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DEPARTMENT OF PHARMACEUTICAL, ORGANIC
AND BIOORGANIC CHEMISTRY

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PHARMACEUTICAL CHEMISTRY

ANALYSIS OF MEDICINES THAT AFFECT THE CENTRAL NERVOUS SYSTEM

Section 2.1

Study and methodical Guide

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

Zaporizhzhia
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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 2 consists of three sections:

Section 1 – "Analysis of medicines that affect the central nervous system. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application".

Section 2 - " Analysis of medicines that affect the central and peripheral nervous system. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application".

Section 3 - "Analysis of medicines of the hormones 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 8th semester.

Lecture plan

of pharmaceutical chemistry for 4th year students of the Faculty of Pharmacy (8th semester)

No.	Lecture topics	Number of hours
1	Analysis of psychotropic drugs. Medicines for the treatment of parkinsonism. General characteristics, classification, relationship between structure and pharmacological action, methods of preparation, methods of analysis, application in medicine.	**2**
2	Analysis of peripheral vasodilators. General characteristics, classification, relationship between structure and pharmacological action, methods of preparation, methods of analysis, application in medicine.	**2**
3	Analysis of narcotic analgesics. Vomiting and antiemetic drugs. General characteristics, classification, relationship between structure and pharmacological action, methods of preparation, methods of analysis, application in medicine.	**2**
4	Analysis of thyroid hormones, antithyroid drugs. General characteristics, classification, relationship between structure and pharmacological action, methods of preparation, methods of analysis, application in medicine.	**2**
5	Analysis of steroid hormones and their analogues. General characteristics, classification, relationship between structure and pharmacological 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 (8th semester)

No.	Lesson topics	Number hours
1.	Analysis of psychotropic drugs: neuroleptics, sedative drugs.	**3**
2.	Analysis of psychotropic drugs: antidepressants, analeptics.	**3**
3.	Analysis of psychotropic drugs: psychostimulants. Medicines for the treatment of parkinsonism.	**3**
4.	**Control lesson from the section.**	**2**
5.	Analysis of peripheral vasodilators.	**3**
6.	Analysis of narcotic analgesics and their analogues. Emetics and antiemetics.	**3**
7.	Analysis of means acting on cholinergic processes. Part 1. Cholinomimetics, anticholinesterase drugs.	**3**
8.	Analysis of means acting on cholinergic processes. Part 2. Cholinergic blockers, ganglioblockers.	**3**
9.	Analysis of agents acting on adrenergic processes: adrenomimetics, adrenoblockers, sympatho mimetics, sympatholytics	**3**
10.	**Control lesson from the section.**	**2**
11.	Analysis of adrenal medulla hormones (catecholamines), thyroid gland, antithyroid drugs and pancreatic hormones. Synthetic analogues of pharmacological action.	**3**
12.	Analysis of drugs from the steroid hormone group: adrenal cortical hormones (corticosteroids). Synthetic analogues of pharmacological action.	**3**
13.	Analysis of sex hormones: progestogens, estrogens, androgens, anabolic steroids and their analogues. Birth control. Estrogens of nonsteroidal structure.	**3**
14.	**Control lesson from the section.**	**3**

SPECIFIC GOALS:

"Analysis of medicines that affect the central nervous system. General characteristics, classification, relationship of structure with pharmacological action, extraction, methods of analysis, application»

- Learn the properties drugs that affect the central nervous system.
- Know the main sources and methods of obtaining drugs that affect the central nervous system.
- To propose and carry out the selection of physical, physicochemical and chemical methods of quality analysis of drugs that affect the central nervous system 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 that affect the central nervous system using physical, physicochemical and chemical methods.
- Interpret the results of studies of the proposed drugs that affect the central nervous system, obtained using physical, physico-chemical and chemical methods.
- Explain the peculiarities of storage of drugs that affect the central nervous system, based on their physical and chemical properties.

Theoretical material

Psychotropic(Greek: psyche – soul, consciousness, tropos – kinship) drugs selectively regulate mental functions, primarily emotions, thinking, memory, motivation of behavior, psychomotor activity, and are intended for use in disorders of mental functions, including borderline states . These tools are also widely prescribed to patients with therapeutic, surgical, oncological and other profiles.

Neuroleptic (antipsychotic) drugs(Greek: neuron – nerve, leptikos – able to take, perceive) – psychotropic drugs that suppress mental (higher) nervous activity, emotional state, behavior, eliminate delusions, hallucinations and other manifestations of psychosis, but do not disturb consciousness. At the same time, they significantly suppress psychomotor excitement. Previously, they were called neuroplegics, anti-schizophrenic drugs, great tranquilizers.

Antipsychotics include drugs that have 5 of the following characteristics:

- antipsychotic effect - reduce manifestations of psychosis (hallucinations, delusions, aggressiveness, etc.);
- eliminate psychomotor excitement of various genesis;
- mainly affect the subcortical structures of the brain;
- possible psychodysleptic effect without hypnotic effect;
- cause characteristic neurological and neurovegetative reactions (3 "H"): hypotension, hypothermia, hypodynamia.

Classification. According to their chemical structure, neuroleptics are divided into derivatives (typical):

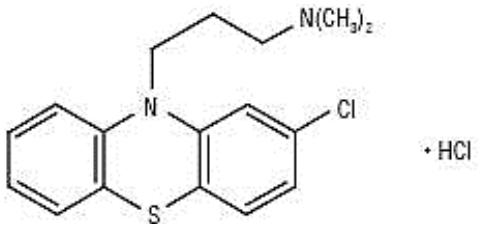
- phenothiazine – aminazine (chlorpromazine), levomepromazine, tryftazine, perphenazine hydrochloride, trifluoperazine, etc.;
- butyrophenone – haloperidol, droperidol, trifluperidol;
- benzamide – sulpiride (eglonil), sultopride;
- of different chemical classes (atypical) – clozapine (azaleptin), sertindole, etc.

Mechanism of action antipsychotics is complex and different for certain aspects of their pharmacodynamics. Neuroleptics have antipsychotic, potentiating, antiemetic, hypothermic, adrenolytic, cholinolytic, antihistaminic effects, weaken muscle tone; have a cataleptogenic effect.

Comparative characteristics of drugs

Phenothiazine derivatives

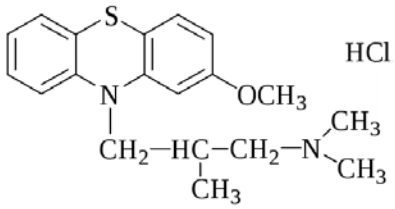
A typical representative of phenothiazines of the aliphatic series is chlorpromazine hydrochloride (Aminazine, Largactyl) - 2-chloro-10-(3-dimethylaminopropyl)-phenothiazine hydrochloride.



The psychotropic effect of aminazine is manifested by pronounced psychosedative (blockade of α-adrenoceptors of the reticular formation of the brain stem) and moderate antipsychotic (blockade of D2-dopamine receptors of the mesolimbic-mesocortical system) effects. Stops various types of psychomotor excitement.

In psychiatry, aminazine is used both alone and in combination with other psychotropic drugs, in various states of psychomotor excitement in patients with schizophrenia, manic excitement in patients with manic-depressive psychosis, alcoholic psychoses, as well as in other mental illnesses and severe neuroses, which are accompanied by excitement, fear, tension.

Levomepromazine hydrochloridehas pronounced potentiating, hypothermic, adrenolytic, antihistaminic effects.

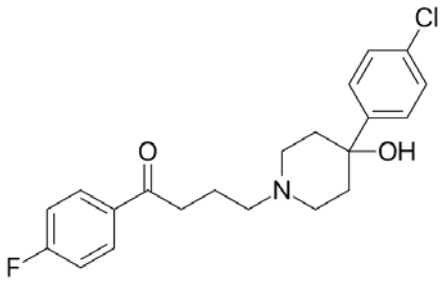


Butyrophenone derivatives

Differ from phenothiazine derivatives by a stronger antipsychotic effect, cause a pronounced anticonvulsant effect.

Thus, among neuroleptics, butyrophenone derivatives are the strongest, followed by phenothiazine, and indole derivatives are the weakest.

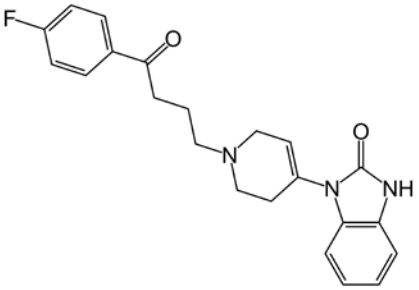
One of the most common representatives of butyrophenone derivatives is haloperidol (senorm) - it is produced in the form of lactate and decanoate (prolonged form).



The mechanism of action of haloperidol is blocking of central post-synaptic dopaminergic receptors of the mesolimbic system (antipsychotic effect), hypothalamus (hypothermic effect and galactorrhea), trigger zone of the vomiting center, extrapyramidal system.

Haloperidol is used to stop excitement, especially in cases of manic state, acute delirium, alcoholic delirium with visual hallucinations, schizophrenia, psychomotor excitement, hallucinatory and paranoid syndromes. Haloperidol is used in combination with sleeping pills, anesthetics, analgesics and antihistamines for preparation for surgery and in the postoperative period to reduce pain, during shock, with myocardial infarction, severe vomiting, convulsions.

Droperidol, unlike haloperidol, is a neuroleptic with a pronounced sedative effect.



It has anti-emetic, muscle relaxant, anti-shock effects. In case of shock, it reduces vasospasm as a result of reducing the reactivity of central sympathetic chains, peripheral α-adrenoblocking activity, and improving blood supply to organs. It is used to stop psychomotor excitement, convulsions, hypertensive crisis, vomiting, in the complex therapy of shock. It is widely used in anesthesiological practice to potentiate narcosis, neuroleptanalgesia.

Sedatives

Sedatives (lat. sedatum – to calm down) are drugs that have a moderate sedative effect.

Classification and preparations:

Sedative drugs are divided into:

I. Preparations of plant origin (Persen, Sanason, valerian extract, peony tincture, etc.);

II. Drugs of synthetic origin (sodium bromide, potassium bromide, bromocamphor, corvalol)

It has been established that the action of bromides (sodium bromide and potassium bromide, bromocamphor) consists in strengthening and concentrating the processes of internal inhibition in the cerebral cortex. Bromides contribute to the restoration of conditioned reflex activity when there is a pathological insufficiency of the inhibitory process.

Drugs of this group are characterized by good tolerability, absence of serious side effects and age restrictions. In normal doses, they do not cause myorelaxation, ataxia, phenomena of mental and physical dependence, which is why they are often used in outpatient settings.

In terms of their sedative effect, sedatives are significantly inferior to neuroleptics and tranquilizers.

Unlike sodium bromide, potassium bromide cannot be administered intravenously due to the inhibitory effect of potassium on myocardial conduction and excitability.

Bromides replace chlorine in body tissues. At the same time, small doses of bromine increase the inhibition process in the cerebral cortex, without reducing the excitation processes. Large doses of bromine cause a significant inhibitory effect, which can lead to the disappearance of conditioned reflexes. Bromides are able to accumulate ("bromism"), which is manifested by dyspnea, conjunctivitis, skin rashes, bronchitis, gastroenterocolitis, slowness of speech, drowsiness, deterioration of memory and vision, bradycardia, etc. When using very large doses, acute poisoning can occur - bromine intoxication and symptoms of kidney irritation (hematuria, etc.).

Antidepressants- drugs capable of eliminating depression, which affects millions of people every year. Depressio is a depressed mental state. Mild depression (bad mood) and severe depression (anxiety, memory impairment, weakness, quiet speech, lack of emotion, slowness of movement) are associated with a low content of monoamines in the brain.

Classification of drugs from the group of antidepressants

Tricyclic, tetracyclic*	MAO inhibitors (irreversible*, reversible)	Selective serotonin reuptake inhibitors	Vegetable, combined*, other**
Mianserin* Amitriptyline Tsoksepin Imipramine	Nialamide* Pyrazidol Befoul	Sertraline (Zoloft) Fluoxetine	Hypericin Amixid* gianeptine**

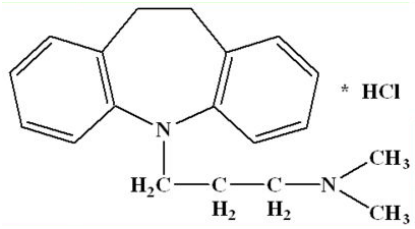
Tricyclic, tetracyclic antidepressants indiscriminately inhibit the reuptake of norepinephrine, dopamine, serotonin, increasing their concentration in the synaptic cleft, which enhances their physiological activity.

Selective serotonin reuptake inhibitors selectively inhibit the neuronal reuptake of serotonin in the synaptic cleft, which leads to its accumulation there and to the strengthening of its action. They have a very weak effect on the reuptake of norepinephrine and dopamine.

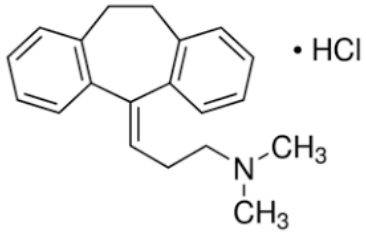
The pharmacodynamics of the drugs is based on the elimination of depression: improvement of mood, emergence of a feeling of cheerfulness, removal

of persistent negative emotions, motor inhibition, feelings of longing, depression, hopelessness. Curiosity about the surrounding world gradually appears, the mood improves (thymoleptic effect), differential inhibition increases, and the ability to fix conditional connections in memory. The drugs increase the positive emotional coloring of reactions.

Comparative characteristics of drugs



Imipramine Hydrochloride (Imisin)belong to antidepressants with a concomitant stimulating effect. It is used in depressive states of various etiologies. Sometimes the drug is prescribed for narcopepsia, and for children - for the treatment of functional nocturnal enuresis.



Amitriptyline hydrochloridehas thymoleptic, cholinolytic and sedative effects (can be prescribed before bedtime). It is especially effective in anxiety-depressive conditions.

Analeptics (Analepsis is a restorative, invigorating action).

Analeptics- emergency medicine. They are antagonists of narcotic, hypnotic and other CNS-depressing drugs, and mainly this group of drugs acts on the centers of the medulla oblongata: it excites the suppressed respiratory and vasomotor center, thus restoring the impaired functions of breathing and blood circulation.

Classification and preparations

Depending on the dose, analeptics can affect different departments of the central nervous system, so they are divided into:

- with a predominant effect in small doses on the cerebral cortex, in large doses - on the medulla oblongata, in toxic doses - on the spinal cord (caffeine);
- with a predominant effect on the medulla oblongata, but in high doses they stimulate the cerebral cortex (bemegrid, cordiamine (niketamide), sulfocamphocaine (consists of sulfocamphoric acid and procaine), etimizole)
- with a predominant effect on the spinal cord; in large doses, they act on the medulla oblongata and cerebral cortex (strychnine).

Some analeptics directly stimulate the vital centers of the medulla oblongata and belong to the analeptics of the first group - direct action (bemegrid, etimizole, caffeine) by their mechanism of action.

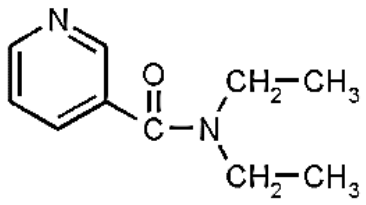
*The second group*analeptics reflexively (through the carotid sinus) excites the centers of the medulla oblongata (cytisine, lobeline).

The third group- in addition to direct action, it also causes a reflex effect from the chemoreceptors of the vessels on the vital centers of the medulla oblongata (sulfocamphocaine, camphor, cordiamine (niketamide)).

