium sulfate (Cc = 1.0018), which is used on the titration of 0.3012 g of Vikasol (M.w. 330.29 g/mol), if the volume of the titrant in the control experiment is 0.46 ml, and the content of the active substance is 96.81%.
6. Calculate the used weight of Vikasol sample (M.w. 330.29 g/mol), if 18.07 ml of 0.1 M solution of cerium sulfate (Cc = 1.0652) was used on its titration, the volume of the titrant in the control experiment was 0.53 ml, and the content of the active substance was 98.96%.
7. Calculate the percent content of Neodicoumarin (M.w. 408.4 g/mol), if 10.05 ml of 0.1 M sodium hydroxide solution (Cc = 1.0011) was used for the titration of 0.3982 g of the substance, and the volume of the titrant in the control experiment was 0.45 ml.
8. Calculate the volume of 0.1 M sodium hydroxide solution (Cc = 0.9963), which is spent on the titration of 0.4008 g of Neodicoumarin (M.w. 408.4 g/mol), if the volume of the titrant in the control experiment is 0.48 ml, and the content of the active substance is 99.29%.
9. Calculate the weight of the Neodicoumarin sample (M.w. 408.4 g/mol), if 10.12 ml of 0.1 M sodium hydroxide solution (Cc = 1.0127) was spent on its titration, the titrant volume in the control experiment was 0.46 ml, and the content of the active substance was 99.78%.
10. Calculate the volume of 0.1 M sodium thiosulfate solution (Cc = 1.0923), which was spent on the titration of iodine released during the determination of Phenindione (M.w. 222.24 g/mol) due to the formation of the 2-bromo derivative, if the weight of the sample was 0.2914 g, loss in mass during drying was 0.46%, and the content of the active substance was 98.32%.

5. LABORATORY WORK

During laboratory work it is necessary to strictly follow the safety rules in the chemical laboratory.

Each student individually carries out reactions of identification of samples of drug substances under the instruction of the teacher and draws up the test report.

LESSON No. 5

1.THEME: Final lesson on theory and practice on the topic: «Analysis of medicines of the vitamin group. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application".

2.PURPOSE: To form systematic knowledge and consolidate practical skills in the analysis of the quality of medicines of the vitamin group and their synthetic analogues using physical, physico-chemical and chemical methods of analysis.

3. TARGETS:

3.1. Check and consolidate theoretical knowledge and practical skills in the use of physical, physicochemical and chemical methods to analyze the quality of medicines of the vitamin group and their synthetic analogues.

3.2. Check the protocols of laboratory work and analyze the correctness of the analysis of of medicines of the vitamin group their synthetic analogues in accordance with the requirements of the State Medical Research Institute, the Ministry of Health.

4. TASK FOR SELF-PREPARATION OF STUDENTS FOR THE FINAL LESSON

4.1. Control questions

1. Vitamins. General characteristics, distribution in nature, role in human life. Pathological conditions associated with a violation of the intake of vitamins in the human body.
2. Classification of vitamins: principles, examples, characteristics of individual groups. Names and synonyms of vitamins.
3. Definition of terms: "vitamers", "provitamins", "antivitamins", "vitamin-like substances". To substantiate the possibility of using the specified groups of substances for medical purposes.
4. Vitamins as medicines. Sources of extraction, chemical structure, nomenclature, physicochemical properties of medicinal substances from the group of vitamins. The concept of multivitamin preparations.
5. Vitamins of aliphatic structure. Medicinal products from the group of vitamins of the aliphatic series, sources and methods of extraction.

5.4. Lactone derivatives of unsaturated polyhydroxycarboxylic acids - ascorbic acid (vitamin C). Structure, nomenclature, properties, analysis, storage, application.

5.5. Derivatives of esters of gluconic acid - pangamic acid (vitamin B15). Calcium pangamate. Structure, nomenclature, properties, analysis, storage, application.

5.6. Derivatives of β-amino acids -pantothenic acid (vitamin B5). Calcium pantothenate. Structure, nomenclature, properties, analysis, storage, application.

6. Vitamins of heterocyclic structure. Characteristics of heterocyclic systems underlying the structure of this group of substances. Medicines from the group of heterocyclic vitamins (chroman, pyridine derivatives), sources and methods of extraction.

7. Medicinal products from the group of vitamins, chroman derivatives.

7.1. Tocopherols (vitamins of group E). Tocopherol acetate. Structure, nomenclature, properties, analysis, storage, application.

7.2. Tocopherols (vitamins of group E). Tocopherol acetate. Structure, nomenclature, properties, analysis, storage, application.

8. Medicines from the group of vitamins, pyridine derivatives.

8.1. Pyridinecarbon vitamins - vitamins of the PP group. Nicotinic acid. Nicotinamide. Structure, nomenclature, properties, analysis, storage, application.

8.2.β-Oxymethylpyridine vitamins are B6 vitamins. Pyridoxine hydrochloride. Pyridoxal phosphate. Structure, nomenclature, properties, analysis, storage, application.

9. Pyrimidine-thiazole derivatives - vitamin B_1. Thiamine hydrobromide. Thiamine hydrochloride. Coenzyme preparations: phosphothiamine, cocarboxylase, benfotiamine. Structure, nomenclature, properties, analysis, storage, application.

10. Derivatives of pteridine - vitamin B (B_9). Folic acid. Methotrexate is an antagonist of folic acid. Structure, nomenclature, properties, analysis, storage, application.

11. Derivatives of isoalloxazine - vitamin B_2. Riboflavin. Riboflavin mononucleotide. Structure, nomenclature, properties, analysis, storage, application.

12. Corrin derivatives - cobalamins (vitamins of group B_{12}). Cyanocobalamin. Vitohepatum. Structure, nomenclature, properties, analysis, storage, application.

13. Medicinal products from the group of vitamins of the alicyclic series.

13.1. Cyclohexenylisoprenoid vitamins (cyclohexene vitamins with a polyene chain of isoprenoid character) - retinols (vitamins of group A). Retinol acetate. Structure, nomenclature, properties, analysis, storage, application.

13.2. Cyclohexanolethylenehydrindan vitamins - calciferols (vitamins of group D). Ergocalciferol. Cholecalciferol. Structure, nomenclature, properties, analysis, storage, application.

14. Medicinal products from the group of vitamins of the aromatic series. Derivatives of naphthoquinones are vitamins of group K: phylloquinone (K_1), menaquinones (K_2). Phytomenadione. Vikasol. Antagonists of vitamins of group K: neodicumarin, Phenindione. Structure, nomenclature, properties, analysis, storage, application.

15. To characterize the usage of chemical, physical and physicochemical methods for quality analysis (qualitative and quantitative determination) of medicines from the group of vitamins.

16. Establishing the biological activity of vitamins. The concept of an international unit (IU). Disadvantages of the biological method of vitamin analysis.

17. The relationship between the chemical structure and the biological effect on the example of drugs from the group of vitamins.

18. Features of storage of medicines from the group of vitamins, based on their physicochemical properties.

4.2. Test tasks for the final lesson

1) Which of the following drugs according to their chemical structure belongs to the derivatives of the aliphatic series?

6. Ascorbic acid
7. Nicotinic acid
8. Riboflavin
9. Pyridoxine hydrochloride
10. Thiamine hydrobromide

2) What is the name of the group of organic compounds that inhibit the biological activity of vitamins?

3. Antivitamine
4. Antioxidants
3. Provitamins
4. Vitamers
5. Vitamin-like substances

3) What is the name of a group of low-molecular organic compounds of a relatively simple structure and diverse chemical nature, united by the sign of absolute necessity for a heterotrophic organism as a component of food?

1. Vitamers

2. Vitamins
3. Provitamins
4. Antivitamins
5. Vitamin-like substances

4) What are the names of organic substances that turn into vitamins in the human body?

1. Antivitamins
2. Antioxidants
3. Vitamers
4. Provitamins
5. Vitamin-like substances

5) How are the different chemical forms of one vitamin called?

1. Antivitamins
2. Antioxidants
3. Vitamers
4. Provitamins
5. Vitamin-like substances

6) What is the name of food irreplaceable biologically active substances of organic nature, the deficiency of which, unlike vitamins, does not lead to a pronounced clinical picture of hypo- or vitamin deficiency?

1. Antivitamins
2. Antioxidants
3. Vitamers
4. Provitamins
5. Vitamin-like substances

7) To identify ascorbic acid [Acidum ascorbicum], a reaction with what solution is not used:

6. Iron(II) sulfate
7. Silver nitrate
8. Potassium permanganate
9. Ammonia
10. 2,6-Dichlorophenolindophenol

8) In accordance with the requirements of the The State Pharmacopoeia of Ukraine (SPhU), the quantitative determination of ascorbic acid is carried out by the following method:

1. Nitritometry
2. Acidimetry
3. Bromatometry
4. Iodometry
5. Complexonometry

9) Which of the following reagents cannot be used to confirm the reducing properties of ascorbic acid?

1. Iron(III) chloride solution
2. Silver nitrate solution
3. Potassium iodate solution
4. Iodine solution
5. Potassium iodide solution

10) Which excipient should be used according to the SPhU to increase the stability of the ascorbic acid solution for injection in concentration 50 milligram per milliliter?

1. Oxalic acid
2. Sodium sulfite
3. Sodium chloride
4. Glucose monohydrate
5. Ammonium oxalate

11) Choose the incorrect statement about ascorbic acid:

1. Easily soluble in water
2. Optically active
3. The manifestation of reducing properties
4. The manifestation of amphoteric properties
5. It darkens under the influence of air and moisture

12) Specify the starting substance used for the synthesis of ascorbic acid:

1. Fructose
2. Rhamnose
3. Lactose
4. Glucose
5. Glycerin

13) What chemical process occurs in the quantitative determination of ascorbic acid by the method of direct alkalimetric titration?