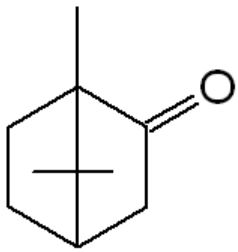
Medicines from the group of analeptics are prescribed for the following conditions:

1. Acute poisoning with sleeping pills and narcotics (sulfocamphocaine, cordiamine).
2. Acute and chronic circulatory disorders (cordiamine, cytisine, sodium caffeine benzoate).
2. Shock, collapse, asphyxia (cordiamine, sulfocamphocaine, etimizole).
3. Acute and chronic heart failure (sulfocamphocaine, camphor, sodium caffeine benzoate).
4. Functional impairment of vision, hearing, smell, paresis, paralysis, atony of the stomach (strychnine).
5. For seizure therapy (bemegrid).

Comparative characteristics of drugs



Cordiamine(Cordiaminum, Niketamide) - 25% solution of diethylamide of nicotinic acid. Cordiamine directly and reflexly excites vital centers through the chemoreceptors of the carotid glomeruli. It has no direct effect on the heart and blood vessels. In case of deep anesthesia, it is not very effective and even increases the anesthesia. Due to the fact that cordiamine is a derivative of nicotinic acid, it has a weak anti-pelagic effect.



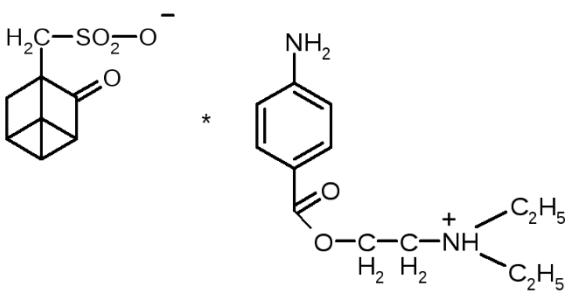
Camphor- a product of the oxidation of borneol alcohol. Synthetic left-handed camphor, which is extracted from fir oil, is also used. Natural camphor (dextrorotatory) is part of the essential oil of the camphor tree. Racemic camphor (from turpentine) is used for external use.

Camphor has local, resorptive and reflex action, central and peripheral. Local effect: irritates the skin (feeling of cold, heat, redness, reduction of pain), used for inflammation of the middle ear, for rheumatism, arthritis, muscle pain, gout, in dermatology. Locally, camphor acts as a weak antiseptic, anti-inflammatory agent.

Camphor enhances metabolic processes in the heart muscle, expands coronary vessels, increases the sensitivity of the heart to the effects of adrenaline.

As a result of the reflex and direct action of camphor, it stimulates the vascular and respiratory centers of the medulla oblongata, especially when they are suppressed, camphor has a calming effect on neuroses. Excreted with urine, suppresses microflora, improves urination.

Sulfocamphocaine (consists of sulfocamphoric acid and procaine)- a drug similar to camphor, but faster in action. It dissolves well in water. Can be administered intravenously.The drug tones up the respiratory and vasomotor centers, enhances metabolic processes in the heart muscle, increasing its sensitivity to the influence of sympathetic nerves.



Indications for use: acute and chronic respiratory failure; acute heart failure in geriatrics; respiratory depression in pneumonia and other infectious diseases; cardiogenic and anaphylactic shock; alcohol poisoning, mild forms of hypnotic poisoning.

Thus, according to the strength of the stimulating effect, these drugs are arranged in the following sequence:

- on the respiratory center: CO2 – bemegrid – cordiamine, camphor;
- on the vascular center: cordiamine - bemegrid - camphor;
- by "awakening" effect: bemegrid - cordiamine.

Psychostimulants- medicines that cause a feeling of strength, cheerfulness, energy, improve mood, weaken negative emotions, suppress feelings of hunger, thirst, drowsiness.

Currently, according to medical indications, psychostimulants are used for non-psychotic disorders of various etiologies, narcolepsy (increased sleepiness). In addition, in healthy people, drugs of this group can be used for fatigue in order to increase mental and muscle performance. At the same time, psychostimulants only mobilize the body's reserves and do not eliminate the need for normal rest and recovery.

According to the chemical structure, psychostimulants are divided into the following groups.

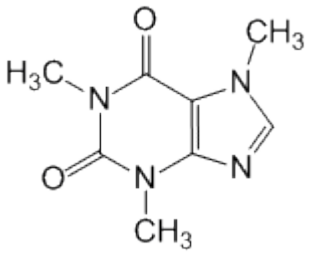
1. Phenylalkylamines: phenamine (amphetamine).
2. Derivatives of sydnonimines: sydnocarb (mesocarb).
3. Xanthines: caffeine, sodium caffeine benzoate.
4. Imidazole derivatives: etimizole.
5. Derivatives of benzimidazole: bemethyl.

*Mechanism of action*of phenylalkylamines is associated with their indirect adrenomimetic effect: the ability to release monoamine neurotransmitters from the granules of presynaptic nerve endings in the central nervous system (mostly norepinephrine and dopamine), disrupt their reuptake, and also inhibit the activity of MAO (monoamine oxidase) in both the central and peripheral nervous system. In the central nervous system, amphetamine stimulates the cortical and stem structures of the brain, as well as the thalamus and nuclei of the midbrain. The latter leads to an improvement in cognitive function.

*Sydnonimyn*mainly cause activation of noradrenergic receptors of the brain (there are no peripheral sympathomimetic effects). They more clearly block MAOIs, which is associated with the thymoleptic effect.

Characteristics of drugs from the group of psychostimulants

Caffeine– an alkaloid belonging to xanthine derivatives. The latter are formed in the body, are part of the cell and are products of its metabolism. It is characterized by a wide range of therapeutic action, relatively fast destruction in the body and the absence of accumulation with long-term use.

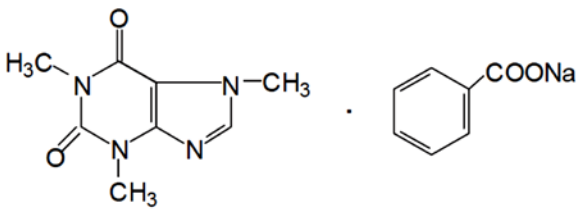


The neurochemical mechanism of the stimulating effect of caffeine is based on the fact that it inhibits the enzyme phosphodiesterase, which leads to the accumulation of intracellular cyclic adenosine monophosphate c-AMP (secondary mediator), and, as a result, the processes of glycogenolysis are enhanced, metabolic processes in various organs and tissues are stimulated, including including in muscle tissue and the central nervous system.

*Effect of caffeine on bark:*relieves drowsiness, fatigue, increases mental capacity, induces a cheerful mood, i.e. stimulates mental activity, improves memory, thinking, perception of external impressions, reduces the number of errors.

Long-term use of caffeine leads to the formation of new adenosine receptors in brain cells, and the effect of caffeine gradually decreases, and when caffeine administration is suddenly stopped, adenosine occupies all available receptors, which can cause increased inhibition with the phenomena of fatigue, drowsiness and depression.

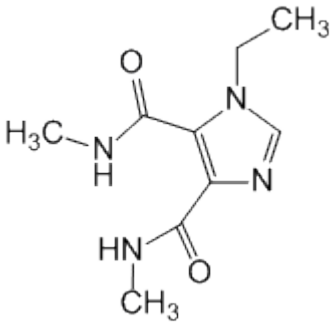
The drug from the group of methylxanthines sodium caffeine benzoate blocks adenosine receptors of the central nervous system.



The neurochemical mechanism of the stimulating effect of caffeine-sodium benzoate is based on the mechanism of action of caffeine, which is part of it. Caffeine sodium benzoate increases AT.

Etimizole **-**a psychostimulant that exhibits a central, resorptive effect. Since etimizole stimulates the adrenocorticotropic function of the pituitary gland, it is used as an anti-inflammatory and anti-allergic substance. In addition, it has a moderate antispasmodic effect in bronchial asthma.

It is used in acute poisoning with sleeping pills and narcotics, shock, collapse, asphyxia.



Etimizol has such side effects as: increased excitability of the central nervous system, restlessness, insomnia, hypertension, epilepsy, increased convulsive readiness. With long-term use, habituation and dyspeptic phenomena are possible.

Medicines for the treatment of parkinsonism is a group of drugs that are used for the treatment of Parkinson's disease and the phenomena of parkinsonism caused by a violation of neurotransmitter processes in the extrapyramidal system of the brain, as well as caused by other reasons (the effect of antipsychotic therapy, atherosclerosis of cerebral vessels, neuroinfections, etc.).

The mechanism of action of the drugs is based on modern data on the pathogenesis of Parkinson's disease and the phenomena of parkinsonism. It has been established that with these diseases, the balance of neurotransmitters is disturbed in some structures of the CNS (subcortical nodes, especially the basal nuclei): the amount of dopamine (one of the transmitters of nervous excitement in the subcortical structures) decreases and the content of acetylcholine increases. According to the mechanism of action, drugs are divided into two groups:

1. Means that strengthen the dopaminergic system of the brain. Dopaminergic drugs increase the content of dopamine in the central nervous system (all except bromocriptine); increase the sensitivity of dopamine receptors to dopamine (amantadine, glutantane); stimulate dopaminergic receptors of the central nervous system (bromocriptine); selectively inhibit MAO-B and thereby block dopamine metabolism (selegiline (yumex)).

2. Means that suppress the cholinergic systems of the brain (central cholinolytics). Anticholinergic agents are characterized by central (mainly) and peripheral cholinolytic action. The mechanism of action of the latter is that they are able to block central and peripheral cholinergic receptors. Synthesis, release and inactivation of acetylcholine are not affected.

All antiparkinsonian drugs eliminate the symptoms of parkinsonism, muscle stiffness, general stiffness, restore the ability to coordinate movements (all except diphenyltropine g/h and dietazine g/x); reduce tremors (levodopa and glutanthan); inhibit salivation (trihexyphenidyl, triperiden, levodopa); reduce sweating, oiliness of the skin (diphenyltropin g/h, dietazine g/h).

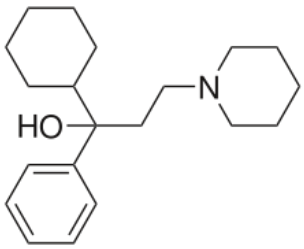
Antiparkinsonian drugs are used in the following pathologies: Parkinson's disease, spastic paresis and paralysis, extrapyramidal disorders caused by neuroleptics, hereditary extrapyramidal disorders, acromegaly, Itsenko-Cushing's disease, to suppress lactation, rigid and akinetic forms of parkinsonism, prevention and treatment of viral diseases, Alzheimer's disease , senile dementia, symptomatic parkinsonism.

Side effects when using levodopa, selegiline, nacoma, madopar are observed quite often: various dyspeptic phenomena (appetite disturbances, nausea, vomiting), orthostatic hypotension, headache, movement disorders, cardiac arrhythmias. Most of the side effects are related to the formation of dopamine from levodopa in peripheral tissues.

When using anticholinergic antiparkinsonian drugs, side effects may occur: dry mouth, impaired accommodation, increased pulse, dizziness, and trihexyphenidyl can become addictive.

COMPARATIVE CHARACTERISTICS OF DRUGS

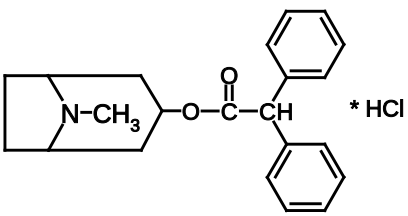
Cyclodol (Trihexyphenidyl)



Pharmacodynamics. The drug causes a central and peripheral cholinoblocking effect. Reduces muscle stiffness, general stiffness, restores the ability to coordinate movements. It has little effect on tremors, but significantly reduces salivation, to a lesser extent - sweating and oiliness of the skin. It has a stimulating effect on the central nervous system, which eases the course of depressive states and, as a rule, increases mental capacity.

Indication: Parkinson's disease, especially after encephalitis, atherosclerotic and syphilitic forms, Little's disease, spastic paralysis caused by damage to the extrapyramidal and pyramidal systems, treatment and prevention of extrapyramidal disorders.

Tropacin



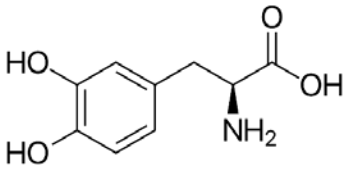
Pharmacodynamics. Reduces the excitability of peripheral M-cholinergic systems, which leads to relaxation of smooth muscles, decrease in secretion, dilation of the pupil of the eye. It has ganglioblocking

properties, has an antispasmodic effect on the smooth muscles of internal organs and blood vessels.

Indication: with Parkinson's disease, parkinsonism, spastic cerebral (infantile) palsy (Little's disease), spastic paralysis, spasms of smooth muscles of internal organs, bronchial asthma, peptic ulcer disease of the stomach and duodenum. The inhibitory effect of tropacin on the contractile activity of the uterus is used in obstetrics when there is a risk of abortion and premature birth.

Levodopa

A drug that strengthens the dopaminergic systems of the brain.

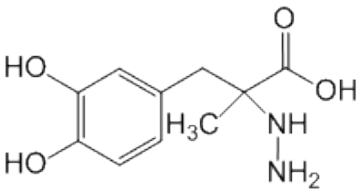


Levodopa– (L-DOPA, levodopa) is a levorotatory isomer of dioxyphenylalanine, formed in the body from tyrosine and is a precursor of dopamine. The drug penetrates through the BBB, and then into neurons and turns into dopamine, which eliminates or weakens the manifestations of parkinsonism. As a result, mobility increases, tremors decrease, speech improves, and the ability to concentrate is restored.

Indication: Parkinson's disease and symptomatic parkinsonism (except parkinsonism caused by antipsychotic drugs).

They produce combined drugs containing levodopa with carbidopa (Nakom, Sinemet) and levodopa with benserazide (Madopar).

Carbidopa

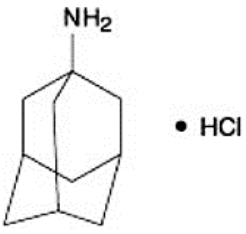


Due to the specific inhibition of peripheral DOPA (L-dihydroxyphenylalanine decarboxylase), it reduces the metabolism of levodopa into dopamine in peripheral tissues. Thus, a larger amount of levodopa enters the brain, and the used doses of the drug are reduced.

Carbidopa has no independent value in the treatment of diseases, but is used exclusively in combination with levodopa for the treatment of parkinsonism.

Indication. Parkinson's disease (in combination with levodopa).

Midantan (Amantadine hydrochloride)



Able to inhibit the generation of impulses in motor neurons of the central nervous system and reduce the severity of parkinsonism symptoms. The drug also causes some M-cholinergic blocking effects.

Indication: Parkinson's disease and symptomatic parkinsonism, especially in cases where levodopa is contraindicated. Midantan eliminates hypokinesia, to a lesser extent - rigidity and tremors.

LESSON No. 1

TOPIC: Analysis of psychotropic drugs: neuroleptics, sedative drugs.

PURPOSE: To master the methods of analysis of medicinal products from the group of psychotropic drugs such as neuroleptics and sedative drugs.

3. TARGETS:

3.1. To study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of psychotropic drugs such as neuroleptics & sedative drugs.

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 psychotropic drugs such as neuroleptics & sedative drugs 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 psychotropic drugs such as neuroleptics & sedative drugs, 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. Psychotropic drugs. General characteristics, classification. The concept of neuroleptics and sedative drugs.
2. Chemical structure, nomenclature, synonyms of drugs from the group of neuroleptics and sedative drugs.

3. To characterize the physicochemical properties of drugs from the group of neuroleptics and sedative drugs.

4. To justify the use of chemical and instrumental methods in the analysis of the quality of neuroleptics and sedative drugs.

5. Medicines from the group of neuroleptics. Classification.

5.1. Phenothiazine derivatives. Chlorpromazine hydrochloride (Aminazine). Levomepromazine hydrochloride (Tisercin). Structure, properties and application features.

5.2. List the possible methods and reactions of the identification of the studied drugs. Purity test. Routes of entry and determination of specific impurities in chlorpromazine hydrochloride (phenothiazine, 2-chlorophenothiazine).

5.3. Describe possible methods of quantitative determination of chlorpromazine hydrochloride and levomepromazine hydrochloride. Give appropriate reaction equations, calculation formulas.

5.4. Butyrophenone derivatives. Droperidol, haloperidol. Structure, properties, features of application.

5.5. To substantiate the possible methods and reactions of the identification of the studied drugs. Purity test.

5.6. Give possible methods of quantitative determination of droperidol and haloperidol. Give appropriate reaction equations, calculation formulas.

6. Sedative drugs. Classification of sedative drugs.

6.1. Sodium bromide, potassium bromide. Properties and features of application.

6.2. List the possible methods and reactions of the identification of the studied drugs. Ways of entry and determination of specific impurities in sodium bromide and potassium bromide.

6.3. Describe possible methods of quantitative determination of sodium bromide and potassium bromide. Give appropriate reaction equations, calculation formulas.

6.4. Bromcamphor. Structure, properties and application features.

6.5. To substantiate the possible methods and reactions of bromocamphor identification. Describe the conduct of purity tests.

6.6. Describe possible methods of quantitative determination of bromocamphor. Give appropriate reaction equations, calculation formulas.

7. Features of storage and accounting of neuroleptics and sedative drugs.

4.3. Test tasks:

#

1. The pharmacy received a medicinal product, the active substance of which has the chemical name "2-chloro-10-(3'-dimethylaminopropyl)phenothiazine hydrochloride". Specify this medicine:

A. **Chlorpromazine hydrochloride**
B. Diphenhydramine hydrochloride
C. Clonidine hydrochloride
D. Promethazine hydrochloride
E. Trifluoroperazine hydrochloride

#

2. The substance chlorpromazine hydrochloride was obtained for analysis. What condensed heterocycle is the basis of the chemical structure of this medicinal substance?

A. Purine
B. **Phenothiazine**
C. Acridine
D. Indole
E. Benzothiazine

#

3. Which of the following compounds is the starting material for the synthesis of chlorpromazine hydrochloride?

A. **2-Chlorphenothiazine**
B. 3-Chlorphenothiazine
C. 4-Chlorphenothiazine
D. 5-Chlorphenothiazine
E. 6-Chlorphenothiazine

#

4. Chlorpromazine hydrochloride is identified by comparing the absorption spectra of standard and test samples of the medicinal substance. What device is used for this?

A. **IR spectrophotometer**
B. Photoelectric colorimeter
C. Polarograph
D. Refractometer
E. Fluorimeter

#

5. A possible method of quantitative determination of sodium bromide in liquid dosage forms is:

A. **Refractometry**
B. Complexonometry

C. Polarimetry
D. Acidimetry
E. Alkalimetry

#

6. The pharmacist-analyst of the pharmacy needs to make a conclusion about the quality of preparation of 3% sodium bromide solution. Quantitative determination of the composition of the mixture was carried out by the pharmacist-analyst using the refractometric method. You can calculate the amount of sodium bromide in this case by determining the value:

A. Refractive index
B. Specific absorption index
C. Optical density of the solution
D. Viscosity of the solution
E. pH of the solution

#

7. The pharmacist-analyst determines the admixture of chlorides in sodium bromide according to the SPhU method:

A. Argentometry
B. Nitritometry
C. Bromatometry
D. Alkalimetry
E. Iodometry

#

8. The pharmacist-analyst of the pharmacy carries out chemical control of the mixture containing calcium chloride and sodium bromide. At the same time, he conducts a summary determination of the ingredients of this dosage form:

A. Argentometrically
B. Complexometrically
C. Alkalimetrically
D. Polarimetrically
E. Nitritometrically

#

9. The pharmacist-analyst determines the admixture of magnesium and alkaline earth metals in potassium bromide. For this, he uses a solution:

A. Sodium edetate
B. Potassium permanganate
C. Hydrochloric acids
D. Silver nitrate
E. Sodium nitrite

#

10. The pharmacopoeial reaction for the identification of potassium ions is interaction with tartaric acid, resulting in the formation of a precipitate of this color:

A. White
B. Black
C. Gray
D. Blue
E. Green

#

11. Potassium salts added to the colorless flame of a gas burner color it:

A. Violet
B. Red
C. Brick
D. Yellow
E. Green

#

12. The chemist of the TCD (technical control department) of the pharmaceutical enterprise can confirm the sodium cation in the tested substance, according to the SPhU, by reacting with a solution:

A. Potassium pyroantimonate
B. Potassium ferrocyanide
C. Potassium chloride
D. Potassium hydroxide
E. Potassium nitrate

#

13. The bromide ion in the medicines "Natrii bromidum" and "Kalii bromidum" is identified with the following reagent:

A. Silver nitrate
B. Lead nitrate
C. Sodium nitrate
D. Sodium nitrite
E. Calcium nitrate

#

14. The general method for determining the quantitative content of preparations from the group of alkali metal halides is:

A. Argentometry
B. Permanganatometry
C. Polarimetry

D. Alkalimetry
E. Nitritometry

#

15. Chlorpromazine hydrochloride is used in medicine as a drug with the main pharmacological effect:
A. Sedative
B. **Neuroleptic**
C. Analgesic
D. Anti-inflammatory
E. Nootropic

#

16. Their ability to be easily oxidized is used to identify phenothiazine derivatives. Which of the listed reagents is not used as an oxidizer?
A. Bromine water
B. Ferrum (III) chloride
C. **Sodium hydroxide**
D. Concentrated sulfuric acid
E. Concentrated nitric acid

#

17. Chlorpromazine hydrochloride substance with bromine water forms a solution of this color:
A. Red
B. **Light crimson**
C. Blue-green
D. Brown
E. Blue

#

18. In order to confirm the presence of a Sulfur atom in chlorpromazine hydrochloride, the substance is heated with a mixture of sodium carbonate and sodium nitrate. After that, the mineralization products should give a positive reaction with the following reagent:
A. **Barium chloride**
B. Sodium sulfide
C. Ammonia with molybdate
D. Argentum nitrate
E. Cobalt(II) chloride

#

19. According to the SPhU, the quantitative determination of phenothiazine derivative medicinal products is carried out by the following method:

A. Acidimetry in a non-aqueous medium
B. Nitritometry
C. Complexonometry
D. Alkalimetry
E. **Cerimetry**

#

20. According to the SPhU, the end point of the titration in the alkalimetric titration of phenothiazine derivatives is determined using:
A. Crystal violet
B. Phenolphthalein
C. **Potentiometric fixing**
D. Methyl orange
E. Bromothymol blue

#

21. Medicines droperidol and haloperidol are derivatives of:
A. Phenothiazine
B. Thioxanthene
C. Indole
D. **Butyrophenone**
E. Piperidine

#

22. To identify the haloperidol substance after combustion in a flask with oxygen, the following determinations are made:
A. **Fluorides**
B. Bromides
C. Sulfates
D. Nitrogen
E. Free ammonia

#

23. The presence of fluorides in haloperidol after mineralization is determined using a complex of alizarin and zirconium nitrate. At the same time, the color is formed:
A. **Yellow**
B. Blue-green
C. Red-purple
D. Green
E. Pink

#

24. The quantitative determination of haloperidol in the medicinal substance is proposed to be carried out by the following method:

A. Acidimetry in a non-aqueous medium
B. Alkalimetry
C. Alkalimetry in alcoholic medium
D. Alkalimetry in a chloroform environment
E. Cerimetry

#

25. The pharmacist-analyst performs the quantitative determination of bromocamphor by the modified (indirect) Folgard method. At the same time, the equivalent amount of bromide ion, which is formed after boiling the alcoholic solution of the drug, is titrated with a standard solution of silver nitrate:

A. With zinc dust in an alkaline medium
B. With potassium permanganate in an acidic environment
C. From silver nitrate in an acidic medium
D. With sodium edetate in a neutral environment
E. With an ether-chloroform mixture (1:1)

#

26. A pharmacist-analyst identifies bromocamphor by reaction with chloramine after preliminary mineralization. The positive result of this reaction should be considered the color of the chloroform layer in:

A. Pink-red color
B. Yellow-brown color
C. Violet
D. Navy blue
E. Emerald green color

#

27. Bromocamphor is a monohalogen derivative of camphor. At the same time, the introduction of a bromine atom into position 3 of the camphor molecule leads to:

A. Appearance of antibacterial effect
B. Changes in the effect on the central nervous system
C. Loss of optical activity
D. Increasing solubility in water
E. Increasing the melting point

#

28. Identification of bromocamphor is carried out after mineralization with zinc dust in an alkaline medium by reaction with:

A. Acetic acid chlorides

B. Chloral hydrate
C. Chloromethane
D. **Chloramine**
E. Sodium chloride

#

29. The pharmacist-analyst identifies the drug by boiling it with a solution of silver nitrate in the presence of nitric and sulfuric acids (until the release of nitrogen oxides stops). At the same time, a yellow precipitate was formed, insoluble in acids and sparingly soluble in ammonia solution. Indicate which medicinal product was identified by the analyst:

A. **Bromcamphor**
B. Racemic camphor
C. Sulfocamphoric acid
D. Racemic menthol
E. Terpine hydrate

#

30. Quantitative determination of bromocamphor after its mineralization is carried out by the modified (indirect) method of Folgard. Titration is performed in a nitric acid environment, in the presence of a solution of ferric ammonium alums and a standard solution of ammonium thiocyanate; titrant - 0.1 M solution of silver nitrate. At the same time, the end point of the titration is fixed by:

A. **Disappearance of red color**
B. Appearance of intense blue color
C. The formation of an orange-yellow precipitate
D. The color of the solution is pink
E. Changes in the color of the precipitate from yellow to pink

4.4. Situational tasks:

1. Describe the physicochemical properties of drugs from the group of phenothiazine derivatives based on their structure.
2. Suggest possible reagents that could be used to prove the presence of a divalent sulfur atom in the structure of chlorpromazine hydrochloride.
3. Justify the conditions for determining the sulfur atom in the phenothiazine cycle. Explain the need and conditions for conducting mineralization for these tests.
4. Explain the origin and justify the methods of detecting specific impurities in the substance chlorpromazine hydrochloride (phenothiazine, 2-chlorophenothiazine).

5. Describe the features of the storage conditions of drugs from the group of neuroleptics. What physical and chemical properties are determined by such storage conditions?
6. Justify and state the methods of quantitative determination that can be applied to the total and individual determination of the ingredients of a mixture containing calcium chloride and sodium bromide.
7. Describe the method for the quantitative determination of bromocamphor, based on the determination of organically bound halogen (argentometry according to the modified Folgard method). Give the corresponding reaction equations, calculation formulas.

4.5. Tasks:

1. Calculate the percentage content of chlorpromazine hydrochloride (M.m. 355.3) in the preparation, if the weight of the test piece is 0.2468 g, the volume of 0.1 M sodium hydroxide solution (C_a = 0.9998) is 6.98 ml.
2. Calculate the weight of chlorpromazine hydrochloride (M.m. 355.3) in the medicinal product, if 6.62 ml of 0.1 M sodium hydroxide solution (C_a = 0.9982) was used for the titration. The content of the active substance in the preparation is 98.62%.
3. Calculate the percentage content of levomepromazine hydrochloride (M.m. 364.9) in the drug, if the weight of the weighing scale is 0.3265 g, the volume of a 0.1 M solution of perchloric acid (C_a = 0.9892) in the working experiment is 8.86 ml, in the control - 0.18 ml, loss in mass during drying - 3.8%.
4. Calculate the weight of levomepromazine hydrochloride (M.m. 364.9), if 8.68 ml of 0.1 M perchloric acid solution (C_a = 0.9800) was spent on its titration, the content of the active substance in the preparation is 98.84%, the volume of the titrant in the control experiment is 0.26 ml.
5. Calculate the percentage content of bromocamphor (M.m. 231.14), if 9.4 ml of 0.1 M silver nitrate solution (C_a = 0.9980) was spent during the determination of 0.2149 g of the substance by the modified Folgard method; the amount of added 0.1 M ammonium rhodanide solution is 0.1 ml.
6. Calculate the weight of sodium bromide (M.m. 102.9), if 18.35 ml of 0.1 M silver nitrate solution (C_a = 0.9970) was spent on its titration, and the content of the active substance in the preparation is 99.42% .
7. Calculate the volume of 0.1 M perchloric acid solution (C_a = 0.9960), which will be spent on the titration of 0.2432 g of the substance haloperidol (M.m. 375.9), if the content of the active substance in the preparation is 99.72% , the volume of the control experiment is 0.12 ml, and the mass loss during drying is 2.6%.

8. Calculate the weight of haloperidol (M.m. 375.9), if 5.48 ml of 0.1 M perchloric acid solution (C_a = 0.9890) was spent on its titration, the content of the active substance in the preparation is 99.68%, volume of titrant in the control experiment – 0.16 ml.

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

TOPIC: Analysis of psychotropic drugs: antidepressants, analeptics.

PURPOSE: To master the methods of analysis of medicinal products from the group of psychotropic drugs such as antidepressants & analeptics drugs.

3. TARGETS:

3.1. Define the main concepts: "psychotropic drugs", "antidepressants", "analeptics", etc.

3.2. To study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of psychotropic drugs such as antidepressants & analeptics drugs.

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

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

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

3.6. Consider the peculiarities of the analysis of drugs from the group of psychotropic drugs such as antidepressants & analeptics drugs using physical, physicochemical and chemical methods.

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

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

3.9. Explain the peculiarities of storage of medicines from the group of psychotropic drugs such as antidepressants & analeptics drugs, based on their physicochemical properties.

3.10. 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. Psychotropic drugs. General characteristics, classification. The concept of antidepressants and analeptics.

2. Chemical structure, nomenclature, synonyms of medicinal substances from the group of antidepressants and analeptics.

3. To characterize the physicochemical properties of medicinal substances from the group of antidepressants and analeptics.

4. To substantiate the use of chemical and instrumental methods in the analysis of the quality of antidepressants and analeptics.

5. Antidepressants. Classification. Medicines from the group of antidepressants.

5.1. Tricyclic antidepressants. Imipramine hydrochloride (imizin), amitriptyline hydrochloride. Structure, properties and application features.

5.2. List the possible methods and reactions of the identification of the studied drugs. Purity test. Routes of entry and determination of specific impurities in amitriptyline hydrochloride in accordance with the requirements of the Federal Drug Administration.

5.3. Describe the possible methods of quantitative determination of imipramine hydrochloride (imizin) and amitriptyline hydrochloride. Give appropriate reaction equations, calculation formulas.

6. Analeptics. Classification of analeptic drugs.

6.1. Camphor, sulfocamphocaine (sulfocamphoric acid and procaine). Structure, properties and application features.

6.2. List the possible methods and reactions of the identification of the studied drugs. Determination of impurities in camphor in accordance with the requirements of the Federal State of Ukraine.

6.3. Describe possible methods of quantitative determination of camphor and sulfocamphocaine. Give appropriate reaction equations, calculation formulas.

6.4. Cordiamine. Composition of the drug, properties and features of use.

6.5. To justify the possible reactions of the identification of cordiamine.

6.6. Describe the possible methods of quantitative determination of cordiamine. Give appropriate reaction equations, calculation formulas.