1. Complex formation
2. Salt formation
3. Hydrolysis
4. Oxidation
5. Reduction

14) Which one of the listed medicinal substances corresponds to the chemical name (5*R*)-5-[(1*S*)-1,2-dihydroxyethyl]-3,4-dihydroxyfuran-2(5*H*)-one?

1. Pantothenic acid
2. Pangamic acid
3. Ascorbic acid
4. Folic acid
5. Methylmethionine sulfonium chloride

15) What functional group determines the acidic properties of ascorbic acid?

1. Enolic hydroxyl
2. Imid group
3. Amino group
4. Amide group
5. Alcoholic hydroxyl

16) According to the chemical classification, ascorbic acid belongs to the following vitamins:

1. Aromatic series
2. Alicyclic series
3. Aliphatic series
4. Heterocyclic series (pyridine derivative)
5. Heterocyclic series (isoalloxazine derivative)

17) During the identification of ascorbic acid, according to the requirements of the Federal State Administration of Ukraine, a reaction was carried out, which resulted in the formation of a gray precipitate in the medium of dilute nitric acid. What reagent was used in the performance of the indicated reaction?

1. Ammonium oxalate solution
2. Sodium edetate solution
3. Copper(II) sulfate solution

4. Silver nitrate solution
5. Potassium pyroantimonate solution

18) What chemical properties does ascorbic acid show due to the presence of an enediol group in its structure?
1. Acidic and reducing
2. Basic and oxidizing
3. Amphoteric and Red/Ox - duality
4. Acidic and oxidizing
5. Basic and restorative

19) Which drug according to its chemical structure is a derivative of unsaturated polyhydroxy lactones and carboxylic acids?
1. Riboflavin
2. Nicotinic acid
3. Calcium pangamate
4. Ascorbic acid
5. Calcium pantothenate

20) When determining the quantitative content of ascorbic acid in the dosage form, the pharmacist-analyst used the alkalimetric method. What are the properties of ascorbic acid based on this definition?
1. acidic
2. basic
3. amphoteric
4. oxidizing
5. reducing

21) The reducing properties of ascorbic acid are the basis of quantitative determination by all the listed methods, except:
1. Iodometry
2. Cerimetry
3. Iodometry
4. Bromatometry
5. Alkalimetry

22) Given the presence of a double bond in the ascorbic acid molecule, the existence of geometric *cis*- and *trans*-isomers is possible. Physiologically active vitamin C has the following configuration:

1. *cis* isomer
2. *trans* isomer

23) Which auxiliary substance, which is a part of the ascorbic acid solution for injections of 50 mg/ml, determines the possibility of its subcutaneous administration due to the reduction of the irritating effect on tissues?
1. Oxalic acid
2. Sodium metabisulfite
3. Sodium bicarbonate
4. Glucose monohydrate
5. Ammonium oxalate

24) The acidic properties of ascorbic acid (γ-lactone of 2,3-dehydro-L-gulonic acid) are more expressed in hydroxyls:
1. In the 2nd position
2. In the 3rd position
3. In the 4th position
4. In the 5th position
5. In the 6th position

25) When extracting ascorbic acid from natural sources, it is most rational to use as raw materials:
1. Rosehip fruits
2. Buckwheat leaves
3. Sea fish liver
4. Rice bran
5. Foxglove leaves

26) Ascorbic acid when titrated with alkali behaves as:
1. Monobasic acid
2. Dibasic acid
3. Tribasic acid
4. Tetrabasic acid
5. Does not interact with alkali

27) When strong oxidizing agents are added to ascorbic acid, it is irreversibly oxidized, which leads to the formation of:
1. Dehydroascorbic acid
2. Ascorbic acid

3. Gulonic acid
4. Furfural
5. Glucose

28) The pharmacist-analyst conducts the reaction of ascorbic acid and iron(II) sulfate in the presence of sodium bicarbonate. The appearance of the purple color of the solution is due to the presence of ascorbic acid:

1. Oxidizing properties
2. Reducing properties
3. Acidic properties
4. Basic properties
5. Amphoteric properties

29) The pharmacist-analyst performs quantitative determination of ascorbic acid by direct iodometric titration. What indicator should analytics use?

1. Phenolphthalein
2. Sodium eosinate
3. Thymolphthalein
4. Ferroin
5. Starch

30) The presence of oxalic acid (impurity E) in the substance of ascorbic acid, in accordance with the requirements of the SPhU is determined by the reaction:

1. With calcium chloride in an acetic acid medium
2. From iron(III) chloride in a sulfuric acid medium
3. With cobalt nitrate in a nitric acid medium
4. With sodium edetate in an ammonia buffer medium
5. With ammonium oxalate in a hydrochloric acid medium

31) In the iodatometric method of quantitative determination of ascorbic acid in injection solutions, to bind antioxidants-stabilizers into the compounds that do not react with the titrant, it is necessary to add:

1. A few crystals of potassium bromide
2. Glycerin
3. Acetic acid
4. Sodium edetate solution
5. Formaldehyde solution

32) Identification of ascorbic acid, in accordance with the requirements of the SPhU, is carried out using a solution of:

1. Ammonium oxalate
2. Calcium carbonate
3. Ammonium thiocyanate
4. Silver nitrate
5. Iron(III) chloride

33) The sedimentation of a shiny precipitate of metallic silver is observed during the identification of ascorbic acid by reaction with:

1. Nesler's reagent
2. Fehling's reagent
3. Tolens reagent
4. Dragendorf's reagent
5. Mark's reagent

34) A powder containing ascorbic and glutamic acids is made in the pharmacy store. What method should the pharmacist-analyst use for the quantitative determination of ascorbic acid in the presence of glutamic acid?

1. Alkalimetry
2. Acidimetry
3. Iodometry
4. Nitritometry
5. Complexonometry

35) Ascorbic acid can be quantitatively determined in a mixture with glucose without preliminary separation by:

1. Mercurimetry
2. Alkalimetry
3. Nitritometry
4. Acidimetry
5. Complexonometry

36) In the practice of control and analytical laboratories, a solution of 2,6-dichlorophenolindophenol is used, the blue color of which disappears under the action of reducing agents. What medicine can be identified using this solution?

1. Ascorbic acid
2. Calcium pantothenate
3. Nicotinic acid

4. Calcium pangamate
5. Pyridoxine hydrochloride

37) The pharmacist-analyst identifies the substance of ascorbic acid using diluted nitric acid and a solution of silver nitrate. The positive effect of the reaction is:
1. Appearance of blue color
2. Appearance of green color
3. Appearance of purple color
4. Fallout of a yellow precipitate
5. Formation of gray precipitate

38) Calcium pantothenate is identified by a complexation reaction, which results in a blue color. What reagent should be used to carry out the specified reaction?
1. Potassium pyroantimonate
2. Sodium edetate
3. Copper(II) sulfate
4. Ammonium oxalate
5. Hydrochloric acid

39) Which of the listed methods is not used during the quantitative analysis of the calcium pangamate?
1. Acidimetry in a non-aqueous medium
2. Complexonometry
3. Argentometry
4. Ion exchange chromatography
5. Nitritometry

40) To identify ascorbic acid, you should use:
1. Potassium chloride and potassium hydroxide solution
2. Iron(II) sulfate in the presence of sodium bicarbonate
3. Dragendorff's reagent (rosin of bismuth iodide in potassium iodide)
4. Glyoxalhydroxyanil in the presence of sodium hydroxide
5. The tannin solution is freshly prepared

41) Specify the starting substance used for the synthesis of pangamic acid:
1. Fructose
2. Rhamnose
3. Lactose
4. Glucose

5. Glycerin

42) The ester bond in the calcium pangamate molecule can be proven by the reaction:
1. Alkaline hydrolysis when heated (the smell of dimethylamine)
2. Formation of azo dye when combined with diazonium salts
3. With general alkaloid reagents
4. With Fehling's reagent
5. With iodine solution (discoloration of the solution)

43) The possibility of quantitative determination of ascorbic acid by the method of iodometry is due to the presence in the structure of this medicinal substance:
1. Lactone fragment
2. Endiol group
3. Alcohol hydroxyls
4. Carboxylic group
5. Oxymethyl group

44) Ascorbic acid (vitamin C) chemically belongs to:
1. Derivatives of polyhydroxy-γ-lactones
2. Derivatives of the alicyclic series
3. Derivatives of *β*-amino acids
4. Polyatomic alcohols
5. Derivatives of γ-amino acids

45) Pangamic acid (vitamin B_{15}) chemically belongs to:
1. Derivatives of polyhydroxy-*γ*-lactones
2. Derivatives of gluconic acid esters
3. Derivatives of *β*-amino acids
4. Polyatomic alcohols
5. Derivatives of *γ*-amino acids

46) Pantothenic acid (vitamin B_5) chemically belongs to:
1. Derivatives of polyhydroxy-*γ*-lactones
2. Derivatives of gluconic acid esters
3. Derivatives of *β*-amino acids
4. Polyatomic alcohols
5. Derivatives of *γ*-amino acids

47) The medicinal substance of calcium pangamate, in addition to the main substance, also contains 25% of calcium gluconate and 6% of calcium chloride. When analyzing this medicinal product by the complexonometry method, the next content is determined:

1. Calcium
2. Nitrogen
3. Chlorides
4. Sums of carboxyl groups
5. Crystallization water

48) The medicinal substance of calcium pangamate, in addition to the main substance, also contains 25% of calcium gluconate and 6% of calcium chloride. When analyzing this medicinal product by the method of acidimetry in a non-aqueous medium, the next content is determined:

1. Calcium
2. Nitrogen
3. Chlorides
4. Sums of carboxyl groups
5. Crystallization water

49) The pharmacist-analyst performs the quantitative determination of ascorbic acid by the method of iodometry. What properties of ascorbic acid the mentioned method of analysis is based on?