7. Features of storage and accounting of drugs from the group of antidepressants and analeptics.

4.3. Test tasks:

#

1. Which of the following reagents is used in pharmaceutical analysis to identify racemic camphor?

A. **NH_2OH**

B. CH_3COOH

C. $FeCl_3$

D. CH_3CH_2OH

E. NaOH

#

2. Name the industrial method of extracting camphor:

A. V. E. Tyshchenko's method from turpentine

B. Scroup's synthesis

C. Esterification of glycerol with nitric acid

D. Interaction of *p*-nitrotoluene and *p*-nitrobenzoic acid

E. Extraction from cocoa beans with chloroform

#

3. To identify racemic camphor, the pharmacist-analyst should conduct a ketoxime formation reaction followed by determination of its melting point. In this case, the analyst should use the following reagent:

A. Hydroxylamine hydrochloride

B. Benzaldehyde

C. Iron(III) chloride

D. 2,4-Dinitrophenylhydrazine

E. Acetic anhydride

#

4. Name the medicinal substance from the terpenoid group that forms a hydrazone with 2,4-dinitrophenylhydrazine?

A. Camphor

B. Menthol

C. Validol

D. Terpine hydrate

E. Retinol

#

5. The pharmacist-analyst determines the quantitative content of racemic camphor by alkalimetric titration of the equivalent amount of hydrochloric acid released as a result of the interaction of camphor with the following reagent:

A. Hydroxylamine hydrochloride

B. *p*-Dimethylaminobenzaldehyde

C. 2,4-Dinitrophenylhydrazine

D. Chloramine

E. Furfurol

#

6. In the material room of the pharmacy, the pharmacist discovered a crystalline plaque in the upper part of the rod filled with racemic camphor. The appearance of such a plaque can be easily explained by the ability of camphor:

A. To sublimate
B. To hydrolyze
C. To oxidize
D. Polymerize
E. Recover

#

7. One of the chemical reactions for the identification of diethylamide of nicotinic acid is the reaction of the release of diethylamine, which has a characteristic smell. The pharmacist-analyst conducts this reaction by boiling the substance under investigation with a solution:

A. Sodium hydroxide
B. Silver nitrate
C. Diphenylamine
D. Barium chloride
E. Phenolphthalein

#

8. The pharmacist-analyst performs the identification of the substance diethylamide of nicotinic acid. With which reagent does he confirm the presence of a pyridine cycle in the structure of the substance under study?

A. 2,4-Dinitrochlorobenzene
B. Silver nitrate
C. Sulfuric acid
D. Sodium thiosulfate
E. Dimethylformamide

#

9. The composition of the drug "Cordiamine", which is used as a stimulant of the nervous system, can be defined as:

A. Aqueous solution of nicotinic acid diethylamide
B. Aqueous solution of nicotinic acid
C. Aqueous solution of nicotinic acid amide
D. Isonicotinic acid hydrazide
E. Oxymethylamide of nicotinic acid

#

10. In order to confirm the presence of a sulfo group in the structure of sulfocamphoric acid, the investigated substance is heated with a mixture of sodium carbonate and sodium nitrate. After that, the mineralization products should give a positive reaction with the following reagent:

A. Barium chloride
B. Sodium sulfide

C. Ammonia with molybdate
D. Argentum nitrate
E. Cobalt(II) chloride

#

11. When identifying sulfocamphoric acid, tests are carried out using a barium chloride solution to identify sulfogroups in its structure. Before performing the specified test, the medicinal substance should be subjected to:

A. Mineralization
B. Hydrolysis
C. Decarboxylation
D. Sulfation
E. Esterification

#

12. The pharmacist-analyst identified sulfocamphoric acid by the formation of a yellow-orange precipitate upon interaction with a solution of 2,4-dinitrophenylhydrazine. This reaction confirms the presence of sulfocamphoric acid in the structure:

A. Keto groups
B. Sulfogroups
C. Sulfate ions
D. Amino groups
E. Carboxylic group

#

13. The quantitative content of sulfocamphoric acid in the solution of sulfocamphocaine for injections can be determined by the method:

A. Alkalimetry
B. Nitritometry
C. Acidimetry
D. Permanganatometry
E. Complexonometry

#

14. The use of the reaction of the formation of an azo dye in the identification of sulfocamphocaine 10% for injections is due to the fact that the composition of this medicinal product includes:

A. Procaine base
B. Sulfocamphoric acid
C. Racemic camphor
D. 3-Quercetin rutinoside
E. Glucose monohydrate

#

15. Identification of the substance amitriptyline hydrochloride in accordance with the requirements of the Federal State Administration of Ukraine is carried out by the following method:

A. Liquid chromatography
B. Thin-layer chromatography
C. Photoelectrocolorimetry
D. Absorption spectrophotometry in the IR region
E. Polarimetry

#

16. The determination of the accompanying impurities in the substance of amitriptyline hydrochloride according to the requirements of the Federal Drug Administration is carried out by the following method:

A. Liquid chromatography
B. Thin-layer chromatography
C. Photoelectrocolorimetry
D. Absorption spectrophotometry in the IR region
E. Polarimetry

#

17. Quantitative determination of the substance amitriptyline hydrochloride in accordance with the requirements of the Federal Drug Administration is carried out by the following method:

A. Liquid chromatography
B. Polarimetry
C. Alkalimetry
D. Acidimetry in a non-aqueous medium
E. Absorption spectrophotometry

#

18. Amitriptyline hydrochloride is identified by comparing the absorption spectra of standard and test samples of the medicinal substance. What device is used for this?

A. IR spectrophotometer
B. Photoelectric colorimeter
C. Polarograph
D. Refractometer
E. Fluorimeter

#

19. When carrying out the quantitative determination of the substance amitriptyline hydrochloride by the method of alkalimetry, is it used as a titrated solution?

A. 0.1 M alcoholic sodium hydroxide solution
B. 0.1 M potassium hydroxide solution
C. 0.1 M sodium methylate solution
D. **0.1 M sodium hydroxide solution**
E. 0.1 M solution of lithium methylate

#

20. To identify imipramine hydrochloride, a reaction with concentrated nitric acid is carried out. What color is formed in this case?

A. Green turning into brown
B. **Blue turning into brown**
C. Green
D. Red
E. Blue-green

#

21. For identification of imipramine hydrochloride (imizin) reaction with picric acid is used. By what indicator is the drug identified?

A. **The melting temperature of the sediment**
B. Release of gaseous products
C. The color of the solution
D. The smell of ammonia
E. Discoloration of the solution

#

22. When carrying out the quantitative determination of imipramine hydrochloride by the method of acidimetry in a non-aqueous environment, is it added?

A. Sulfuric acid solution
B. Dimethylformamide
C. **A solution of mercury (II) acetate**
D. Sodium hydroxide solution
E. Ammonia solution

#

23. What method is used for the quantitative determination of imipramine hydrochloride (imizin)?

A. Nitritometry
B. Permanganatometry
C. **Alkalimetry**
D. Acidimetry
E. Cerimetry

#

24. Which quantification method cannot be used for imipramine hydrochloride?

A. Acidimetry in a non-aqueous environment
B. Argentometry
C. UV-spectrophotometry
D. Nitritometry
E. Alkalimetry

#

25. State the main pharmacological action of imipramine hydrochloride (imizin):

A. Antidepressant
B. Analeptic
C. Nootropic
D. Anticonvulsant
E. Neuroleptic

#

26. What reaction effect is observed when adding a solution of silver nitrate to the substance imipramine hydrochloride in the presence of nitric acid?

A. Dark gray sediment
B. Red color
C. Blue color
D. White sediment
E. Yellow precipitate

#

27. Specify the indicator that is used for the quantitative determination of the substance imipramine hydrochloride by the argentometric method (direct titration):

A. Methyl orange
B. Potassium chromate
C. Iron ammonium alums
D. Phenolphthalein
E. Crystal violet

4.4. Situational tasks:

1. Describe the relationship between the extraction method used and the optical form of the camphor released.
2. Indicate which reagents can be used to prove the presence of a keto group in the structure of camphor. Give the equations of the corresponding reactions and their justification.
3. Justify the possibility of using the oxime method (substituent titration) for the quantitative determination of racemic camphor. Give the corresponding reaction equations, calculation formulas.

4. Describe the features of identification and quantification of an injectable 10% solution of sulfocamphocaine, based on its structure. Give the corresponding reaction equations, calculation formulas.
5. Describe the physicochemical properties of drugs from the group of tricyclic antidepressants using the example of amitriptyline hydrochloride and imipramine hydrochloride, based on their structure.
6. Explain the origin and justify the methods of detection of specific impurities in the substance of amitriptyline hydrochloride according to the requirements of the SPhU.
7. Justify the use of the refractometric method for the quantitative determination of the active substance in cordiamine, the advantages and disadvantages of this method over other methods.

4.5. Tasks:

1. Calculate the specific rotation of camphor, if the angle of rotation of the 10% alcohol solution is +8.4°, and the length of the cuvette is 200 mm.
2. Calculate the percentage content of racemic camphor (M.m. 152.24) in the preparation, if 12.1 ml of 0.1 M sodium hydroxide solution was spent during the determination of 0.1869 g of the substance by the oxime method for the titration of the hydrochloric acid that was released (A_c = 1.0000).
3. Calculate the volume of 0.1 M sodium hydroxide solution (A_c = 1.0105), which was spent on the titration of the hydrochloric acid released when determining 0.1625 g of racemic camphor (M.m. 152.24) by the oxime method, and the content of the active substance in the substance is 99.8%.
4. Calculate the percentage content of amitriptyline hydrochloride (M.m. 313.9) in the preparation, if the weight of the weighing scale is 0.1875 g, the volume of 0.1 M sodium hydroxide solution (A_c = 0.9960) is 5.96 ml.
5. Calculate the weight of amitriptyline hydrochloride (M.m. 313.9) in the medicinal product, if 7.45 ml of 0.1 M sodium hydroxide solution (A_c = 0.9980) was used for the titration. The content of the active substance in the preparation is 99.58%, the loss in mass during drying is 2.4%.
6. Calculate the volume of 0.1 M sodium hydroxide solution (A_c = 0.9990), which will be spent on the titration of 0.2035 g of the substance imipramine hydrochloride (M.m. 316.87), if the content of the active substance in the preparation is 99.28 %, the volume of the control experiment is 0.25 ml, and the mass loss during drying is 1.8%.
7. Calculate the percentage content of imipramine hydrochloride (M.m. 316.87) in the preparation, if the mass of the weighing scale is 0.2304 g, the volume of

0.1 M sodium hydroxide solution (A_c = 0.9970) is 7.48 ml, and the volume of the control experiment is 0.16 ml.

8. Calculate the content of nicotinic acid diethylamide (in g) in cordiamine, if it is known that the refractive index of the tested solution is 1.3820, *F*= 0.002, and the refractive index of the solvent is 1.3330.

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. 3

TOPIC: Analysis of psychotropic drugs: psychostimulants. Medicines for the treatment of parkinsonism.

PURPOSE: To master the methods of analysis of medicinal products from the group of psychotropic drugs such as psychostimulants & medicines for the treatment of parkinsonism.

3. TARGETS:

3.1. Define the main concepts: "psychotropic drugs", "psychostimulants", "antiparkinsonian medications", etc.

3.2. To study the structure, nomenclature, synonyms, physicochemical properties, sources and methods of obtaining medicines from the group of psychotropic drugs such as psychostimulants & medicines for the treatment of parkinsonism.

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

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

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

3.6. Consider the peculiarities of the analysis of drugs from the group of psychotropic drugs such as psychostimulants & medicines for the treatment of parkinsonism, using physical, physicochemical and chemical methods.

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

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

3.9. Explain the peculiarities of storage of medicines from the group of psychotropic drugs such as psychostimulants & medicines for the treatment of parkinsonism, based on their physicochemical properties.

3.10. 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. Psychotropic drugs. General characteristics, classification. The concept of psychostimulants & medicines for the treatment of parkinsonism.
2. Chemical structure, nomenclature, synonyms of medicinal substances from the groups of psychostimulants & medicines for the treatment of parkinsonism.
3. To characterize the physico-chemical properties of medicinal substances from the groups of psychostimulants & medicines for the treatment of parkinsonism.
4. To substantiate the use of chemical and instrumental methods in the analysis of the quality of psychostimulants & medicines for the treatment of parkinsonism.
5. Psychostimulants. Classification. Medicines from the group of psychostimulants.
   - **5.1.** Purine derivatives. Caffeine, sources and extraction methods. Caffeine sodium benzoate. Structure, properties, features of application.
   - **5.2.** List the possible methods and reactions of the identification of the studied drugs. Purity test. Routes of entry and determination of accompanying impurities in caffeine according to the SPhU.
   - **5.3.** Murexide test as a general group reaction to drugs from the group of purine derivatives. Reaction mechanism, its specificity, conditions and performance technique.
   - **5.4.** Describe the possible methods of quantitative determination of caffeine and sodium caffeine benzoate. Give appropriate reaction equations, calculation formulas.
   - **5.5.** Etimizol. Structure, properties, features of application.
   - **5.6.** Justify the possible reactions of identification of etimizole, give the corresponding reaction equations.
   - **5.7.** Describe the possible methods of quantitative determination of etimizole. Give appropriate reaction equations, calculation formulas.
6. Medicines for the treatment of parkinsonism. General characteristics, classification. The concept of Parkinson's disease and the phenomenon of parkinsonism.
7. Medicines that inhibit the function of the cholinergic system. Classification.
   - **7.1.** Cyclodol. Structure, properties, features of application.
   - **7.2.** To cite possible methods of identification of cyclodol, to justify the expediency of using instrumental methods of analysis.
   - **7.3.** Describe the possible methods of quantitative determination of cyclodol. Give appropriate reaction equations, calculation formulas.
   - **7.4.** Tropacin. Structure, properties, features of application.
   - **7.5.** To substantiate the possible methods and reactions of tropacin identification.

7.6. Give possible methods of quantitative determination of tropacin. Give appropriate reaction equations, calculation formulas.

8. Medicines that activate the function of the dopaminergic system. Classification.

8.1. Levodopa, carbidopa. Structure, properties, features of application.

8.2. Give possible methods and reactions for identification of levodopa and carbidopa.

8.3. Describe possible methods of quantitative determination of levodopa and carbidopa. Give appropriate reaction equations, calculation formulas.

8.4. Midantan (amantadine hydrochloride). Properties of the drug, features of use.

8.5. To substantiate the possible methods and reactions of identification of midantane (amantadine hydrochloride).

8.6. Describe the possible methods of quantitative determination of midantane. Give appropriate reaction equations, calculation formulas.

9. Features of storage and accounting of drugs from the groups of psychostimulants & medicines for the treatment of parkinsonism.

4.3. Test tasks:

#

1. The pharmacist-analyst determines the quantitative content of caffeine in accordance with the requirements of the SPhU by the method of acidimetry in non-aqueous media. He used a solution as a titrant:

A. Iodine
B. **Chloric acid**
C. Potassium bromate
D. Sodium hydroxide
E. Sodium nitrite

#

2. Choose the indicator to be used by the pharmacist-analyst during the quantitative determination of medicinal products - organic bases and their salts (caffeine, caffeine-sodium benzoate) by the method of acidimetry in glacial acetic acid medium:

A. **Crystal violet**
B. Acid chrome is dark blue
C. Neutral red
D. Phenolphthalein
E. Bromothymol blue

#

3. The pharmacist-analyst performs the quantitative determination of caffeine using the iodometric method. What indicator does it use?

A. Starch
B. Methyl red
C. Methyl orange
D. Phenolphthalein
E. Potassium chromate

#

4. Medicines caffeine, sodium caffeine benzoate belong to alkaloids, purine derivatives, that is, they contain heterocyclic fragments of molecules in their structure:

A. Morpholine and pyridine
B. Pyridine and pyrazine
C. Imidazole and pyrimidine
D. Pyrazole and pyrrolidine
E. Pyrrole and pyrimidine

#

5. According to the SPhU, the reaction for identifying medicinal substances from the xanthine group is:

A. Beilstein's test
B. Maltol sample
C. Murexide test
D. Biuret reaction
E. Iodoform test

#

6. According to the requirements of the SPhU, a concentrated solution of hydrogen peroxide, diluted hydrochloric acid, and diluted ammonia are used to identify caffeine. The indicated reagents are necessary to perform the reaction on xanthines, which is called:

A. Thiochrome test
B. Taleiochin test
C. Maltol sample
D. Murexide test
E. Hydroxam test

#

7. In the warehouse of finished products, a damaged marking on one of the packages was accidentally discovered. It is known that the medicinal substance in this package belongs to alkaloids. In the course of group qualitative reactions to alkaloids, the murexide test gave a positive result. What group of alkaloids

should be limited to the following steps in the identification of a medicinal substance?