1. Acidic
2. The basic ones
3. Amphoteric
4. Oxidizing
5. Reducing

50) The pharmacist-analyst of the central factory laboratory of the chemical-pharmaceutical factory determines the quantitative content of the produced substance of ascorbic acid by the iodatometric method. Specialist must perform the titration in the presence of:

1. Sodium acetate
2. Potassium iodide
3. Calcium sulfate
4. Magnesium chloride
5. Ammonium nitrate

51) Calcium cations in the composition of calcium pantothenate can be identified by the reaction with:

1. Copper sulfate
2. Silver nitrate
3. Ammonia oxalate
4. Sodium nitrate
5. Barium sulfate

52) Identification of calcium pangamate is carried out by the reaction of alkaline hydrolysis in the presence of hydroxylamine hydrochloride with subsequent increase in the solution of iron(III) chloride during acidification. The appearance of a red-brown color confirms the presence of calcium pangamate in the structure:

1. Calcium cations
2. Complex ether bond
3. Phenolic hydroxyl
4. Pyridine cycle
5. Primary aromatic amino group

53) Which of the following statements incorrectly characterizes pyridoxine hydrochloride?

1. Easily dissolves in water
2. Gives an azo coupling reaction with diazonium salts
3. Forms complexes with boric acid
4. Hydrolyzed under the treatment of hydrochloric acid
5. Quantitatively determined by the method of acid-base titration in non-aqueous media

54) According to the requirements of the SPhU, to detect the amide group in the structure of nicotinamide, a sample of the substance should be heated with a diluted solution of:

1. Sodium hydroxide
2. Hydrochloric acid
3. Cyan bromide reagent
4. Ammonium chloride
5. Potassium ferricyanide

55) Which of the proposed reagents can be used to identify pyridoxine hydrochloride?

1. 2-Chloro-4-methoxybenzene

2. 2,6-Dichloroquinone chloride
3. 2,4,6-Trinitrophenol
4. 2,4-Dichloro-4-oxybenzene
5. 2,4,6-Tribromophenol

56) Pyridoxine hydrochloride and pyridoxal phosphate cannot be distinguished based on:
1. External view
2. Solubility in purified water
3. Reactions with iron(III) chloride
4. Reactions of azo dye formation
5. Reactions with phenylhydrazine

57) To identify pyridoxal phosphate, reactions with a copper-tartrate reagent (Fehling's reagent) and with an ammonia solution of silver nitrate (Tolens' reagent) are used. What properties of pyridoxal phosphate are the basis of these tests?
1. Acidic
2. Basic
3. Amphoteric
4. Oxidizing
5. Reducing

58) What heterocycle is the basis of the structure of pyridoxal phosphate?
1. Pyridine
2. Pyrimidine
3. Furane
4. Chromane
5. Pyrane

59) The formation of an indophenol dye is an identification reaction for:
1. Tocopherol acetate
2. Nicotinic acid
3. Nicotinamide
4. Pyridoxine hydrochloride
5. Ascorbic acid

60) The presence of which functional group in the structure of pyridoxine hydrochloride determines the possibility of reaction with iron(III) chloride?

1. Phenolic hydroxyl
2. Pyridine cycle
3. Alcoholic hydroxyl
4. Oxymethyl group
5. Methyl group

61) The following method cannot be used for the quantitative determination of pyridoxine hydrochloride:
1. Acidimetry in a non-aqueous medium
2. Alkalimetry (in the presence of chloroform)
3. Gravimetry
4. Argentometry
5. Complexonometry

62) Identification of pyridoxal phosphate is carried out by the reaction of the formation of a yellow precipitate of phenylhydrazone. What this reaction confirms in the structure of pyridoxal phosphate:
1. Phenolic hydroxyl
2. Pyridine cycle
3. Phosphate ions
4. Aldehyde group
5. Methyl group

63) Indicate the acid-base properties of nicotinic acid:
1. Acidic and
2. Basic
3. Amphoteric

64) What reagent is used in pharmaceutical analysis to prove the presence of a pyridine heterocycle in the structure of medicinal substances?
1. 2,4-Dichlorobenzene
2. 2,4-Dinitrochlorobenzene
3. 2,6-Dichloroquinone chloride
4. Sodium 2,6-Dichlorophenolindophenolate
5. 2,4,6-Trinitrophenol

65) In order to identify the substance rutin, the pharmacist-analyst conducted a reaction with metallic magnesium in the presence of concentrated hydrochloric

acid and observed the appearance of a red color. In pharmaceutical analysis, the indicated reaction is known as:

1. Hydroxam test
2. Cyanine test
3. Thiochrome test
4. Murexide test
5. Taleiochin test

66) What heterocyclic system is the basis of the chemical structure of nicotinic acid?

1. Pyrimidine
2. Pyrazole
3. Pyrrol
4. Pyridine
5. Pyrazine

67) Indicate which method should be used according to the SPhU for the quantitative determination of nicotinamide:

1. Acid-base titration
2. Acid-base titration in non-aqueous solvents
3. Determination of nitrogen by Kjeldahl
4. Cerimetry
5. Argentometry

68) The pharmacist-analyst performs the identification of nicotinic acid by reaction with solutions of cyanobromide and aniline. Due to what fragment in the nicotine acid structure the yellow colour appears:

1. Carboxylic group
2. Aldehyde group
3. Pyridine cycle
4. Amide group
5. Primary aromatic amino group

69) Indicate which method should be used according to the SPhU for the quantitative determination of nicotinic acid:

1. Determination of nitrogen by Kjeldahl
2. Acid-base titration in non-aqueous solvents
3. Acid-base titration
4. Iodometric

5. Cuprimetric

70) Which of the following substances is the starting point for the synthesis of nicotinic acid?
1. Benzene
2. Phenol
3. Benzoic acid
4. γ-Picoline
5. β-Picoline

71) Choose the incorrect statement about nicotinic acid:
1. Forms complexes with copper ions
2. Moderately soluble in water
3. It is a pyrimidine derivative
4. It is decarboxylated to form pyridine
5. Quantitatively determined by the method of neutralization

72) According to the IUPAC nomenclature, nicotinic acid is called:
1. Pyridine-2-carboxylic acid
2. Pyridine-3-carboxylic acid
3. Pyridine-4-carboxylic acid
4. β-Picolinic acid
5. 2-Carboxypyridine

73) When identifying the substance of nicotinic acid, a reaction was carried out, and as a a result of it a blue color appeared. What reagent was used?
1. Nesler's reagent
2. Sodium hydroxide solution
3. Sodium carbonate anhydrous
4. Copper(II) sulfate solution
5. Cyan bromide reagent

74) Indicate which reagent is used to identify the tocopherol acetate:
1. Concentrated ammonia solution
2. Concentrated nitric acid
3. Ammonium thiocyanate solution
4. Sodium edetate solution
5. Copper sulfate solution

75) Indicate which of the following medicines belongs to the antioxidant vitamins:
1. Tocopherol acetate
2. Riboflavin
3. Thiamine hydrochloride
4. Pyridoxine hydrochloride
5. Nicotinic acid

76) Indicate which of the methods is used for quantitative determination of tocopherol acetate:
1. Complexonometry
2. Cerimetry
3. Mercurimetry
4. Acidimetry
5. Argentometry

77) Which of the following indicators is used in cerimetric determination of the tocopherol acetate?
1. Phenolphthalein
2. Diphenylamine
3. Bromophenol blue
4. Thymolphthalein
5. Fluorescein

78) Tocopherol acetate is identified by the appearance of a red-orange color when heated with nitric acid, which fumes. What chemical process is the basis of this reaction?
1. Oxidation
2. Azo compound
3. Dianitrogenation
4. Complex formation
5. Hydration

79) The possibility of the formation of azo dyes during the identification of pyridoxine hydrochloride by reaction with diazonium salts is due to the presence in its structure of:
1. Alcoholic hydroxyl
2. Phenolic hydroxyl
3. Primary aromatic amino group
4. Methyl group

5. Crystallization water

80) The application of the cerimetry method for the quantitative determination of tocopherol acetate is based on its ability to:
1. Reducing
2. Salt formation
3. Oxidation
4. Complex formation
5. Sedimentation

81) When boiling nicotinamide with alkali, the smell is felt:
1. Ammonia
2. Pyridine
3. Benzaldehyde
4. Formaldehyde
5. Ethyl acetate

82) To identify the nicotinamide substance, a reaction was carried out with 2,4-dinitrochlorobenzene. The formation of a yellow color confirms the presence of nicotinamide in the structure of:
1. Amide group
2. Aldehyde group
3. Pyridine cycle
4. Primary aromatic amino group
5. Carboxylic group

83) The reaction of alkaline hydrolysis in the presence of ethanol and concentrated sulfuric acid is used to confirm the presence of tocopherol acetate in the structure:
1. Chromane cycle
2. Acetyl radical
3. A phytol fragment
4. Methyl groups
5. Crystallization water

84) When identifying and quantifying the tocopherol acetate, a reaction with a solution of cerium(IV) sulfate is used. The basis of this reaction is the ability of tocopherol acetate to:
1. Complex formation
2. Sedimentation

3. Reduction
4. Oxidation
5. Salt formation

85) According to the requirements of the SPhU, the method of thin-layer chromatography is used for the identification of pyridoxine hydrochloride. The use of 2,6-dichloroquinone chloride solution as a developer is based on the formation of:
   1. Azo dye
   2. Azomethine dye
   3. Aurine dye
   4. Indophenol dye
   5. Pyrazolone dye

86) To identify rutin, a reaction was carried out with metallic magnesium in the presence of concentrated hydrochloric acid. At the same time, the appearance of a red color is due to the formation of:
   1. Khalkon
   2. Pyrylium salt
   3. Diazonium salt
   4. Azo dye
   5. Thiochrome

87) A natural source of rutin extraction is:
   1. Cinnamon rosehip fruits
   2. Yeast
   3. Unrefined cereal grains
   4. Leaves of digitalis purple
   5. Buds of Japanese sophora