A. Purine derivatives
B. Quinoline derivatives
C. Derivatives hit me
D. Isoquinoline derivatives
E. Indole derivatives

#

8. According to the SPhU, the group reaction for the identification of drugs from the xanthine group is the murexide test. What intermediate product is formed when caffeine is treated with an oxidant?

A. Uracil
B. 1,3-Dimethylaloxane
C. Timin
D. Uric acid
E. Hypoxanthine

#

9. Specify the medicinal substance, the colored product of the identification reaction of which is the ammonium salt of tetramethylpurpuric acid:

A. Atropine sulfate
B. Platyphyllin hydrotartrate
C. Morphine hydrochloride
D. Caffeine monohydrate
E. Quinine sulfate

#

10. Indicate which drug from the group of alkaloids will give a positive result in the reaction to xanthines (murexide test):

A. Caffeine
B. Atropine sulfate
C. Papaverine hydrochloride
D. Quinine sulfate
E. Ephedrine hydrochloride

#

11. The benzoate ion in caffeine sodium benzoate can be identified by reaction with a solution of iron(III) chloride. Which reaction result should be considered positive?

A. Appearance of red color
B. Appearance of blue color
C. The formation of a white precipitate

D. The formation of a pink-yellow precipitate

E. Release of brown vapors

#

12. For the quantitative determination of sodium benzoate in caffeine sodium benzoate method is used?

A. Acidimetry

B. Alkalimetry

C. Alkalimetry in a non-aqueous environment

D. Nitritometry

E. Permanganatometry

#

13. Which medicinal substance from the group of alkaloids, purine derivatives, forms a white precipitate with a 0.1% solution of tannin, which dissolves in an excess of the reagent?

A. Caffeine

B. Theobromine

C. Theophylline

D. Euphilinus

E. Diprofilin

#

14. The substance caffeine is being studied in the control and analytical laboratory. Specify the number of the atom of the purine system of caffeine, which is protonated during its quantitative determination by the method of acidimetry in a non-aqueous medium:

A. 9

B. 1

C. 3

D. 7

E. 8

#

15. In the control-analytical laboratory, the dosage form containing sodium benzoate is analyzed. Which of the following reagents forms a yellow-pink precipitate with the drug under study?

A. Sodium bicarbonate solution

B. Potassium permanganate solution

C. Magnesium sulfate solution

D. Sodium nitrate solution

E. Iron(III) chloride solution

#

16. The sodium cation in sodium caffeine benzoate, when introduced into the colorless flame of a gas burner, colors it in color:

A. Yellow
B. Brick
C. Violet
D. Red
E. Green

#

17. Sodium benzoate in sodium caffeine benzoate is determined acidimetrically in the presence of the following mixed indicator:

A. A solution of methyl orange and phenolphthalein
B. A solution of methyl orange and methylene blue
C. A solution of methylene blue and thymolphthalein
D. A solution of phenolphthalein and thymolphthalein
E. A solution of methyl orange and methyl red

#

18. Acidimetric titration of sodium benzoate in caffeine-sodium benzoate is carried out when adding solventfor extracting benzoic acid. Specify this solvent:

A. Ethyl alcohol
B. Ether
C. Acetone
D. Methanol
E. Butanol

#

19. Caffeine has the following properties:

A. Strong core
B. Weakly acidic
C. Amphoteric
D. Weak main ones
E. Strongly acidic

#

20. Specify the conditions for the identification reaction under which the formation of a precipitate of caffeine periodide is observed:

A. Neutral environment
B. Acidic environment
C. Alkaline environment
D. In the presence of ether
E. Caffeine does not form a periodide precipitate

#

21. Etimizole is a derivative of:

A. Imidazole
B. Pyrimidine
C. Purine
D. Pyridine
E. Pyrrol

#

22. Specify the functional group in the etimizole molecule that causes its acidic properties:

A. Tertiary nitrogen atom
B. Methyl
C. Amide
D. Carbonyl
E. Ethyl

#

23. Specify the functional group in the etimizole molecule that determines its main properties:

A. Tertiary nitrogen atom
B. Metilna
C. Amidna
D. Carbonyl
E. Ethyl

#

24. In order to identify etimizole, its alkaline hydrolysis is carried out in the presence of hydroxylamine. As a result of the reaction, hydroxamic acid is formed, which the pharmacist-analyst must identify with the following reagent:

A. Iron(III) chloride
B. Potassium tetraiodomercurate
C. Silver nitrate
D. Sodium bicarbonate
E. Ammonia with molybdate

#

25. The etimizole molecule contains an amide group. To confirm the presence of this group, the analyst used the reaction:

A. With salts of heavy metals
B. With ammonium oxalate
C. With sodium nitrite
D. With bromine water
E. With sodium bicarbonate

#

26. As a result of alkaline hydrolysis of etimisol during boiling, the following is released:

A. Methylamine
B. Ammonia
C. Ethylamine
D. Dimethylamine

#

27. The following method was used for the quantitative determination of the active substance in etimisol:

A. Alkalimetry in a non-aqueous environment
B. Nitritometry
C. Acidimetry in a non-aqueous medium
D. Cerimetry
E. Alkalimetry in alcoholic medium

#

28. For the quantitative determination of etimizole by the acidimetry method in a non-aqueous environment, the following indicators were used:

A. Phenolphthalein
B. Tropeolin 00
C. Xylene orange
D. Crystal violet
E. Murexid

#

29. To identify cyclodol, a reaction is carried out with a saturated solution of picric acid. What color is the picrate precipitate formed?

A. Green
B. Yellow
C. Red
D. Blue-green
E. Pink

#

30. Select the indicator to be used in the quantification of cyclodol by acidimetry in a non-aqueous medium:

A. Crystal violet
B. Acid chrome is dark blue
C. Neutral red
D. Phenolphthalein
E. Bromothymol blue

#

31. Select the solvent used for the quantification of cyclodol by acidimetry in a non-aqueous medium:

A. Sodium hydroxide solution
B. Dimethylformamide
C. **A mixture of formic acid and acetic anhydride**
D. Ethyl alcohol
E. Perchloric acid solution

#

32. To identify tropacin in pharmaceutical analysis, the following is used:

A. Formation of maltol
B. Taleiochin test
C. Murexide test
D. Lieberman-Burchardt reaction
E. **Vitaly-Moren's reaction**

#

33. Indicate which heterocyclic systems are the basis of the structure of the alkaloid tropacin:

A. Isoquinoline and pyrrole
B. **Pyrrolidine and piperidine**
C. Piperidine and furan
D. Pyrrolizidine and imidazole
E. Pyridine and pyrazole

#

34. Fuming nitric acid, acetone, and an alcoholic solution of potassium hydroxide are used to identify tropacin. These reagents are used to detect:

A. Phenolic hydroxyl
B. Crystallization water
C. Sulfate ions
D. Remainder of tropin
E. **Diphenylacetic acid residue**

#

35. To identify tropacin, the Vitali-Morena reaction is used. The visual effect of this reaction is:

A. **The color of the solution is purple**
B. Release of gas bubbles
C. The color of the solution is green
D. Fallout of black sediment
E. Precipitation of a white precipitate

#

36. Indicate which of the medicinal substances gives a positive result when conducting a hydroxam test:

A. Cyclodol
B. **Tropacin**
C. Levodopa
D. Carbidopa
E. Midantan

#

37. To determine the quantitative content of the tropacin substance by the acid-base titration method in non-aqueous solvents, the following solution is used as a titrant:

A. Sodium nitrite
B. Hydrochloric acids
C. **Chloric acid**
D. Acetic acid
E. Mercury (II) acetate

#

38. Indicate which of the listed reagents are used to identify diphenylacetic acid in tropacin:

A. Concentrated sulfuric acid
B. **Fuming nitric acid, alcoholic solution of potassium hydroxide**
C. A mixture of sulfuric acid and nitric acid
D. Bromine water, ammonia solution
E. Erdman's reagent

#

39. Which of the following methods of analysis cannot be used for the quantitative determination of tropacin?

A. **Complexonometry**
B. Acidimetry in a non-aqueous medium
C. Alkalimetry
D. Argentometry (direct titration)
E. Argentometry (back titration)

#

40. Choose a medicinal substance that belongs to the group of alkaloids, tropane derivatives?

A. Cyclodol
B. **Tropacin**
C. Levodopa

D. Carbidopa
E. Midantan

#

41. The presence of which functional group in levodopa is confirmed by interaction with a solution of iron (III) chloride?
A. Alcoholic hydroxyl
B. **Phenolic hydroxyls**
C. Aromatic amino group
D. Aliphatic amino group
E. Carboxylic group

#

42. A solution of iron (III) chloride is used to identify levodopa and carbidopa. What color is formed in this case?
A. **Green**
B. Yellow
C. Blue-green
D. Red
E. Pink

#

43. Specify the medium used in the quantitation method for levodopa:
A. Dioxane
B. Sodium hydroxide solution
C. Acetone
D. **Glacial acetic acid**
E. Perchloric acid solution

#

44. What medicinal substance corresponds to the chemical name L-3-(3,4-dioxyphenyl)-L-alanine?
A. Carbidopa
B. **Levodopa**
C. Cyclodol
D. Methyldopa
E. Midantan

#

45. What medicinal substance corresponds to the chemical name 1-phenyl-1-cyclohexyl-3-(N-piperidino)-propanol-1 hydrochloride?
A. Carbidopa
B. Levodopa
C. **Cyclodol**

D. Tropacin
E. Midantan

#

46. Name the drug that is used in medicine only in combination with levodopa?
A. Carbidopa
B. Methyldopa
C. Cyclodol
D. Tropacin
E. Midantan

#

47. To identify midantane, boiling is carried out with sodium hydroxide solution. At the same time, the drug decomposes with the release of:
A. Pyridine
B. Ammonia
C. Carbon dioxide
D. Free chlorine
E. Water

48. A silver nitrate solution and nitric acid are used to identify midantane (amantadine hydrochloride). What color is the sediment formed in this case?
A. Pale pink
B. White
C. Light yellow
D. Dark grey
E. Yellow

#

49. Quantitative determination of midantane is carried out by the method of acidimetry in a non-aqueous environment in the presence of?
A. Lead acetate
B. Potassium bromide
C. Sodium bicarbonate
D. Mercury(II) acetate
E. Sodium chloride

#

50. For what purpose is a solution of mercury (II) acetate added during the quantitative determination of midantane by acidimetry in a non-aqueous environment?
A. For binding chloride ions into a slightly dissociated compound

B. To accelerate the course of the reaction between the substance and the titrant

C. To change the density of the solution

D. To create the optimal pH value of the solution

E. To accelerate precipitation of midantane base

4.4. Situational tasks:

1. Describe the physico-chemical properties of drugs derived from xanthine using the example of caffeine and sodium caffeine benzoate.

2. Describe the physico-chemical properties of imidazole derivatives using the example of etimizole.

3. Describe the group reaction used to identify purine derivative drugs. Why is this reaction not specific?

4. Explain the possibility of using the hydroxam test for the identification of etimizole. Give the conditions and the corresponding reaction equations.

5. Justify the conditions for the reaction of caffeine with iodine solution. Give the corresponding reaction equations.

6. Describe the method of acid-base titration of medicinal substances in non-aqueous media using caffeine as an example. Give the reaction equations, the formula for calculating the quantitative content.

7. Explain the conditions for the quantitative determination of sodium benzoate in sodium caffeine benzoate. Give the corresponding reaction equations.

8. Justify the possibility of using the acid-base titration method in non-aqueous media for the quantitative determination of etimisole. Give the reaction equations, the formula for calculating the quantitative content.

9. Describe the physicochemical properties of drugs derived from arylalkylamines using the example of levodopa and carbidopa.

10. Give the possible identification reactions of levodopa and carbidopa, based on the presence of phenolic hydroxyls in the molecule. Justify the conditions for these reactions.

11. Suggest possible methods for quantitative determination of levodopa and carbidopa. Give the corresponding reaction equations, formulas for calculating the quantitative content.

12. Explain the possibility of using the Vitali-Moren reaction to identify tropacin. Give the conditions and the corresponding reaction equations.

13. Explain the role of mercury(II) acetate in the quantitative determination of tropacin by acid-base titration in non-aqueous media. Give the corresponding reaction equations.

14. Suggest and explain possible methods for the identification of midantane. Give the corresponding reaction equations and the conditions for their implementation.

15. Describe the conditions for carrying out acid-base titration of medicinal substances in non-aqueous media using the example of midantane. Give the reaction equations, the formula for calculating the quantitative content.

4.5. Tasks:

1. Determine the mass fraction of anhydrous caffeine (M.m. 194.19) in the medicinal product, if 7.73 ml of 0.1 M perchloric acid solution was spent on the titration of 0.1536 g of the substance (C_a = 1.0165).

2. Calculate the volume of a 0.1 M solution of perchloric acid (C_a = 1.0183), which is spent on the titration of 0.1516 g of caffeine (M.m. 194.19), if the volume of the titrant in the control experiment is 0.15 ml, and the content of the active substance in the preparation is 99.5%.

3. Calculate the weight of the caffeine test (M.m. 194.19), taken for determination, if 7.45 ml of a 0.1 M perchloric acid solution (C_a = 0.9980) was spent on the titration. The content of the active substance in the preparation is 99.58%, the loss in mass during drying is 2.4%.

4. Determine the mass fraction of sodium benzoate (M.m. 144.11) in sodium caffeine benzoate, if 12.54 ml of 0.5 M hydrochloric acid solution (C_a = 1.0022) was spent on the titration of 1.5114 g of the substance.

5. Calculate the volume of 0.1 M solution of hydrochloric acid (C_a = 1.0500), which is spent on the titration of sodium benzoate (M.m. 144.11) in sodium caffeine benzoate, if the volume of the titrant in the control experiment is 0 ,12 ml, the weight of the sample was 0.1450 g, and the content of sodium benzoate in the preparation is 60.4%.

6. Determine the weight of sodium caffeine benzoate taken for analysis, if 11.58 ml of 0.5 M hydrochloric acid solution (C_a = 1.0035) was spent on its titration with sodium benzoate (M.m. 144.11). The content of sodium benzoate in the preparation is 59.80%, the loss in mass during drying is 0.85%.

7. Calculate the percentage of caffeine (M.m. 194.19) insodium caffeine benzoate, if 0.3056 g of the drug was dissolved in a 100 ml volumetric flask, 50 ml of 0.05 M iodine solution was added, the volume of the solution was brought up to the mark with water. Titration of excess iodine in 50 ml of filtrate required 12.45 ml of 0.1 M sodium thiosulfate solution(C_a = 1.0100). The volume of the titrant in the control experiment is 24.82 ml.

8. Determine the percentage content of cyclodol (M.m. 301.47) in the medicinal product, if 8.43 ml of 0.1 M perchloric acid solution (C_a = 1.0100) was spent on the titration of 0.2582 g of the substance.

9. Calculate the volume of 0.1 M perchloric acid solution (C_a = 1.0165), which is spent on the titration of 0.2056 g of cyclodol (M.m. 301.47), if the volume of the titrant in the control experiment is 0.25 ml, and the content of the active substance in the preparation is 99.3%.

10. Calculate the weight of the tropacin test (M.m. 371.9), taken for determination, if 9.56 ml of 0.1 M sodium hydroxide solution (C_a = 0.9980) was spent on the titration. The content of the active substance in the preparation is 99.58%, the loss in mass during drying is 1.8%.

11. Calculate the volume of 0.1 M perchloric acid solution (C_a = 1.0500), which is spent on the titration of tropacin (M.m. 371.9), if the volume of the titrant in the control experiment is 0.25 ml, the weight of the weighing was 0.3056 g, and the content of tropacin in the preparation is 98.86%, the loss in mass during drying is 2.4%.

12. Determine the percentage content of levodopa (M.m. 197.19) in the medicinal product, if 12.68 ml of a 0.1 M solution of perchloric acid was spent on the titration of 0.2509 g of the substance (C_a = 1.0120).