88) Which of the listed medicines is identified using the cyanine reaction?
   1. Pyridoxine hydrochloride
   2. Retinol acetate
   3. Tocopherol acetate
   4. Rutin
   5. Nicotinic acid

89) Rutin can be distinguished from quercetin using the following reaction:
   1. With sodium hydroxide solution

2. Production of azo dye
3. Cyanine sample
4. With Fehling's reagent
5. With a solution of iron(III) chloride

90) The reaction product of an alkaline solution of rutin with a diazonium salt is:
1. Pyryllium salt
2. Thiochrome
3. Azo dye
4. Murexid
5. Shif's base

91) It is possible to detect a specific admixture of quercetin in the substance rutin with the help of:
1. Fehling's reagent
2. Cyanine sample
3. Sodium hydroxide solution
4. UV spectrophotometry
5. Iron(III) chloride solution

92) To identify rutin, a reaction is carried out with a solution of iron(III) chloride, which is accompanied by the appearance of a dark green color. This reaction makes it possible to detect a routine in the structure:
1. Piran cycle
2. D-glucose
3. Phenolic hydroxyl
4. Alcoholic hydroxyl
5. Chrome cycle

93) The chemist of department of technical control identifies the substance rutin. He confirms the presence of a sugar component using Fehling's reagent by the formation of:
1. Brick-red sediment
2. Yellow-green sediment
3. Blue-violet sediment
4. Dark gray sediment
5. White sediment

94) Rutin as a glycoside contains the disaccharide rutinose as a sugar part, consisting of:

1. Glucose and fructose
2. Galactose and glucose
3. Glucose and rhamnose
4. Fructose and galactose
5. Fructose and rhamnose

95) For routine identification, a sample of the substance was dissolved in a 1 M sodium hydroxide solution. The appearance of the yellow-orange color is due to the formation of:

1. Pyrylium salt
2. Diazonium salt
3. Azo dye
4. Chalconoids
5. Thiochrome

96) Which drug from the group of vitamins is identified by the reaction of the formation of ethyl ester of acetic acid, which has a characteristic smell?

1. Rutin
2. Nicotinamide
3. Nicotinic acid
4. Pyridoxine hydrochloride
5. Tocopherol acetate

97) Quantitative determination of tocopherol acetate is carried out after preliminary acid hydrolysis by redox titration. What titrimetric method is used for this?

1. Mercurimetry
2. Cerimetry
3. Argentometry
4. Alkalimetry
5. Acidimetry

98) Which drug from the group of vitamins according to its chemical structure belongs to pterin derivatives?

1. Riboflavin
2. Folic acid
3. Tocopherol acetate
4. Cyanocobalamin

99) Cleavage of the thiazole nucleus, which leads to the formation of the open thiol form of thiamine, occurs when:

1. pH > 7
2. pH = 7
3. pH < 7

100) The chemical structure of cocarboxylase is a semi-synthetic derivative:

1. Pyridoxine (vitamin B_6)
2. Thiamine (vitamin B_1)
3. Riboflavin (vitamin B_2)
4. Folic acid (vitamin B)
5. Cobalamin (vitamin B_{12})

101) Which of the following heterocyclic systems are included in the structure of thiamine hydrobromide?

1. Pyridine and furan
2. Pyrazole and chroman
3. Pyrimidine and thiazole
4. Thiophene and corrin
5. Pterin and corrin

102) Indicate which method should be used according to the SPhU for the quantitative determination of thiamine hydrobromide:

1. Acid-base titration
2. Acid-base titration in non-aqueous solvents
3. Gravimetric
4. Spectrophotometric
5. Argentometric

103) Indicate which method should be used according to the SPhU for the quantitative determination of thiamine hydrochloride:

1. Acid-base titration
2. Argentometric
3. Mercurimetric
4. Gravimetric
5. Spectrophotometric

104) To identify thiamine hydrobromide, the pharmacist-analyst conducts a thiochrome formation reaction. What reagent should the analyst use for this test?

1. Calcium chloride
2. Ammonium thiocyanate
3. Potassium ferricyanide
4. Sodium acetate
5. Iron(II) sulfate

105) Name the medicinal product which, when identified by reaction with a solution of silver nitrate, forms a yellow precipitate insoluble in dilute nitric acid:

1. Pyridoxine hydrochloride
2. Thiamine hydrobromide
3. Retinol acetate
4. Ascorbic acid
5. Cyanocobalamin

106) The chemical structure of folic acid is based on a condensed heterocyclic system consisting of pyrimidine and pyrazine rings. What is the name of the specified heterocyclic system?

1. Corrin
2. Pyridine
3. Pteridine
4. Purine
5. Phenothiazine

107) According to the chemical structure, the phosphorylated derivative of thiamine is:

1. Cocarboxylase
2. Lumiflavin
3. Riboflavin
4. Folic acid
5. Cyanocobalamin

108) Due to its acidic properties, riboflavin is identified by reaction with salts of heavy metals to form colored complex compounds. The presence of which functional group in the structure of riboflavin confirms this test?

1. Amino group
2. Methyl group
3. Imide group

4. Heterocyclic nitrogen
5. Benzene cycle

109) Indicate to what heterocyclic compound do riboflavin belongs to:
1. Quinoline
2. Pterin
3. Pyridine
4. Pyrimidine
5. Isoalloxazine

110) What specific impurity can appear in riboflavin preparations during improper storage (effect of light, alkalinity of the medium)?
1. Ergosterol
2. 2-Methyl-1,4-naphthoquinone
3. Lumiflavin
4. 4-Methyl-5β-oxyethylthiazole
5. Oxalic acid

111) The doctor prescribed vitamin B_2 eye drops to the patient. When taking a prescription, the pharmacist must check the availability of the substance in the pharmacy:
1. Riboflavin
2. Thiamine hydrochloride
3. Folic acid
4. Nicotinic acid
5. Retinol acetate

112) Choose the statement that incorrectly characterizes folic acid:
1. It is a yellowish crystalline powder
2. A fragment of sulfanilic acid is present in the structure
3. Easily soluble in alkali metal hydroxide solutions
4. Enters into a complex formation reaction with copper(II) sulfate
5. Decomposes under the influence of light, hygroscopic

113) According to the SPhU, the aqueous solution of which of the listed substances has a pale greenish-yellow color in transmitted light, and in reflected light it exhibits an intense yellowish-green fluorescence that disappears when mineral acids or alkalis are added?
1. Thiamine hydrobromide

2. Folic acid
3. Pyridoxine hydrochloride
4. Riboflavin
5. Cyanocobalamin

114) The chemical name "3-[(4-amino-2-methylpyrimidin-5-yl)methyl]-5-(2-hydroxyethyl)-4-methylthiazolium bromide hydrobromide" corresponds to the medicinal product:
1. Thiamine hydrobromide
2. Bromisoval
3. Scopolamine hydrobromide
4. Bromcamphora
5. Homatropin hydrobromide

115) Which medicinal product from the group of vitamins, according to its chemical structure, is a nucleotide connected to the main system by a peptide bond?
1. Riboflavin
2. Cyanocobalamin
3. Folic acid
4. Cocarboxylase
5. Thiamine hydrochloride

116) When identifying cyanocobalamin, a sample of the substance is treated with potassium hydrosulfate. The specified manipulation is performed for the purpose of further detection:
1. D-ribose residue
2. Corrin cycle
3. Cobalt(III) ions
4. 5,6-Dimethylbenzimidazole
5. Amide groups

117) The pharmacist-analyst identifies the substance “Thiamine hydrobromide” by reaction with a solution of potassium ferricyanide in an alkaline medium with the subsequent addition of butanol. At the same time, he observes the light blue fluorescence of the alcohol layer in UV light. What product is formed during this reaction?
1. Murexid
2. Ninhydrin
3. Thiochrome

4. Hinonymin
5. Taleiochin

118) Which of the proposed tests is not used to identify the cyanocobalamin substance?
1. Disappearance of color of aqueous solution during acidification
2. Determination of absorption maxima of an aqueous solution
3. Complexation reaction after mineralization
4. Calculation of optical density relations of an aqueous solution at different wavelengths
5. According to the results of thin-layer chromatography

119) Indicate which method is used for the quantitative determination of cyanocobalamin (vitamin B_{12}):
1. Bromatometry
2. Alkalimetry
3. Spectrophotometry
4. Refractometry
5. Nitritometry

120) Which medicinal substance from the group of vitamins contains a corrin heterocycle in its structure?
1. Folic acid
2. Thiamine hydrobromide
3. Cyanocobalamin
4. Riboflavin
5. Rutin

121) The color of cyanocobalamin is associated with the presence in its structure:
1. Cobalt(III) atom
2. 6,7-Dimethylbenzimidazole
3. The rest of hydrocyanic acid
4. Azomethine group
5. D-ribose residue

122) A feature of the chemical structure of vitamin B_{12} is the macrocyclic planar corrine system. Hydrogenated rings of which heterocycle are the basis of the corrin system?
1. Pyrazole

2. Imidazole
3. Pyrrol
4. Thiazole
5. Oxazole

123) Indicate what heterocyclic system the derivatives of folic acid belong to:
1. Pterin
2. Isoalloxazine
3. Lame
4. Thiazolidine
5. Pyrimidine

124) Quantitative determination of the riboflavin substance, according to the SPhU, is carried out by the following method:
1. Refractometry
2. Spectrophotometry
3. Complexonometry
4. Ion exchange chromatography
5. Gas chromatography

125) Indicate which method should be used according to the SPhU for the quantitative determination of folic acid:
1. Photoelectrocolorimetry
2. Acid-base titration
3. Liquid chromatography
4. Permanganatometry
5. Iodometry

126) The quantitative content of thiamine hydrochloride in powders can be determined by a pharmacist-analyst by the following method:
1. Alkalimetry
2. Nitritometry
3. Bromatometry
4. Permanganatometry
5. Complexonometry