13. Calculate the volume of a 0.1 M solution of perchloric acid (C_a = 1.0150), which is spent on the titration of levodopa (M.m. 197.19), if the volume of the titrant in the control experiment is 0.45 ml, the mass of the weighing was 0.1954 g, and the content of levodopa in the preparation is 100.4%, the loss in mass during drying is 3.2%.

14. Calculate the weight of midantane measurement (M.m. 151.25) taken for determination, if 12.55 ml of 0.1 M perchloric acid solution (C_a = 0.9900) was spent on the titration. The content of the active substance in the preparation is 99.75%, the loss in mass during drying is 2.7%.

15. Determine the percent content of midantane (M.m. 151.25) in the medicinal product, if 9.85 ml of 0.1 M perchloric acid solution (C_a = 1.0100) was spent on the titration of 0.1458 g of the substance, if the volume titrant in the control experiment - 0.35 ml.

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: Final lesson on theory and practice on the topic: «Analysis of medicines that affect the central nervous system. 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 that affect the central nervous system and their semi- & synthetic derivatives 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 that affect the central nervous system and their semi- & synthetic derivatives.

3.2. Check the protocols of laboratory work and analyze the correctness of the analysis of medicines that affect the central nervous system and their semi- & synthetic derivatives 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. **Psychotropic drugs.** General characteristics, classification. Chemical structure, nomenclature, synonyms of drugs from the group of psychotropic drugs.
2. To characterize the physicochemical properties of drugs from the group of psychotropic drugs.
3. To justify the use of chemical and instrumental methods in the analysis of the quality of psychotropic drugs.
4. **Medicines from the group of neuroleptics**. The concept of neuroleptics. Classification.
   4.1. Phenothiazine derivatives. Chlorpromazine hydrochloride (Aminazine). Levomepromazine hydrochloride (Tisercin). Structure, properties and application features.
   4.2. List the possible methods and reactions of the identification of the studied drugs. Purity test. Routes of entry and determination of specific impurities in chlorpromazine hydrochloride (phenothiazine, 2-chlorophenothiazine).

4.3. Describe possible methods of quantitative determination of chlorpromazine hydrochloride and levomepromazine hydrochloride. Give appropriate reaction equations, calculation formulas.

4.4. Butyrophenone derivatives. Droperidol, haloperidol. Structure, properties, features of application.

4.5. To substantiate the possible methods and reactions of the identification of the studied drugs. Purity test.

4.6. Give possible methods of quantitative determination of droperidol and haloperidol. Give appropriate reaction equations, calculation formulas.

5. **The concept of sedative drugs**. Classification.

5.1. Sodium bromide, potassium bromide. Properties and features of application.

5.2. List the possible methods and reactions of the identification of the studied drugs. Ways of entry and determination of specific impurities in sodium bromide and potassium bromide.

5.3. Describe possible methods of quantitative determination of sodium bromide and potassium bromide. Give appropriate reaction equations, calculation formulas.

5.4. Bromcamphor. Structure, properties and application features.

5.5. To substantiate the possible methods and reactions of bromocamphor identification. Describe the conduct of purity tests.

5.6. Describe possible methods of quantitative determination of bromocamphor. Give appropriate reaction equations, calculation formulas.

6. **The concept of antidepressants**. Classification. Medicines from the group of antidepressants.

6.1. Tricyclic antidepressants. Imipramine hydrochloride (imizin), amitriptyline hydrochloride. Structure, properties and application features.

6.2. List the possible methods and reactions of the identification of the studied drugs. Purity test. Routes of entry and determination of specific impurities in amitriptyline hydrochloride in accordance with the requirements of the Federal Drug Administration.

6.3. Describe the possible methods of quantitative determination of imipramine hydrochloride (imizin) and amitriptyline hydrochloride. Give appropriate reaction equations, calculation formulas.

7. **Analeptics.** Classification of analeptic drugs.

7.1. Camphor, sulfocamphocaine (sulfocamphoric acid and procaine). Structure, properties and application features.

7.2. List the possible methods and reactions of the identification of the studied drugs. Determination of impurities in camphor in accordance with the requirements of the Federal State of Ukraine.

7.3. Describe possible methods of quantitative determination of camphor and sulfocamphocaine. Give appropriate reaction equations, calculation formulas.

7.4. Cordiamine. Composition of the drug, properties and features of use.

7.5. To justify the possible reactions of the identification of cordiamine.

7.6. Describe the possible methods of quantitative determination of cordiamine. Give appropriate reaction equations, calculation formulas.

8. The concept of psychostimulants. Classification. Medicines from the group of psychostimulants.

8.1. Purine derivatives. Caffeine, sources and extraction methods. Caffeine sodium benzoate. Structure, properties, features of application.

8.2. List the possible methods and reactions of the identification of the studied drugs. Purity test. Routes of entry and determination of accompanying impurities in caffeine according to the SPhU.

8.3. Murexide test as a general group reaction to drugs from the group of purine derivatives. Reaction mechanism, its specificity, conditions and performance technique.

8.4. Describe the possible methods of quantitative determination of caffeine and sodium caffeine benzoate. Give appropriate reaction equations, calculation formulas.

8.5. Etimizol. Structure, properties, features of application.

8.6. Justify the possible reactions of identification of etimizole, give the corresponding reaction equations.

8.7. Describe the possible methods of quantitative determination of etimizole. Give appropriate reaction equations, calculation formulas.

9. Medicines for the treatment of parkinsonism. General characteristics, classification. The concept of Parkinson's disease and the phenomenon of parkinsonism.

10. Medicines that inhibit the function of the cholinergic system. Classification.

10.1. Cyclodol. Structure, properties, features of application.

10.2. To cite possible methods of identification of cyclodol, to justify the expediency of using instrumental methods of analysis.

10.3. Describe the possible methods of quantitative determination of cyclodol. Give appropriate reaction equations, calculation formulas.

10.4. Tropacin. Structure, properties, features of application.

10.5. To substantiate the possible methods and reactions of tropacin identification.

10.6. Give possible methods of quantitative determination of tropacin. Give appropriate reaction equations, calculation formulas.

11. Medicines that activate the function of the dopaminergic system. Classification.

11.1. Levodopa, carbidopa. Structure, properties, features of application.

11.2. Give possible methods and reactions for identification of levodopa and carbidopa.

11.3. Describe possible methods of quantitative determination of levodopa and carbidopa. Give appropriate reaction equations, calculation formulas.

11.4. Midantan (amantadine hydrochloride). Properties of the drug, features of use.

11.5. To substantiate the possible methods and reactions of identification of midantane (amantadine hydrochloride).

11.6. Describe the possible methods of quantitative determination of midantane. Give appropriate reaction equations, calculation formulas.

12. Features of storage and accounting of drugs from the groups of psychotropic drugs.

4.2. Test tasks for the final lesson

#

1. The pharmacy received a medicinal product, the active substance of which has the chemical name "2-chloro-10-(3'-dimethylaminopropyl)phenothiazine hydrochloride". Specify this medicine:

A. Chlorpromazine hydrochloride
B. Diphenhydramine hydrochloride
C. Clonidine hydrochloride
D. Promethazine hydrochloride
E. Trifluoroperazine hydrochloride

#

2. The substance chlorpromazine hydrochloride was obtained for analysis. What condensed heterocycle is the basis of the chemical structure of this medicinal substance?

A. Purine
B. Phenothiazine
C. Acridine
D. Indole
E. Benzothiazine

#

3. Which of the following compounds is the starting material for the synthesis of chlorpromazine hydrochloride?

A. **2-Chlorphenothiazine**
B. 3-Chlorphenothiazine
C. 4-Chlorphenothiazine
D. 5-Chlorphenothiazine
E. 6-Chlorphenothiazine

#

4. Chlorpromazine hydrochloride is identified by comparing the absorption spectra of standard and test samples of the medicinal substance. What device is used for this?

A. **IR spectrophotometer**
B. Photoelectric colorimeter
C. Polarograph
D. Refractometer
E. Fluorimeter

#

5. A possible method of quantitative determination of sodium bromide in liquid dosage forms is:

A. **Refractometry**
B. Complexonometry
C. Polarimetry
D. Acidimetry
E. Alkalimetry

#

6. The pharmacist-analyst of the pharmacy needs to make a conclusion about the quality of preparation of 3% sodium bromide solution. Quantitative determination of the composition of the mixture was carried out by the pharmacist-analyst using the refractometric method. You can calculate the amount of sodium bromide in this case by determining the value:

A. **Refractive index**
B. Specific absorption index
C. Optical density of the solution
D. Viscosity of the solution
E. pH of the solution

#

7. The pharmacist-analyst determines the admixture of chlorides in sodium bromide according to the SPhU method:

A. **Argentometry**

B. Nitritometry
C. Bromatometry
D. Alkalimetry
E. Iodometry

#

8. The pharmacist-analyst of the pharmacy carries out chemical control of the mixture containing calcium chloride and sodium bromide. At the same time, he conducts a summary determination of the ingredients of this dosage form:
A. **Argentometrically**
B. Complexometrically
C. Alkalimetrically
D. Polarimetrically
E. Nitritometrically

#

9. The pharmacist-analyst determines the admixture of magnesium and alkaline earth metals in potassium bromide. For this, he uses a solution:
A. **Sodium edetate**
B. Potassium permanganate
C. Hydrochloric acids
D. Silver nitrate
E. Sodium nitrite

#

10. The pharmacopoeial reaction for the identification of potassium ions is interaction with tartaric acid, resulting in the formation of a precipitate of this color:
A. **White**
B. Black
C. Gray
D. Blue
E. Green

#

11. Potassium salts added to the colorless flame of a gas burner color it:
A. **Violet**
B. Red
C. Brick
D. Yellow
E. Green

#

12. The chemist of the TCD (technical control department) of the pharmaceutical enterprise can confirm the sodium cation in the tested substance, according to the SPhU, by reacting with a solution:

A. **Potassium pyroantimonate**
B. Potassium ferrocyanide
C. Potassium chloride
D. Potassium hydroxide
E. Potassium nitrate

#

13. The bromide ion in the medicines "Natrii bromidum" and "Kalii bromidum" is identified with the following reagent:

A. **Silver nitrate**
B. Lead nitrate
C. Sodium nitrate
D. Sodium nitrite
E. Calcium nitrate

#

14. The general method for determining the quantitative content of preparations from the group of alkali metal halides is:

A. **Argentometry**
B. Permanganatometry
C. Polarimetry
D. Alkalimetry
E. Nitritometry

#

15. Chlorpromazine hydrochloride is used in medicine as a drug with the main pharmacological effect:

A. Sedative
B. **Neuroleptic**
C. Analgesic
D. Anti-inflammatory
E. Nootropic

#

16. Their ability to be easily oxidized is used to identify phenothiazine derivatives. Which of the listed reagents is not used as an oxidizer?

A. Bromine water
B. Ferrum (III) chloride
C. **Sodium hydroxide**
D. Concentrated sulfuric acid

E. Concentrated nitric acid

#

17. Chlorpromazine hydrochloride substance with bromine water forms a solution of this color:

A. Red
B. **Light crimson**
C. Blue-green
D. Brown
E. Blue

#

18. In order to confirm the presence of a Sulfur atom in chlorpromazine hydrochloride, the substance is heated with a mixture of sodium carbonate and sodium nitrate. After that, the mineralization products should give a positive reaction with the following reagent:

A. **Barium chloride**
B. Sodium sulfide
C. Ammonia with molybdate
D. Argentum nitrate
E. Cobalt(II) chloride

#

19. According to the SPhU, the quantitative determination of phenothiazine derivative medicinal products is carried out by the following method:

A. Acidimetry in a non-aqueous medium
B. Nitritometry
C. Complexonometry
D. Alkalimetry
E. **Cerimetry**

#

20. According to the SPhU, the end point of the titration in the alkalimetric titration of phenothiazine derivatives is determined using:

A. Crystal violet
B. Phenolphthalein
C. **Potentiometric fixing**
D. Methyl orange
E. Bromothymol blue

#

21. Medicines droperidol and haloperidol are derivatives of:

A. Phenothiazine
B. Thioxanthene

C. Indole
D. **Butyrophenone**
E. Piperidine

#

22. To identify the haloperidol substance after combustion in a flask with oxygen, the following determinations are made:
A. **Fluorides**
B. Bromides
C. Sulfates
D. Nitrogen
E. Free ammonia

#

23. The presence of fluorides in haloperidol after mineralization is determined using a complex of alizarin and zirconium nitrate. At the same time, the color is formed:
A. **Yellow**
B. Blue-green
C. Red-purple
D. Green
E. Pink

#

24. The quantitative determination of haloperidol in the medicinal substance is proposed to be carried out by the following method:
A. **Acidimetry in a non-aqueous medium**
B. Alkalimetry
C. Alkalimetry in alcoholic medium
D. Alkalimetry in a chloroform environment
E. Cerimetry

#

25. The pharmacist-analyst performs the quantitative determination of bromocamphor by the modified (indirect) Folgard method. At the same time, the equivalent amount of bromide ion, which is formed after boiling the alcoholic solution of the drug, is titrated with a standard solution of silver nitrate:
A. **With zinc dust in an alkaline medium**
B. With potassium permanganate in an acidic environment
C. From silver nitrate in an acidic medium
D. With sodium edetate in a neutral environment
E. With an ether-chloroform mixture (1:1)

#

26. A pharmacist-analyst identifies bromocamphor by reaction with chloramine after preliminary mineralization. The positive result of this reaction should be considered the color of the chloroform layer in:

A. Pink-red color
B. **Yellow-brown color**
C. Violet
D. Navy blue
E. Emerald green color

#

27. Bromocamphor is a monohalogen derivative of camphor. At the same time, the introduction of a bromine atom into position 3 of the camphor molecule leads to:

A. Appearance of antibacterial effect
B. **Changes in the effect on the central nervous system**
C. Loss of optical activity
D. Increasing solubility in water
E. Increasing the melting point

#

28. Identification of bromocamphor is carried out after mineralization with zinc dust in an alkaline medium by reaction with:

A. Acetic acid chlorides
B. Chloral hydrate
C. Chloromethane
D. **Chloramine**
E. Sodium chloride

#

29. The pharmacist-analyst identifies the drug by boiling it with a solution of silver nitrate in the presence of nitric and sulfuric acids (until the release of nitrogen oxides stops). At the same time, a yellow precipitate was formed, insoluble in acids and sparingly soluble in ammonia solution. Indicate which medicinal product was identified by the analyst:

A. **Bromcamphor**
B. Racemic camphor
C. Sulfocamphoric acid
D. Racemic menthol
E. Terpine hydrate

#

30. Quantitative determination of bromocamphor after its mineralization is carried out by the modified (indirect) method of Folgard. Titration is performed in a

nitric acid environment, in the presence of a solution of ferric ammonium alums and a standard solution of ammonium thiocyanate; titrant - 0.1 M solution of silver nitrate. At the same time, the end point of the titration is fixed by:

A. Disappearance of red color
B. Appearance of intense blue color
C. The formation of an orange-yellow precipitate
D. The color of the solution is pink
E. Changes in the color of the precipitate from yellow to pink

#

31. Which of the following reagents is used in pharmaceutical analysis to identify racemic camphor?

A. NH_2OH
B. CH_3COOH
C. $FeCl_3$
D. CH_3CH_2OH
E. NaOH

#

32. Name the industrial method of extracting camphor:

A. V. E. Tyshchenko's method from turpentine
B. Scroup's synthesis
C. Esterification of glycerol with nitric acid
D. Interaction of *p*-nitrotoluene and *p*-nitrobenzoic acid
E. Extraction from cocoa beans with chloroform

#

33. To identify racemic camphor, the pharmacist-analyst should conduct a ketoxime formation reaction followed by determination of its melting point. In this case, the analyst should use the following reagent:

A. Hydroxylamine hydrochloride
B. Benzaldehyde
C. Iron(III) chloride
D. 2,4-Dinitrophenylhydrazine
E. Acetic anhydride

#

34. Name the medicinal substance from the terpenoid group that forms a hydrazone with 2,4-dinitrophenylhydrazine?

A. Camphor
B. Menthol
C. Validol
D. Terpine hydrate

E. Retinol

#

35. The pharmacist-analyst determines the quantitative content of racemic camphor by alkalimetric titration of the equivalent amount of hydrochloric acid released as a result of the interaction of camphor with the following reagent:

A. Hydroxylamine hydrochloride
B. *p*-Dimethylaminobenzaldehyde
C. 2,4-Dinitrophenylhydrazine
D. Chloramine
E. Furfurol

#

36. In the material room of the pharmacy, the pharmacist discovered a crystalline plaque in the upper part of the rod filled with racemic camphor. The appearance of such a plaque can be easily explained by the ability of camphor:

A. To sublimate
B. To hydrolyze
C. To oxidize
D. Polymerize
E. Recover

#

37. One of the chemical reactions for the identification of diethylamide of nicotinic acid is the reaction of the release of diethylamine, which has a characteristic smell. The pharmacist-analyst conducts this reaction by boiling the substance under investigation with a solution:

A. Sodium hydroxide
B. Silver nitrate
C. Diphenylamine
D. Barium chloride
E. Phenolphthalein

#

38. The pharmacist-analyst performs the identification of the substance diethylamide of nicotinic acid. With which reagent does he confirm the presence of a pyridine cycle in the structure of the substance under study?

A. 2,4-Dinitrochlorobenzene
B. Silver nitrate
C. Sulfuric acid
D. Sodium thiosulfate
E. Dimethylformamide

#

39. The composition of the drug "Cordiamine", which is used as a stimulant of the nervous system, can be defined as:

A. Aqueous solution of nicotinic acid diethylamide
B. Aqueous solution of nicotinic acid
C. Aqueous solution of nicotinic acid amide
D. Isonicotinic acid hydrazide
E. Oxymethylamide of nicotinic acid

#

40. In order to confirm the presence of a sulfo group in the structure of sulfocamphoric acid, the investigated substance is heated with a mixture of sodium carbonate and sodium nitrate. After that, the mineralization products should give a positive reaction with the following reagent:

A. Barium chloride
B. Sodium sulfide
C. Ammonia with molybdate
D. Argentum nitrate
E. Cobalt(II) chloride

#

41. When identifying sulfocamphoric acid, tests are carried out using a barium chloride solution to identify sulfogroups in its structure. Before performing the specified test, the medicinal substance should be subjected to:

A. Mineralization
B. Hydrolysis
C. Decarboxylation
D. Sulfation
E. Esterification

#

42. The pharmacist-analyst identified sulfocamphoric acid by the formation of a yellow-orange precipitate upon interaction with a solution of 2,4-dinitrophenylhydrazine. This reaction confirms the presence of sulfocamphoric acid in the structure:

A. Keto groups
B. Sulfogroups
C. Sulfate ions
D. Amino groups
E. Carboxylic group

#

43. The quantitative content of sulfocamphoric acid in the solution of sulfocamphocaine for injections can be determined by the method:

A. Alkalimetry
B. Nitritometry
C. Acidimetry
D. Permanganatometry
E. Complexonometry

#

44. The use of the reaction of the formation of an azo dye in the identification of sulfocamphocaine 10% for injections is due to the fact that the composition of this medicinal product includes:

A. Procaine base
B. Sulfocamphoric acid
C. Racemic camphor
D. 3-Quercetin rutinoside
E. Glucose monohydrate

#

45. Identification of the substance amitriptyline hydrochloride in accordance with the requirements of the Federal State Administration of Ukraine is carried out by the following method:

A. Liquid chromatography
B. Thin-layer chromatography
C. Photoelectrocolorimetry
D. Absorption spectrophotometry in the IR region
E. Polarimetry

#

46. The determination of the accompanying impurities in the substance of amitriptyline hydrochloride according to the requirements of the Federal Drug Administration is carried out by the following method:

A. Liquid chromatography
B. Thin-layer chromatography
C. Photoelectrocolorimetry
D. Absorption spectrophotometry in the IR region
E. Polarimetry

#

47. Quantitative determination of the substance amitriptyline hydrochloride in accordance with the requirements of the Federal Drug Administration is carried out by the following method:

A. Liquid chromatography
B. Polarimetry
C. Alkalimetry

D. Acidimetry in a non-aqueous medium
E. Absorption spectrophotometry

#

48. Amitriptyline hydrochloride is identified by comparing the absorption spectra of standard and test samples of the medicinal substance. What device is used for this?
A. IR spectrophotometer
B. Photoelectric colorimeter
C. Polarograph
D. Refractometer
E. Fluorimeter

#

49. When carrying out the quantitative determination of the substance amitriptyline hydrochloride by the method of alkalimetry, is it used as a titrated solution?
A. 0.1 M alcoholic sodium hydroxide solution
B. 0.1 M potassium hydroxide solution
C. 0.1 M sodium methylate solution
D. 0.1 M sodium hydroxide solution
E. 0.1 M solution of lithium methylate

#

50. To identify imipramine hydrochloride, a reaction with concentrated nitric acid is carried out. What color is formed in this case?
A. Green turning into brown
B. Blue turning into brown
C. Green
D. Red
E. Blue-green

#

51. For identification of imipramine hydrochloride (imizin) reaction with picric acid is used. By what indicator is the drug identified?
A. The melting temperature of the sediment
B. Release of gaseous products
C. The color of the solution
D. The smell of ammonia
E. Discoloration of the solution

#

52. When carrying out the quantitative determination of imipramine hydrochloride by the method of acidimetry in a non-aqueous environment, is it added?
A. Sulfuric acid solution

B. Dimethylformamide
C. A solution of mercury (II) acetate
D. Sodium hydroxide solution
E. Ammonia solution

#

53. What method is used for the quantitative determination of imipramine hydrochloride (imizin)?
A. Nitritometry
B. Permanganatometry
C. Alkalimetry
D. Acidimetry
E. Cerimetry

#

54. Which quantification method cannot be used for imipramine hydrochloride?
A. Acidimetry in a non-aqueous environment
B. Argentometry
C. UV-spectrophotometry
D. Nitritometry
E. Alkalimetry

#

55. State the main pharmacological action of imipramine hydrochloride (imizin):
A. Antidepressant
B. Analeptic
C. Nootropic
D. Anticonvulsant
E. Neuroleptic

#

56. What reaction effect is observed when adding a solution of silver nitrate to the substance imipramine hydrochloride in the presence of nitric acid?
A. Dark gray sediment
B. Red color
C. Blue color
D. White sediment
E. Yellow precipitate

#

57. Specify the indicator that is used for the quantitative determination of the substance imipramine hydrochloride by the argentometric method (direct titration):

A. Methyl orange
B. Potassium chromate
C. Iron ammonium alums
D. Phenolphthalein
E. Crystal violet

#

58. The pharmacist-analyst determines the quantitative content of caffeine in accordance with the requirements of the SPhU by the method of acidimetry in non-aqueous media. He used a solution as a titrant:
A. Iodine
B. Chloric acid
C. Potassium bromate
D. Sodium hydroxide
E. Sodium nitrite

#

59. Choose the indicator to be used by the pharmacist-analyst during the quantitative determination of medicinal products - organic bases and their salts (caffeine, caffeine-sodium benzoate) by the method of acidimetry in glacial acetic acid medium:
A. Crystal violet
B. Acid chrome is dark blue
C. Neutral red
D. Phenolphthalein
E. Bromothymol blue

#

60. The pharmacist-analyst performs the quantitative determination of caffeine using the iodometric method. What indicator does it use?
A. Starch
B. Methyl red
C. Methyl orange
D. Phenolphthalein
E. Potassium chromate

#

61. Medicines caffeine, sodium caffeine benzoate belong to alkaloids, purine derivatives, that is, they contain heterocyclic fragments of molecules in their structure:
A. Morpholine and pyridine
B. Pyridine and pyrazine
C. Imidazole and pyrimidine

D. Pyrazole and pyrrolidine
E. Pyrrole and pyrimidine

#

62. According to the SPhU, the reaction for identifying medicinal substances from the xanthine group is:
A. Beilstein's test
B. Maltol sample
C. Murexide test
D. Biuret reaction
E. Iodoform test

#

63. According to the requirements of the SPhU, a concentrated solution of hydrogen peroxide, diluted hydrochloric acid, and diluted ammonia are used to identify caffeine. The indicated reagents are necessary to perform the reaction on xanthines, which is called:
A. Thiochrome test
B. Taleiochin test
C. Maltol sample
D. Murexide test
E. Hydroxam test

#

64. In the warehouse of finished products, a damaged marking on one of the packages was accidentally discovered. It is known that the medicinal substance in this package belongs to alkaloids. In the course of group qualitative reactions to alkaloids, the murexide test gave a positive result. What group of alkaloids should be limited to the following steps in the identification of a medicinal substance?
A. Purine derivatives
B. Quinoline derivatives
C. Derivatives hit me
D. Isoquinoline derivatives
E. Indole derivatives

#

65. According to the SPhU, the group reaction for the identification of drugs from the xanthine group is the murexide test. What intermediate product is formed when caffeine is treated with an oxidant?
A. Uracil
B. 1,3-Dimethylaloxane
C. Timin

D. Uric acid
E. Hypoxanthine

#

66. Specify the medicinal substance, the colored product of the identification reaction of which is the ammonium salt of tetramethylpurpuric acid:
A. Atropine sulfate
B. Platyphyllin hydrotartrate
C. Morphine hydrochloride
D. Caffeine monohydrate
E. Quinine sulfate

#

67. Indicate which drug from the group of alkaloids will give a positive result in the reaction to xanthines (murexide test):
A. Caffeine
B. Atropine sulfate
C. Papaverine hydrochloride
D. Quinine sulfate
E. Ephedrine hydrochloride

#

68. The benzoate ion in caffeine sodium benzoate can be identified by reaction with a solution of iron(III) chloride. Which reaction result should be considered positive?
A. Appearance of red color
B. Appearance of blue color
C. The formation of a white precipitate
D. The formation of a pink-yellow precipitate
E. Release of brown vapors

#

69. For the quantitative determination of sodium benzoate in caffeine sodium benzoate method is used?
A. Acidimetry
B. Alkalimetry
C. Alkalimetry in a non-aqueous environment
D. Nitritometry
E. Permanganatometry

#

70. Which medicinal substance from the group of alkaloids, purine derivatives, forms a white precipitate with a 0.1% solution of tannin, which dissolves in an excess of the reagent?

A. Caffeine
B. Theobromine
C. Theophylline
D. Euphilinus
E. Diprofilin

#

71. The substance caffeine is being studied in the control and analytical laboratory. Specify the number of the atom of the purine system of caffeine, which is protonated during its quantitative determination by the method of acidimetry in a non-aqueous medium:
A. 9
B. 1
C. 3
D. 7
E. 8

#

72. In the control-analytical laboratory, the dosage form containing sodium benzoate is analyzed. Which of the following reagents forms a yellow-pink precipitate with the drug under study?
A. Sodium bicarbonate solution
B. Potassium permanganate solution
C. Magnesium sulfate solution
D. Sodium nitrate solution
E. Iron(III) chloride solution

#

73. The sodium cation in sodium caffeine benzoate, when introduced into the colorless flame of a gas burner, colors it in color:
A. Yellow
B. Brick
C. Violet
D. Red
E. Green

#

74. Sodium benzoate in sodium caffeine benzoate is determined acidimetrically in the presence of the following mixed indicator:
A. A solution of methyl orange and phenolphthalein
B. A solution of methyl orange and methylene blue
C. A solution of methylene blue and thymolphthalein
D. A solution of phenolphthalein and thymolphthalein

E. A solution of methyl orange and methyl red

#

75. Acidimetric titration of sodium benzoate in caffeine-sodium benzoate is carried out when adding solventfor extracting benzoic acid. Specify this solvent:

A. Ethyl alcohol
B. Ether
C. Acetone
D. Methanol
E. Butanol

#

76. Caffeine has the following properties:

A. Strong core
B. Weakly acidic
C. Amphoteric
D. Weak main ones
E. Strongly acidic

#

77. Specify the conditions for the identification reaction under which the formation of a precipitate of caffeine periodide is observed:

A. Neutral environment
B. Acidic environment
C. Alkaline environment
D. In the presence of ether
E. Caffeine does not form a periodide precipitate

#

78. Etimizole is a derivative of:

A. Imidazole
B. Pyrimidine
C. Purine
D. Pyridine
E. Pyrrol

#

79. Specify the functional group in the etimizole molecule that causes its acidic properties:

A. Tertiary nitrogen atom
B. Methyl
C. Amide
D. Carbonyl
E. Ethyl

#

80. Specify the functional group in the etimizole molecule that determines its main properties:

A. Tertiary nitrogen atom
B. Metilna
C. Amidna
D. Carbonyl
E. Ethyl

#

81. In order to identify etimizole, its alkaline hydrolysis is carried out in the presence of hydroxylamine. As a result of the reaction, hydroxamic acid is formed, which the pharmacist-analyst must identify with the following reagent:

A. Iron(III) chloride
B. Potassium tetraiodomercurate
C. Silver nitrate
D. Sodium bicarbonate
E. Ammonia with molybdate

#

82. The etimizole molecule contains an amide group. To confirm the presence of this group, the analyst used the reaction:

A. With salts of heavy metals
B. With ammonium oxalate
C. With sodium nitrite
D. With bromine water
E. With sodium bicarbonate

#

83. As a result of alkaline hydrolysis of etimisol during boiling, the following is released:

A. Methylamine
B. Ammonia
C. Ethylamine
D. Dimethylamine

#

84. The following method was used for the quantitative determination of the active substance in etimisol:

A. Alkalimetry in a non-aqueous environment
B. Nitritometry
C. Acidimetry in a non-aqueous medium
D. Cerimetry

E. Alkalimetry in alcoholic medium

#

85. For the quantitative determination of etimizole by the acidimetry method in a non-aqueous environment, the following indicators were used:

A. Phenolphthalein
B. Tropeolin 00
C. Xylene orange
D. Crystal violet
E. Murexid

#

86. To identify cyclodol, a reaction is carried out with a saturated solution of picric acid. What color is the picrate precipitate formed?