127) Medicines with anti-vitamin activity include:
1. Cocarboxylase
2. Benfotiamine

3. Riboflavin mononucleotide
4. Methotrexate
5. Vitohepatum

128) To identify thiamine hydrochloride, the pharmacist-analyst conducts the formation reaction of:
1. Azo dye
2. Murexida
3. Taleiochin
4. Thiochrome
5. Indophenol

129) Oxidation-reduction properties of folic acid are the basis of its quantitative determination by the method:
1. Polarimetry
2. Complexonometry
3. Polarography
4. Alkalimetry
5. Refractometry

130) According to the SPhU, riboflavin as an optically active substance is identified by:
1. Refractive index
2. Melting point
3. pH of freshly prepared aqueous solution
4. Specific optical rotation
5. Molar absorption index

131) Which method is not used for the quantitative determination of thiamine hydrobromide in a substance?
1. Alkalimetry, direct titration
2. Bromatometry, reverse titration
3. Argentometry according to the Fayance method
4. Argentometry after alkali neutralization
5. Gravimetry

132) When identifying cyanocobalamin, cobalt (III) ions are detected by reaction with sodium 1-nitroso-2-naphthol-3,6-disulfonate. Before performing the specified test, the medicinal substance should be subjected to:

1. Decarboxylation
2. Sulfation
3. Hydrolysis
4. Mineralization
5. Esterification

133) The structure of cyanocobalamin includes a cobalt (III) atom, which, upon identification, is converted into an ionogenic state. The formed Co^{3+} ions are detected by reaction with sodium 1-nitroso-2-naphthol-3,6-disulfonate. What chemical process is the basis of this reaction?

1. Decarboxylation
2. Dianitrogenation
3. Complex formation
4. Hydrolysis
5. Esterification

134) A pharmacist-analyst observed a bright greenish-yellow fluorescence when examining a sample of vitamin eye drops in UV light. What component this confirms in the composition of eye drops:

1. Riboflavin
2. Thiamine hydrochloride
3. Ascorbic acid
4. Folic acid
5. Cyanocobalamin

135) To detect the imide group in the structure of riboflavin, the complex formation reaction is used of orange-red color. What reagent is used in the specified reaction?

1. Potassium permanganate solution
2. Sodium edetate solution
3. Sodium hydrosulfite solution
4. Silver nitrate solution
5. Ammonium oxalate solution

136) According to the chemical structure, the derivatives of the alicyclic series include:

1. Phytomenadione
2. Tocopherol acetate
3. Retinol acetate

4. Riboflavin
5. Neodicumarin

137) An injection solution of Vikasol 1% in ampoules was sent to the Control Analytical Laboratory for analysis. One of the reactions for identifying the active substance in the drug is the interaction with concentrated sulfuric acid. What is the analytical effect of the indicated reaction?

1. The solution acquires a purple color
2. The smell of sulfur gas
3. A dark brown precipitate falls out
4. Brown gas is released
5. A transparent gelatinous mass is formed

138) Which substance from the group of vitamins according to its chemical structure belongs to the derivatives of the alicyclic series?

1. Phytomenadione
2. Tocopherol acetate
3. Routine
4. Riboflavin
5. Ergocalciferol

139) What substance is used as a starting material in the synthesis of retinol acetate?

1. Pyridine
2. Pyrimidine
3. Glycerin
4. Citral
5. γ-Picoline

140) Indicate which of the following medicines belongs to antioxidant vitamins:

1. Ergocalciferol
2. Folic acid
3. Retinol acetate
4. Riboflavin
5. Thiamine hydrochloride

141) Specify the reagent, the interaction of which with retinol acetate in a chloroform medium leads to the appearance of a blue color:

1. Ammonium oxalate
2. Potassium ferricyanide
3. Iron(II) oxide
4. Stibium(III) chloride
5. Acetic acid

142) The presence of enol hydroxyls in the structure of neodicumarin allows its quantitative determination by the acetylation method. This method of analysis is based on the following reaction:

1. Hydration
2. Oxidation
3. Esterification
4. Dianitrogenation
5. Complex formation

143) The retinol acetate substance should be stored in sealed ampoules at a temperature not higher than +5°C, protected from light. Managing such conditions is due to the fact that the substance is easily susceptible to:

1. Oxidation
2. Weathering
3. Hydrolysis
4. Weaning
5. Evaporation

144) According to the chemical structure, retinol acetate belongs to:

1. Monocyclic terpenoids
2. Bicyclic terpenoids
3. Tetraterpenoids
4. Polyterpenoids
5. Sesquiterpenes

145) The substances ergocalciferol and retinol acetate can be distinguished based on the reaction:

1. Formation of azo dye
2. With ammonium oxalate
3. With stibium(III) chloride
4. Cyanine sample
5. Murexide sample

146) Indicate which method should be used according to the SPhU for the quantitative determination of ergocalciferol:

1. Permanganatometry
2. Liquid chromatography
3. Complexonometry
4. Refractometry
5. Acid-base titration in non-aqueous media

147) The starting material for the synthesis of ergocalciferol (vitamin D_2) is ergosterol obtained by extraction from yeast. The basis of the transformation of ergosterol into ergocalciferol is:

1. Ion exchange reaction
2. Electrochemical reaction
3. Photochemical reaction
4. Complexation reaction
5. Exothermic reaction

148) Quantitative determination of vikasol is carried out by the cerimetric method. What indicator is used in this case?

1. Starch
2. Phenolphthalein
3. Ferroin
4. Sodium eosinate
5. Potassium chromate

149) Specify the reagent whose interaction with ergocalciferol in a chloroform medium (in the presence of acetyl chloride) leads to the appearance of an orange-pink color:

1. Ammonium oxalate
2. Potassium ferricyanide
3. Iron(II) oxide
4. Stibium(III) chloride
5. Acetic acid

150) The drug ”Vikasol” is a synthetic analogue of which group of vitamins?

1. Vitamins of group A
2. Vitamins of group B
3. Vitamins of group D
4. Vitamins of group K

5. Vitamins of group E

151) Which of the following drugs is an antagonist of vitamins of group K?
1. Retinol acetate
2. Neodicumarin
3. Quercetin
4. Venoruton
5. Calcium pangamate

152) Which of the following vitamins corresponds to the medicine under the international non-proprietary name “Phytomenadione”?
1. Vitamin E
2. Vitamin K_1
3. Vitamin A_1
4. Vitamin D_2
5. Vitamin R

153) When Vikasol interacts with concentrated sulfuric acid, the following is formed:
1. Sodium hydrosulphite
2. Elementary gray
3. Sulfur dioxide
4. Hydrogen sulfide
5. Ammonia

154) Which of the following medicines belongs to the derivatives of the aromatic series according to their chemical structure?
1. Retinol acetate
2. Phytomenadione
3. Ergocalciferol
4. Cholecalciferol
5. Calcium pantothenate

155) The drug, whose active ingredient is sodium 2,3-dihydro-2-methyl-1,4-naphthoquinone-2-sulfonate, has been delivered to the pharmacy. What active substance is part of the drug?
1. Neodicumarin
2. Routine
3. Riboflavin

4. Vikasol
5. Ergocalciferol

156) What medicine is identified by the formation of sulfur(IV) oxide in the process of reaction with concentrated sulfuric acid?

1. Retinol acetate
2. Vikasol
3. Ergocalciferol
4. Neodicumarin
5. Retinol acetate

157) The quantitative content of the active substance of the 0.125% solution of ergocalciferol in oil is determined by a pharmacist-analyst by a physicochemical method, having previously performed a staining reaction with stibium(III) chloride. What method of analysis requires such a preliminary procedure?

1. Refractometry
2. Polarimetry
3. Polarography
4. Potentiometry
5. Photocolorimetry

158) When Vikasol interacts with a solution of sodium hydroxide, a precipitate of 2-methyl-1,4-naphthoquinone falls out, which is extracted with chloroform, purified and the melting point is determined. What functional group is cleaved from the Vikasol molecule?

1. $-SO_3Na$
2. $-CH_3$
3. $=O$
4. $-NO_2$
5. Benzene cycle

159) A specific impurity in the Vikasol substance is sodium hydrosulfite. What method is used to determine the content of the indicated admixture?

1. Complexonometry
2. Alkalimetry
3. Iodometry
4. Polarimetry
5. Refractometry

160) To identify Vikasol, the pharmacist-analyst conducted a flame coloration reaction. During this test, the colorless flame of the gas burner is colored in the following color:

1. Green
2. Yellow
3. Violet
4. Brick red
5. Blue

161) Quantitative determination of Vikasol includes precipitation, extraction and recovery procedures, as well as subsequent titration with a standard solution:

1. Cerium(IV) sulfate
2. Hydrochloric acid
3. Sodium hydroxide
4. Chloric acid
5. Sodium edetate

162) The presence of an ester group and lactone cycles in the structure of neodicumarin makes it possible to use it for its identification:

1. Thiochrome test
2. Cyanine test
3. Hydroxamic test
4. Murexide test
5. Taleiochin test

163) What method should be used according to the SPhU to detect the impurity of ergosterol in the ergocalciferol substance?

1. Iodometry
2. Thin-layer chromatography
3. Potentiometry
4. Ion exchange chromatography
5. Refractometry

164) For the quantitative determination of neodicumarin by the method of acid-base titration in a non-aqueous medium, the following should be used as a solvent:

1. Acetone

2. Butylamine
3. Chloric acid
4. Lithium hydroxide
5. Glacial acetic acid

165) During the esterification of neodicumarin with acetic anhydride, the corresponding diacetate is formed, which is identified by its melting point. The indicated reaction takes place due to the presence of neodicumarin in the structure:

1. Keto groups
2. Complex ether group
3. Enolic hydroxyls
4. The rest of the ethyl alcohol
5. The rest of the acetic acid

166) What method is used for the quantitative determination of neodicumarin?