A. Green
B. Yellow
C. Red
D. Blue-green
E. Pink

#

87. Select the indicator to be used in the quantification of cyclodol by acidimetry in a non-aqueous medium:

A. Crystal violet
B. Acid chrome is dark blue
C. Neutral red
D. Phenolphthalein
E. Bromothymol blue

#

88. Select the solvent used for the quantification of cyclodol by acidimetry in a non-aqueous medium:

A. Sodium hydroxide solution
B. Dimethylformamide
C. A mixture of formic acid and acetic anhydride
D. Ethyl alcohol
E. Perchloric acid solution

#

89. To identify tropacin in pharmaceutical analysis, the following is used:

A. Formation of maltol
B. Taleiochin test
C. Murexide test
D. Lieberman-Burchardt reaction

E. Vitaly-Moren's reaction

#

90. Indicate which heterocyclic systems are the basis of the structure of the alkaloid tropacin:

A. Isoquinoline and pyrrole
B. **Pyrrolidine and piperidine**
C. Piperidine and furan
D. Pyrrolizidine and imidazole
E. Pyridine and pyrazole

#

91. Fuming nitric acid, acetone, and an alcoholic solution of potassium hydroxide are used to identify tropacin. These reagents are used to detect:

A. Phenolic hydroxyl
B. Crystallization water
C. Sulfate ions
D. Remainder of tropin
E. **Diphenylacetic acid residue**

#

92. To identify tropacin, the Vitali-Morena reaction is used. The visual effect of this reaction is:

A. **The color of the solution is purple**
B. Release of gas bubbles
C. The color of the solution is green
D. Fallout of black sediment
E. Precipitation of a white precipitate

#

93. Indicate which of the medicinal substances gives a positive result when conducting a hydroxam test:

A. Cyclodol
B. **Tropacin**
C. Levodopa
D. Carbidopa
E. Midantan

#

94. To determine the quantitative content of the tropacin substance by the acid-base titration method in non-aqueous solvents, the following solution is used as a titrant:

A. Sodium nitrite
B. Hydrochloric acids

C. **Chloric acid**
D. Acetic acid
E. Mercury (II) acetate

#

95. Indicate which of the listed reagents are used to identify diphenylacetic acid in tropacin:
A. Concentrated sulfuric acid
B. **Fuming nitric acid, alcoholic solution of potassium hydroxide**
C. A mixture of sulfuric acid and nitric acid
D. Bromine water, ammonia solution
E. Erdman's reagent

#

96. Which of the following methods of analysis cannot be used for the quantitative determination of tropacin?
A. **Complexonometry**
B. Acidimetry in a non-aqueous medium
C. Alkalimetry
D. Argentometry (direct titration)
E. Argentometry (back titration)

#

97. Choose a medicinal substance that belongs to the group of alkaloids, tropane derivatives?
A. Cyclodol
B. **Tropacin**
C. Levodopa
D. Carbidopa
E. Midantan

#

98. The presence of which functional group in levodopa is confirmed by interaction with a solution of iron (III) chloride?
A. Alcoholic hydroxyl
B. **Phenolic hydroxyls**
C. Aromatic amino group
D. Aliphatic amino group
E. Carboxylic group

#

99. A solution of iron (III) chloride is used to identify levodopa and carbidopa. What color is formed in this case?
A. **Green**

B. Yellow
C. Blue-green
D. Red
E. Pink

#

100. Specify the medium used in the quantitation method for levodopa:
A. Dioxane
B. Sodium hydroxide solution
C. Acetone
D. **Glacial acetic acid**
E. Perchloric acid solution

#

101. What medicinal substance corresponds to the chemical name L-3-(3,4-dioxyphenyl)-L-alanine?
A. Carbidopa
B. **Levodopa**
C. Cyclodol
D. Methyldopa
E. Midantan

#

102. What medicinal substance corresponds to the chemical name 1-phenyl-1-cyclohexyl-3-(N-piperidino)-propanol-1 hydrochloride?
A. Carbidopa
B. Levodopa
C. **Cyclodol**
D. Tropacin
E. Midantan

#

103. Name the drug that is used in medicine only in combination with levodopa?
A. **Carbidopa**
B. Methyldopa
C. Cyclodol
D. Tropacin
E. Midantan

#

104. To identify midantane, boiling is carried out with sodium hydroxide solution. At the same time, the drug decomposes with the release of:
A. Pyridine
B. **Ammonia**

C. Carbon dioxide
D. Free chlorine
E. Water

105. A silver nitrate solution and nitric acid are used to identify midantane (amantadine hydrochloride). What color is the sediment formed in this case?
A. Pale pink
B. **White**
C. Light yellow
D. Dark grey
E. Yellow

#

106. Quantitative determination of midantane is carried out by the method of acidimetry in a non-aqueous environment in the presence of?
A. Lead acetate
B. Potassium bromide
C. Sodium bicarbonate
D. **Mercury(II) acetate**
E. Sodium chloride

#

107. For what purpose is a solution of mercury (II) acetate added during the quantitative determination of midantane by acidimetry in a non-aqueous environment?
A. **For binding chloride ions into a slightly dissociated compound**
B. To accelerate the course of the reaction between the substance and the titrant
C. To change the density of the solution
D. To create the optimal pH value of the solution
E. To accelerate precipitation of midantane base

4.3. Situational tasks:

1. Describe the physicochemical properties of drugs from the group of phenothiazine derivatives based on their structure.
2. Suggest possible reagents that could be used to prove the presence of a divalent sulfur atom in the structure of chlorpromazine hydrochloride.
3. Justify the conditions for determining the sulfur atom in the phenothiazine cycle. Explain the need and conditions for conducting mineralization for these tests.

4. Explain the origin and justify the methods of detecting specific impurities in the substance chlorpromazine hydrochloride (phenothiazine, 2-chlorophenothiazine).
5. Describe the features of the storage conditions of drugs from the group of neuroleptics. What physical and chemical properties are determined by such storage conditions?
6. Justify and state the methods of quantitative determination that can be applied to the total and individual determination of the ingredients of a mixture containing calcium chloride and sodium bromide.
7. Describe the method for the quantitative determination of bromocamphor, based on the determination of organically bound halogen (argentometry according to the modified Folgard method). Give the corresponding reaction equations, calculation formulas.
8. Describe the relationship between the extraction method used and the optical form of the camphor released.
9. Indicate which reagents can be used to prove the presence of a keto group in the structure of camphor. Give the equations of the corresponding reactions and their justification.
10. Justify the possibility of using the oxime method (substituent titration) for the quantitative determination of racemic camphor. Give the corresponding reaction equations, calculation formulas.
11. Describe the features of identification and quantification of an injectable 10% solution of sulfocamphocaine, based on its structure. Give the corresponding reaction equations, calculation formulas.
12. Describe the physicochemical properties of drugs from the group of tricyclic antidepressants using the example of amitriptyline hydrochloride and imipramine hydrochloride, based on their structure.
13. Explain the origin and justify the methods of detection of specific impurities in the substance of amitriptyline hydrochloride according to the requirements of the SPhU.
14. Justify the use of the refractometric method for the quantitative determination of the active substance in cordiamine, the advantages and disadvantages of this method over other methods.
15. Describe the physico-chemical properties of drugs derived from xanthine using the example of caffeine and sodium caffeine benzoate.
16. Describe the physico-chemical properties of imidazole derivatives using the example of etimizole.
17. Describe the group reaction used to identify purine derivative drugs. Why is this reaction not specific?

18. Explain the possibility of using the hydroxam test for the identification of etimizole. Give the conditions and the corresponding reaction equations.

19. Justify the conditions for the reaction of caffeine with iodine solution. Give the corresponding reaction equations.

20. Describe the method of acid-base titration of medicinal substances in non-aqueous media using caffeine as an example. Give the reaction equations, the formula for calculating the quantitative content.

21. Explain the conditions for the quantitative determination of sodium benzoate in sodium caffeine benzoate. Give the corresponding reaction equations.

22. Justify the possibility of using the acid-base titration method in non-aqueous media for the quantitative determination of etimisole. Give the reaction equations, the formula for calculating the quantitative content.

23. Describe the physicochemical properties of drugs derived from arylalkylamines using the example of levodopa and carbidopa.

24. Give the possible identification reactions of levodopa and carbidopa, based on the presence of phenolic hydroxyls in the molecule. Justify the conditions for these reactions.

25. Suggest possible methods for quantitative determination of levodopa and carbidopa. Give the corresponding reaction equations, formulas for calculating the quantitative content.

26. Explain the possibility of using the Vitali-Moren reaction to identify tropacin. Give the conditions and the corresponding reaction equations.

27. Explain the role of mercury(II) acetate in the quantitative determination of tropacin by acid-base titration in non-aqueous media. Give the corresponding reaction equations.

28. Suggest and explain possible methods for the identification of midantane. Give the corresponding reaction equations and the conditions for their implementation.

29. Describe the conditions for carrying out acid-base titration of medicinal substances in non-aqueous media using the example of midantane. Give the reaction equations, the formula for calculating the quantitative content.

4.4. Tasks:

1. Calculate the percentage content of chlorpromazine hydrochloride (M.m. 355.3) in the preparation, if the weight of the test piece is 0.2468 g, the volume of 0.1 M sodium hydroxide solution (C_a = 0.9998) is 6.98 ml.

2. Calculate the weight of chlorpromazine hydrochloride (M.m. 355.3) in the medicinal product, if 6.62 ml of 0.1 M sodium hydroxide solution (C_a = 0.9982) was used for the titration. The content of the active substance in the preparation is 98.62%.

3. Calculate the percentage content of levomepromazine hydrochloride (M.m. 364.9) in the drug, if the weight of the weighing scale is 0.3265 g, the volume of a 0.1 M solution of perchloric acid (C_a = 0.9892) in the working experiment is 8.86 ml, in the control - 0.18 ml, loss in mass during drying - 3.8%.

4. Calculate the weight of levomepromazine hydrochloride (M.m. 364.9), if 8.68 ml of 0.1 M perchloric acid solution (C_a = 0.9800) was spent on its titration, the content of the active substance in the preparation is 98.84%, the volume of the titrant in the control experiment is 0.26 ml.

5. Calculate the percentage content of bromocamphor (M.m. 231.14), if 9.4 ml of 0.1 M silver nitrate solution (C_a = 0.9980) was spent during the determination of 0.2149 g of the substance by the modified Folgard method; the amount of added 0.1 M ammonium rhodanide solution is 0.1 ml.

6. Calculate the weight of sodium bromide (M.m. 102.9), if 18.35 ml of 0.1 M silver nitrate solution (C_a = 0.9970) was spent on its titration, and the content of the active substance in the preparation is 99.42% .

7. Calculate the volume of 0.1 M perchloric acid solution (C_a = 0.9960), which will be spent on the titration of 0.2432 g of the substance haloperidol (M.m. 375.9), if the content of the active substance in the preparation is 99.72% , the volume of the control experiment is 0.12 ml, and the mass loss during drying is 2.6%.

8. Calculate the weight of haloperidol (M.m. 375.9), if 5.48 ml of 0.1 M perchloric acid solution (C_a = 0.9890) was spent on its titration, the content of the active substance in the preparation is 99.68%, volume of titrant in the control experiment – 0.16 ml.

9. Calculate the specific rotation of camphor, if the angle of rotation of the 10% alcohol solution is +8.4°, and the length of the cuvette is 200 mm.

10. Calculate the percentage content of racemic camphor (M.m. 152.24) in the preparation, if 12.1 ml of 0.1 M sodium hydroxide solution was spent during the determination of 0.1869 g of the substance by the oxime method for the titration of the hydrochloric acid that was released (A_c = 1.0000).

11. Calculate the volume of 0.1 M sodium hydroxide solution (A_c = 1.0105), which was spent on the titration of the hydrochloric acid released when determining 0.1625 g of racemic camphor (M.m. 152.24) by the oxime method, and the content of the active substance in the substance is 99.8%.

12. Calculate the percentage content of amitriptyline hydrochloride (M.m. 313.9) in the preparation, if the weight of the weighing scale is 0.1875 g, the volume of 0.1 M sodium hydroxide solution (A_c = 0.9960) is 5.96 ml.

13. Calculate the weight of amitriptyline hydrochloride (M.m. 313.9) in the medicinal product, if 7.45 ml of 0.1 M sodium hydroxide solution (A_c = 0.9980)

was used for the titration. The content of the active substance in the preparation is 99.58%, the loss in mass during drying is 2.4%.

14. Calculate the volume of 0.1 M sodium hydroxide solution (A_c = 0.9990), which will be spent on the titration of 0.2035 g of the substance imipramine hydrochloride (M.m. 316.87), if the content of the active substance in the preparation is 99.28 %, the volume of the control experiment is 0.25 ml, and the mass loss during drying is 1.8%.

15. Calculate the percentage content of imipramine hydrochloride (M.m. 316.87) in the preparation, if the mass of the weighing scale is 0.2304 g, the volume of 0.1 M sodium hydroxide solution (A_c = 0.9970) is 7.48 ml, and the volume of the control experiment is 0.16 ml.

16. Calculate the content of nicotinic acid diethylamide (in g) in cordiamine, if it is known that the refractive index of the tested solution is 1.3820, *F*= 0.002, and the refractive index of the solvent is 1.3330.

17. Determine the mass fraction of anhydrous caffeine (M.m. 194.19) in the medicinal product, if 7.73 ml of 0.1 M perchloric acid solution was spent on the titration of 0.1536 g of the substance (C_a = 1.0165).

18. Calculate the volume of a 0.1 M solution of perchloric acid (C_a = 1.0183), which is spent on the titration of 0.1516 g of caffeine (M.m. 194.19), if the volume of the titrant in the control experiment is 0.15 ml, and the content of the active substance in the preparation is 99.5%.

19. Calculate the weight of the caffeine test (M.m. 194.19), taken for determination, if 7.45 ml of a 0.1 M perchloric acid solution (C_a = 0.9980) was spent on the titration. The content of the active substance in the preparation is 99.58%, the loss in mass during drying is 2.4%.

20. Determine the mass fraction of sodium benzoate (M.m. 144.11) in sodium caffeine benzoate, if 12.54 ml of 0.5 M hydrochloric acid solution (C_a = 1.0022) was spent on the titration of 1.5114 g of the substance.

21. Calculate the volume of 0.1 M solution of hydrochloric acid (C_a = 1.0500), which is spent on the titration of sodium benzoate (M.m. 144.11) in sodium caffeine benzoate, if the volume of the titrant in the control experiment is 0 ,12 ml, the weight of the sample was 0.1450 g, and the content of sodium benzoate in the preparation is 60.4%.

22. Determine the weight of sodium caffeine benzoate taken for analysis, if 11.58 ml of 0.5 M hydrochloric acid solution (C_a = 1.0035) was spent on its titration with sodium benzoate (M.m. 144.11). The content of sodium benzoate in the preparation is 59.80%, the loss in mass during drying is 0.85%.

23. Calculate the percentage of caffeine (M.m. 194.19) insodium caffeine benzoate, if 0.3056 g of the drug was dissolved in a 100 ml volumetric flask, 50 ml of

0.05 M iodine solution was added, the volume of the solution was brought up to the mark with water. Titration of excess iodine in 50 ml of filtrate required 12.45 ml of 0.1 M sodium thiosulfate solution(C_a = 1.0100). The volume of the titrant in the control experiment is 24.82 ml.

24. Determine the percentage content of cyclodol (M.m. 301.47) in the medicinal product, if 8.43 ml of 0.1 M perchloric acid solution (C_a = 1.0100) was spent on the titration of 0.2582 g of the substance.

25. Calculate the volume of 0.1 M perchloric acid solution (C_a = 1.0165), which is spent on the titration of 0.2056 g of cyclodol (M.m. 301.47), if the volume of the titrant in the control experiment is 0.25 ml, and the content of the active substance in the preparation is 99.3%.

26. Calculate the weight of the tropacin test (M.m. 371.9), taken for determination, if 9.56 ml of 0.1 M sodium hydroxide solution (C_a = 0.9980) was spent on the titration. The content of the active substance in the preparation is 99.58%, the loss in mass during drying is 1.8%.

27. Calculate the volume of 0.1 M perchloric acid solution (C_a = 1.0500), which is spent on the titration of tropacin (M.m. 371.9), if the volume of the titrant in the control experiment is 0.25 ml, the weight of the weighing was 0.3056 g, and the content of tropacin in the preparation is 98.86%, the loss in mass during drying is 2.4%.

28. Determine the percentage content of levodopa (M.m. 197.19) in the medicinal product, if 12.68 ml of a 0.1 M solution of perchloric acid was spent on the titration of 0.2509 g of the substance (C_a = 1.0120).

29. Calculate the volume of a 0.1 M solution of perchloric acid (C_a = 1.0150), which is spent on the titration of levodopa (M.m. 197.19), if the volume of the titrant in the control experiment is 0.45 ml, the mass of the weighing was 0.1954 g, and the content of levodopa in the preparation is 100.4%, the loss in mass during drying is 3.2%.

30. Calculate the weight of midantane measurement (M.m. 151.25) taken for determination, if 12.55 ml of 0.1 M perchloric acid solution (C_a = 0.9900) was spent on the titration. The content of the active substance in the preparation is 99.75%, the loss in mass during drying is 2.7%.

31. Determine the percent content of midantane (M.m. 151.25) in the medicinal product, if 9.85 ml of 0.1 M perchloric acid solution (C_a = 1.0100) was spent on the titration of 0.1458 g of the substance, if the volume titrant in the control experiment - 0.35 ml.

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