1. Iodometry
2. Complexonometry
3. Permanganatometry
4. Acidimetry
5. Alkalimetry

167) To identify neodicumarin, a substance sample is alloyed with potassium hydroxide. What reagent should be used to detect salicylate ions formed in this case?

1. Ammonium oxalate
2. Sodium edetate
3. Potassium pyroantimonate
4. Iron(III) chloride
5. Glyoxalhydroxyanil

168) The quantitative determination of neodicumarin by the method of alkalimetry in an acetone medium is based on its:

1. Acidic properties
2. Basic properties
3. Amphoteric properties
4. Oxidizing properties
5. Restorative properties

169) For the quantitative determination of neodicumarin by the method of acid-base titration in a non-aqueous medium, what titrant should be used:

1. Acetone
2. Butylamine
3. Chloric acid
4. Lithium hydroxide
5. Glacial acetic acid

170) The presence of two enol hydroxyls in the structure of neodicumarin determines the possibility of all the listed chemical processes, except:

1. Acetylation
2. Reaction with sodium bicarbonate solution
3. Neutralization with alkali solution
4. Reaction with a solution of iron(III) chloride
5. Hydroxam test

171) What reaction is used to identify the product of hydrolytic decomposition of neodicumarin with a 10% solution of sodium hydroxide, carried out during heating?

1. Dianitrogenation
2. Formation of indophenol dye
3. Precipitation with general alkaloid reagents
4. Hydroxam test
5. Formation of hydrazones

172) Atlantic cod liver can serve as a natural source of which vitamin?

1. Ascorbic acid (vitamin C)
2. Thiamine (vitamin B_1)
3. Retinol (vitamin A)
4. Nicotinic acid (vitamin PP)
5. Phylloquinone (vitamin K_1)

173) The following international non-proprietary name corresponds to the drug ”Vikasol”:

1. Menadione sodium bisulfite
2. Metamizole sodium
3. Sodium hexobarbital
4. Caffeine sodium benzoate

5. Kanamycin sulfate

174) Neodicumarin contains two enol hydroxyls in its structure, which allow its quantitative determination by the following method:

1. Nitritometry
2. Acidimetry
3. Alkalimetry
4. Complexonometry
5. Permanganatometry

175) What reaction is used to identify the product of hydrolytic decomposition of neodicumarin with a 10% solution of sodium hydroxide, carried out during heating?

1. Dianitrogenation
2. Hydroxam test
3. Thiochrome test
4. Formation of azo dye
5. Formation of hydrazones

4.3. Situational tasks:

1. Describe the acid-base properties of ascorbic acid. What features of the chemical structure of ascorbic acid are they related to? Give the equation and describe the conditions for the identification reaction of ascorbic acid, based on its acid-base properties.

2. Justify the possibility of using acid-base titration as a method of quantitative determination of ascorbic acid. Describe the titration conditions and give the reaction equation underlying this method.

3. Describe the redox properties of ascorbic acid. What features of the chemical structure of ascorbic acid are they related to? What is called reversible and irreversible oxidation of ascorbic acid? Which of these processes is the basis of its biological action?

4. Justify the possibility of using the reaction with silver nitrate solution to identify ascorbic acid. Give the equation and describe the conditions for this reaction.

5. What is the basis for using the reaction with a solution of 2,6-dichlorophenolindophenol to identify ascorbic acid? Give the equation and describe the conditions for this reaction.

6. Explain how its optical activity is used in the analysis of ascorbic acid. Describe the relevant quality indicator and the method of its determination.

7. Justify the possibility of using direct iodometric titration for the quantitative determination of ascorbic acid. Describe the titration conditions and give the corresponding chemistry.
8. Describe the method of direct iodatometric determination of ascorbic acid. What is it based on? Give the corresponding reaction equations.
9. Justify the necessity of introducing sodium sulfite and sodium bicarbonate into the composition of the ascorbic acid solution for injections of 50 mg/ml. Why do these auxiliary substances not interfere with the reaction with silver nitrate solution when identifying the active substance by the DFU method? Give the corresponding reaction equations.
10. Describe the iodatometric method of quantitative determination of ascorbic acid in a solution for injections of 50 mg/ml. What causes the need to add formaldehyde solution in this case? Give the corresponding reaction equations.
11. Justify the possibility of using cerimetric titration for the quantitative determination of ascorbic acid. Describe the titration conditions and give the corresponding reaction equations.
12. What structural fragment determines the possibility of using a hydroxam test to identify calcium pangamate? Describe the conditions for conducting this test and give the corresponding reaction equations.
13. What is the peculiarity of the quantitative determination of the substance calcium pangamate? What quality indicators are evaluated in this case? Describe the appropriate methods of analysis, give the necessary reaction equations.
14. Justify the possibility of using a reaction with a solution of copper(II) sulfate in an alkaline medium to identify calcium pantothenate. Give the equation of the corresponding reaction.
15. An acid hydrolysis reaction is used to identify calcium pantothenate. One of the products of this reaction is substance X, for the detection of which the hydroxam test is used. Define substance X and write the equations of all mentioned reactions.
16. Explain the basis of the use of the complexonometry method in the quantitative determination of calcium pantothenate. Describe the titration conditions and give the corresponding reaction equations.
17. Describe the redox properties of tocopherol acetate. What features of the chemical structure of tocopherol acetate are they related to? How does the structure of oxidation products depend on the nature of the oxidizing agent?
18. What is the basis of the formation of ethyl acetate reaction used in the tocopherol acetate identification? Describe the test conditions and give the corresponding reaction equations.

19. Substance **X** is a reaction product of tocopherol acetate with concentrated nitric acid. When substance **X interacts** with *o*-phenylenediamine, substance **Y is formed.** Identify the substances **X and Y,** write the equations of all the mentioned reactions. What characteristic optical property of substance **Y** is used for its detection?

20. Describe the cerimetric method of quantitative determination of tocopherol acetate. What is it based on? Give the corresponding reaction equations.

21. Describe the usage of a reaction with 1 M sodium hydroxide solution to identify rutin. The appearance of a yellow-orange color is associated with the formation of which product? Give the appropriate reaction equation.

22. Justify the possibility of identifying rutin by the reaction of the cyanine sample. What is this reaction based on? How do the colored reaction products are called? Give the corresponding reaction equations.

23. Explain whether the cyanine test can be used to distinguish the substances rutin and quercetin. Give the corresponding reaction equations.

24. Explain whether it is possible to use the reaction with the copper-tartrate reagent to distinguish the substances rutin and quercetin. Give the corresponding reaction equations.

25. Justify the possibility of using the reaction with copper(II) salts to identify nicotinic acid. What is the advantage of using copper(II) acetate in comparison with copper(II) sulfate when performing the mentioned reaction? Give the corresponding reaction equations.

26. When identifying nicotinic acid, a reaction with 2,4-dinitrochlorobenzene is carried out followed by the addition of sodium hydroxide solution. What structural fragment of nicotinic acid is detected in this test? Give the corresponding reaction equations and analytical effects that are observed.

27. Justify the possibility of using a reaction with a solution of cyanobromide (with the subsequent addition of aniline) to identify nicotinic acid. What type of organic dye is formed in this test? Give the corresponding reaction equations.

28. Justify the possibility of using acid-base titration for the quantitative determination of nicotinic acid. Describe the titration conditions and give the corresponding reaction equations.

29. Describe the cupriiodmetric method of quantitative determination of nicotinic acid in a 1% injection solution. Give the corresponding reaction equations.

30. Describe the decomposition reactions of nicotinamide that occur when heated with sodium hydroxide solution and when mixed with anhydrous sodium carbonate. How do you detect the products that have formed? Give the corresponding reaction equations.

31. Justify the possibility of quantitative determination of nicotinamide based on ammonia release as a result of hydrolysis. Give the corresponding reaction equations.

32. Describe the method of acid-base titration of medicinal substances in aqueous media using the example of nicotinamide. Give the corresponding reaction equations.

33. Justify the possibility of identifying pyridoxine hydrochloride by reaction with 2,6-dichloroquinone chloride. What is the reason of the change in the analytical effect when this reaction is carried out in the presence of boric acid? Give the corresponding reaction equations.

34. Explain the purpose of using 2,6-dichloroquinone chloride in the identification of pyridoxine hydrochloride by thin-layer chromatography. What type of organic dye is formed in this test? Give the corresponding reaction equations.

35. Justify the possibility of using the azo coupling reaction to identify and quantify pyridoxine hydrochloride. For what purpose are heavy metal salts introduced into the reaction medium? Give the corresponding reaction equations.

36. Explain the necessity of adding mercury(II) acetate in the quantitative determination of pyridoxine hydrochloride by the acid-base titration method in a non-aqueous medium. Give the corresponding reaction equations.

37. Describe the quantitative determination of pyridoxine hydrochloride by the method of acidimetry in a mixture of anhydrous formic acid and acetic anhydride. Why is mercury(II) acetate not added in this case? Give the corresponding reaction equations.

38. Describe the quantitative determination of pyridoxine hydrochloride by the method of acidimetry in a mixture of anhydrous formic acid and acetic anhydride. What is the reason for the need for constant stirring during titration and its termination immediately after reaching the equivalence point? Give the corresponding reaction equations.

39. Justify the possibility of quantitative determination of pyridoxine hydrochloride by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.

40. Justify the possibility of using the reaction with phenylhydrazine hydrochloride to identify pyridoxal phosphate. Give the corresponding reaction equations.

41. Explain what is associated with the instability of thiamine hydrochloride in an alkaline medium. Describe the stages of transformation of thiamine preparations that occur under the influence of sodium hydroxide solution.

42. Describe the thiochrome test as a reaction for the identification of thiamine preparations. Explain its essence, conditions of implementation, specificity. Give

the corresponding reaction equations using the example of thiamine hydrobromide.

43. Justify the possibility of using a reaction with a solution of potassium ferricyanide in an alkaline medium to identify thiamine hydrochloride. Describe the test conditions and give the corresponding reaction equations.

44. Explain whether the thiochrome test can be used to distinguish the substances of thiamine hydrobromide and benfotiamine. Describe the test conditions and give the corresponding reaction equations.

45. Explain whether the reaction with chloramine solution can be used to distinguish the substances of thiamine hydrochloride and thiamine hydrobromide. Describe the test conditions and give the corresponding reaction equations.

46. Explain the necessity of adding mercury(II) acetate in the quantitative determination of thiamine hydrobromide by the method of acid-base titration in a non-aqueous medium. Give the corresponding reaction equations.

47. Describe the quantitative determination of thiamine hydrochloride by the method of acidimetry in a mixture of anhydrous formic acid and acetic anhydride. Why is mercury(II) acetate not added in this case? Give the corresponding reaction equations.

48. Describe the quantitative determination of thiamine hydrobromide by the argentometric method after neutralization with alkali. Give the corresponding reaction equations.

49. Justify the possibility of quantitative determination of thiamine hydrobromide by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.

50. Justify the possibility of quantitative determination of thiamine hydrobromide by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.

51. Justify the possibility of quantitative determination of cocarboxylase by the alkalimetric method. Describe the titration conditions and give the corresponding reaction equations.

52. Describe the chemical structure of folic acid. What fragments (parts) are distinguished in the structure of folic acid? Explain why drugs from the group of sulfonamides are antivitamins of folic acid.

53. Describe the acid-base properties of folic acid. What features of the chemical structure of folic acid are they related to? How are the acid-base properties of folic acid used when assessing the quality of the substance according to the ”Solubility” indicator?

54. Explain how its optical activity is used in the analysis of folic acid. Describe the corresponding quality indicator and the method of its determination.

55. Justify the possibility of using the reaction with potassium permanganate solution to identify folic acid. For what purpose a solution of hydrogen peroxide is added to the reaction medium? Describe the test conditions and give the corresponding reaction equations.

56. Justify the possibility of quantitative determination of folic acid by the photocolorimetric method based on the reaction of the formation of an azo dye. Describe the test conditions and give the corresponding reaction equations.

57. Justify the possibility of quantitative determination of folic acid by the polarographic method. Describe the conditions of the test and give the corresponding chemistry.

58. Explain whether it is possible to use the reaction with a solution of potassium permanganate to distinguish the substances of folic acid and methotrexate. Give the corresponding reaction equations.

59. Explain how light affects the stability of riboflavin. What changes can occur in the structure of riboflavin under the influence of light (considering the pH of the medium)? How should these changes be considered when evaluating the purity and storage of the riboflavin substance?

60. Justify the possibility of using the reaction with sodium hydrosulfite to identify riboflavin. Give the corresponding reaction equations.

61. Explain how its optical activity is used in the analysis of riboflavin. Describe the corresponding quality indicator and the method of its determination.

62. Justify the possibility of using a reaction with a solution of sodium 1-nitroso-2-naphthol-3,6-disulfonate to identify cyanocobalamin. Describe the conditions of the test and write the corresponding reaction.

63. Explain whether it is possible to use the reaction with a solution of stibium(III) chloride to distinguish the substances retinol acetate and ergocalciferol.

64. Justify the possibility of using the reaction with 3,5-dinitrobenzoyl chloride to identify ergocalciferol. Describe the test conditions and give the corresponding reaction equations.

65. Explain how optical activity is used in the analysis of ergocalciferol. Describe the corresponding quality indicator and the method of its determination.

66. Explain how you can distinguish the retinol acetate and ergocalciferol based on their structure and physicochemical properties. Describe the test conditions and give the corresponding reaction equations.

67. Justify the possibility of using a reaction with sodium hydroxide solution to identify Vikasol. Describe the test conditions and give the corresponding reaction equations.

68. Justify the possibility of using a reaction with concentrated sulfuric acid to identify Vikasol. Describe the conditions of the test and give the corresponding reaction equation.

69. Describe the cerimetric method of quantitative determination of Vikasol. Describe the titration conditions and give the corresponding reaction equations.

70. Explain what causes the color change of the ferroin indicator at the equivalence point in the quantitative determination of Vikasol by the cerimetric method. Why do titrations lead to the appearance of a green color, although the complex of 1.10-phenanthroline with the Fe^{3+} cation is colored blue? Give the corresponding reaction equation.

71. Justify the possibility of using the reaction of an alloy with potassium hydroxide to identify Neodicoumarin. Describe the test conditions and give the corresponding reaction equations.

72. Justify the possibility of carrying out reactions of the formation of azo and indophenol dyes after heating Neodicoumarin with a 10% solution of sodium hydroxide. Describe the test conditions and give the corresponding reaction equations.

73. Justify the possibility of using an iodoform test for the identification of Neodicoumarin. Describe the test conditions and give the corresponding reaction equations.

74. Justify the possibility of using the acetylation reaction for the identification and quantification of Neodicoumarin. Describe the test conditions and give the corresponding reaction equations.

75. Justify the possibility of quantitative determination of Neodicoumarin by direct alkalimetric titration in acetone. What is the role of methylene blue in the composition of the used mixed indicator? Describe the titration conditions and give the corresponding reaction equations.

76. Justify the possibility of quantitative determination of Neodicoumarin by acid-base titration in a non-aqueous medium. Describe the titration conditions and give the corresponding reaction equation.

77. Explain the reasons for the differences in the behavior of Neodicoumarin during acid-base titration in an acetone medium and in a non-aqueous medium. Describe the titration conditions and give the corresponding reaction equations.

78. Justify the possibility of using the reaction with sodium hydroxide solution to identify and quantify the Phenindione. Describe the test conditions and give the corresponding reaction equations.

79. Describe the method of quantitative determination of Phenindione, based on the formation of the 2-bromo derivative of this medicinal substance. For what

purpose is β-naphthol added to the reaction medium? Describe the titration conditions and give the corresponding reaction equations.

4.4. Tasks:

1. Calculate the volume of 0.05 M potassium iodate solution (Kp = 0.9915), which is spent on the titration of 0.4974 g of ascorbic acid (M.m. 176.13), if the content of the active substance in the substance is 99.43% .
2. Calculate the percentage content of ascorbic acid (M.m. 176.13), if 14.0 ml of 0.1 M sodium hydroxide solution was spent on the titration of 0.2530 g of the substance (Kp = 1.0030).
3. Calculate the mass of the test of ascorbic acid (M.m. 176.13), if 20.10 ml of 0.05 M iodine solution (Kp = 1.0000) was spent on its titration, and the percentage content in the substance was 99.0%.
4. Calculate the percentage content of ascorbic acid (M.m. 176.13), if 14.55 ml of 0.1 M sodium hydroxide solution was spent on the titration of 0.2589 g of the substance (Kp = 1.0084).
5. Calculate the volume of 0.0167 M potassium iodate solution (Kp = 1.0010), which is spent on the titration of 0.4520 g of ascorbic acid (M.m. 176.13), if its percentage content in the substance is 98.70% , the volume of the used volumetric flask is 50.0 ml, and the volume of the pipette is 10.00 ml.
6. Calculate the specific rotation of a 2% solution of ascorbic acid if the angle of rotation is +0.95 and the length of the cuvette used is 19.0 cm.
7. For two aqueous solutions of ascorbic acid with a content of 4.44% and 6.36%, the refractive indices were determined, which are equal to 1.3400 and 1.3430, respectively, and for the studied solution - 1.3420. Calculate the concentration of ascorbic acid in the already mentioned solution, if it is known that in the considered interval there is a linear dependence of n - C%, and the refractive index of purified water under the same conditions is 1.3330.
8. Calculate the concentration of the ascorbic acid solution if the angle of rotation for this solution is +2.20 °, the thickness of the layer is 1 dm, and the specific rotation is +23.0 °.
9. Calculate the concentration (%) of a solution of ascorbic acid if it is known that the refractive index of this solution is 1.3346, F = 0.00160, and the refractive index of the solvent is 1.3330.
10. Calculate the volume of a 0.05 M solution of sodium edetate (Kp = 1.0015), which was spent on the titration of 0.2037 g of calcium pantothenate in the quantitative determination of calcium cations (M.m. 40.08), if their content was 8, 52%, and the loss in mass during drying is 4.12%.
11. Calculate the volume of 0.1 M sodium hydroxide solution (Cc = 1.0030), which is used on the titration of 0.3010 g of nicotinic acid (M.w. 123.11 g/mol), if its

percentage content in the substance is 99.5%, and the loss in mass during drying is 0.4%.

12. Calculate the initial weight of the nicotinic acid (M.w. 123.11 g/mol), if 19.88 ml of 0.1 M sodium hydroxide solution (Cc = 1.0030) was spent on its titration, the percentage content in the substance is 99.6%, and the loss in mass during drying is 0.5%.

13. Calculate the percentage content of nicotinamide (M.w. 122.13), if 11.80 ml of a 0.1 M solution of perchloric acid (Cc = 1.0000) was spent on the titration of 0.1520 g of the substance, the loss in mass during drying was 0.4%, and the volume of titrant in the control experiment is 0.3 ml.

14. Calculate the volume of 0.1 M perchloric acid solution (Cc = 1.0000), which is spent on the titration of 0.1450 g of pyridoxine hydrochloride (M.w. 205.64 g/mol), if its percentage content in the substance is 98.7%, the loss in mass during drying is 0.45%, and the titrant volume in the control experiment is 0.3 ml.

15. Calculate the percentage content of chloride ions (M.w. 35.45 g/mol) in the substance of pyridoxine hydrochloride, if 1.80 ml of 0.1 M sodium hydroxide solution (Cc = 1.0863) was spent on the titration of a weighing 0.1015 g, the loss in mass during drying was 0.6%, the volume of the measuring flask was 50 ml, and the volume of the pipette was 20 ml.

16. Calculate the weight of the tocopherol acetate test (M.w. 472.8 g/mol), if 19.2 ml of a 0.1 M solution of cerium sulfate (Cc = 1.0000) was spent on its titration, the percentage content of the active substance in the substance was 94.9%, and the titrant volume in the control experiment was 0.4 ml.

17. Estimate the quality of tocopherol acetate (M.w. 472.8 g/mol) according to its quantitative content, if 21.10 ml of 0.01 M cerium sulfate solution (Cc = 0.9900) was used for the titration of 0.1203 g of the substance, and for the control experiment - 1.1 ml of the same titrant. The volume of the used volumetric flask is 50.0 ml, and the volume of the pipette is 20.0 ml. According to QCM, the content of tocopherol acetate in the substance should be from 95.0% to 100.5%.

18. Calculate the quantitative content of rutin if 0.7730 g of the substance was dissolved in ethanol in a 50 ml volumetric flask, 2 ml of this solution was transferred to a 50 ml volumetric flask and adjusted to the mark with ethanol. 0.5 ml of 0.1 M sodium hydroxide solution was added to 1.6 ml of the resulting solution and diluted to 10 ml with ethanol. The optical density measured in a cuvette with a thickness of 10 mm at 400 nm is 0.612. In parallel, the reaction was carried out with 0.5 ml of a 0.02% standard solution of rutin, the optical density of which was 0.624.

19. Estimate the quality of tocopherol acetate (M.w. 472.8 g/mol) by the specific absorption index of a 0.01% alcohol solution, if its optical density is 0.45, the measurement is made at 285 nm, and the thickness of the used cuvette is 10 mm. According to QCM, the specific absorption index should have a value from 42 to 47.

20. Calculate the percentage content of pyridoxine hydrochloride (M.w. 205.64 g/mol) if, during the potentiometric titration of 0.1515 g of the substance, the volume of 0.1 M sodium hydroxide solution (Cc = 1.0030), which corresponds to the first potential jump on the curve titration is 0.42 ml, the second jump is 7.77 ml, and the loss in mass during drying is 0.48%.

21. Calculate the volume of 0.1 M solution of perchloric acid (Cc = 1.0100), which is used on the titration of 0.0988 g of thiamine hydrochloride (M.w. 337.27 g/mol), if its content in the substance is 95.8%, the loss in mass during drying is 5.0%, and the titrant volume in the control experiment is 0.25 ml.

22. The following dosage form is analyzed at the pharmaceutical enterprise:

Riboflavin tablets in 0.005 g

Calculate the content of riboflavin in one tablet, if for determination by QCM 0.8200 g of powder of crushed tablets was dissolved in water in a volumetric flask with a capacity of 500 ml, 10 ml of the resulting solution was transferred to a volumetric flask with a capacity of 50 ml and the volume of the solution was brought to the mark with purified water. The value of the optical density of the obtained solution was 0.510 with a layer thickness of 10 mm. The specific index of absorption of riboflavin is 850, and the average weight of the tablets is 0.3050 g.

23. Calculate the specific rotation of riboflavin and conclude about the quality, if the angle of rotation of a 0.5% solution in a 0.05 M solution of sodium hydroxide was -1.2°, and the length of the used polarimeter tube was 19.96 cm. According to QCM, the specific rotation of riboflavin should be from -115° to -135°.

24. The pharmacy has prepared a dosage form with the following composition:

Thiamine hydrobromide 0.01
Nicotinic acid 0.02
Glucose 0.1

A weight of powder weighing 0.1000 g was dissolved in 3 ml of purified water and titrated with a solution of sodium hydroxide (0.02 M, Cc = 1.0000) until an orange color (indicator - phenolphthalein). 1 ml of diluted nitric acid, 1 ml of ferric ammonium alum solution, 0.20 ml of ammonium thiocyanate solution (0.02 M, Cc = 1.0000) were added to the titrated liquid and titrated with silver nitrate solution (0.02 M, Cc = 1.0000), until the orange color changes to yellow. Calculate the volume of titrants used for the determination of thiamine hydrobromide (M.w. 435.2 g/mol) and nicotinic acid (M.w. 123.1 g/mol).

25. Calculate the value of the specific rotation of methotrexate and conclude about its quality, if the angle of rotation of a 1% solution in sodium carbonate solution was +0.48°, and the length of the used polarimeter tube was 190 mm. According to QCM, the specific rotation of methotrexate should be from +19° to +24°.

26. Calculate the percentage content of riboflavin in the composition of eye drops, if for analysis 5.0 ml of the test solution was taken with a pipette, placed in a measuring flask with a capacity of 50 ml, brought to the mark with purified water

and thoroughly mixed. The optical density of the resulting solution, measured in a cuvette with a layer thickness of 10 mm at a wavelength of 445 nm, is 0.24. In parallel, the optical density of a standard solution containing 0.00002 g of riboflavin in 1 ml was measured. It was 0.22.

27. Calculate the measured angle of rotation of a 0.5% alkaline solution of riboflavin if the specific rotation is -120° and the thickness of the cuvette is 10 cm.

28. Calculate the percentage content of thiamine hydrobromide (M.w. anhydrous 426.2 g/mol), if 7.61 ml of a 0.1 M perchloric acid solution (Cc = 1.0000) was spent on the titration of 0.1529 g of the substance, the titrant volume in the control experiment was 0.63 ml, and the loss in mass during drying was 3.17%.

29. Calculate the mass of thiamine hydrochloride (M.w. 337.27 g/mol), if 6.73 ml of 0.1 M perchloric acid solution (Cc = 1.0000) was spent on its titration, the content of the active substance in the substance was 98.12%, the volume of the titrant in the control experiment was 0.41 ml, and the mass loss during drying was 3.48%.

30. Calculate the percentage content of thiamine hydrochloride (M.w. 337.27 g/mol), if 8.30 ml of a 0.1 M perchloric acid solution (Cc = 1.0601) was spent on the titration of 0.1503 g of the substance, the volume of the titrant in the control experiment was 0.32 ml, and the mass loss during drying was 4.5%.

31. Calculate the percentage content of cyanocobalamin, if 25.0 mg of the substance was placed in a volumetric flask, dissolved in purified water and 1000.0 ml of the tested solution were obtained. The optical density of the tested solution, measured at a wavelength of 361 nm in a cuvette with a layer thickness of 10 mm, is 0.520. The specific absorption index of cyanocobalamin at 361 nm is 207.

32. Calculate the percentage content of retinol acetate, if 0.0287 g of the substance was dissolved in ethanol and 100 ml of the original solution were obtained. Then 1.0 ml of this solution was transferred to a volumetric flask, brought up to the mark with ethanol, and 100 ml of the tested solution were obtained. The optical density of the tested solution, measured at a wavelength of 326 nm in a cuvette with a layer thickness of 10 mm, is 0.443. The specific absorption index of an alcoholic solution of retinol acetate at 326 nm is 1550.

33. Calculate the percentage content of retinol acetate (M.w. = 328.5 g/mol), if 0.0300 g of the substance was dissolved in ethanol and 100 ml of the original solution were obtained. Then 1.0 ml of this solution was transferred to a volumetric flask, brought up to the mark with ethanol, and 100 ml of the tested solution were obtained. The optical density of the tested solution, measured at a wavelength of 326 nm in a cuvette with a layer thickness of 1 cm, is 0.456. The molar absorptivity of an alcoholic solution of retinol acetate at 326 nm is 50900.

34. Calculate the specific rotation and evaluate the quality of ergocalciferol, if the angle of rotation of a 15% solution of the substance in anhydrous ethanol is equal to +15.28°, and the length of the used cuvette is 10 cm. According to QCM, the specific rotation should be from +103° to +108°.

35. Calculate the percentage content of Vikasol (M.w. 330.29 g/mol), if 18.04 ml of 0.1 M solution of cerium sulfate (Cc = 0.9968) was spent on the titration of 0.2877 g of the substance, and the volume of the titrant in the control experiment was 0.62 ml.

36. Calculate the volume of 0.1 M solution of cerium sulfate (Cc = 1.0018), which is used on the titration of 0.3012 g of Vikasol (M.w. 330.29 g/mol), if the volume of the titrant in the control experiment is 0.46 ml, and the content of the active substance is 96.81%.

37. Calculate the used weight of Vikasol sample (M.w. 330.29 g/mol), if 18.07 ml of 0.1 M solution of cerium sulfate (Cc = 1.0652) was used on its titration, the volume of the titrant in the control experiment was 0.53 ml, and the content of the active substance was 98.96%.

38. Calculate the percent content of Neodicoumarin (M.w. 408.4 g/mol), if 10.05 ml of 0.1 M sodium hydroxide solution (Cc = 1.0011) was used for the titration of 0.3982 g of the substance, and the volume of the titrant in the control experiment was 0.45 ml.

39. Calculate the volume of 0.1 M sodium hydroxide solution (Cc = 0.9963), which is spent on the titration of 0.4008 g of Neodicoumarin (M.w. 408.4 g/mol), if the volume of the titrant in the control experiment is 0.48 ml, and the content of the active substance is 99.29%.

40. Calculate the weight of the Neodicoumarin sample (M.w. 408.4 g/mol), if 10.12 ml of 0.1 M sodium hydroxide solution (Cc = 1.0127) was spent on its titration, the titrant volume in the control experiment was 0.46 ml, and the content of the active substance was 99.78%.

41. Calculate the volume of 0.1 M sodium thiosulfate solution (Cc = 1.0923), which was spent on the titration of iodine released during the determination of Phenindione (M.w. 222.24 g/mol) due to the formation of the 2-bromo derivative, if the weight of the sample was 0.2914 g, loss in mass during drying was 0.46%, and the content of the active substance was 98.32%.

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