MINISTRY OF HEALTH OF THE REPUBLIC OF UZBEKISTAN

TASHKENT PHARMACEUTICAL INSTITUTE

ORGANIC CHEMISTRY

Training manual
for practical and laboratory work
for bachelors in the direction of
5510500-Pharmacy (by type), 5111000-Professional education
(5510500-pharmacy (pharmaceutical business)
(part 1 – 18 classes)

Tashkent-2020

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«CONFIRM»
Vice Rector for Academic Affairs,
Professor Z.A.Yuldashev
"24" 11 2020 y.

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2020y. " 16 " 11 protocol № 10

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2020y. " 21 " 11 protocol № 3

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2020 y. " 24 " 11 protocol № 4

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INTRODUCTION

Improving the system for training specialists in various fields of science is one of the most important stipulations for the country's development. In this regard, the issues of ensuring effective training and training of qualified personnel on the basis of modern educational programs are reflected in the "National training program of preparing specialists ".

Among the disciplines that make up the basic training of specialists in the field of "pharmacy", an important place is occupied by organic chemistry.

Organic chemistry is a branch of chemical science that studies carbon compounds, their structure, properties, production methods, and practical use. It should be noted that many organic compounds, in particular heterocyclic compounds, are used in the preparation of many drugs (vitamin PP, cordiamine, isoniazid, 5-NOK, etc.) and have an important biological value.

In this regard, one of the main tasks in studying the subject of organic chemistry is to improve the effectiveness of teaching this subject. The success of this task largely depends on teaching methods that allow students to supply them with deep knowledge and teach them to integrate them in the study of such subjects as biological chemistry, pharmaceutical chemistry, Toxicological chemistry, and drug development technology.

This training manual is a logical addition to the lecture course on organic chemistry and is a single educational and methodological complex that promotes a creative approach to the study of the discipline, conducting laboratory and practical classes, taking into account modern pedagogical and information technologies of training.

Organic chemistry is studied by 2nd year students during the 3rd and 4th semesters of the academic year. The manual contains 15 laboratory and 3 practical (seminar) classes.

The purpose of conducting laboratory work on organic chemistry is to form students knowledge of the laws of chemical behavior of the main classes of organic compounds in relation to their structure. Using this knowledge to obtain individual representatives of different classes of organic compounds, conducting characteristic reactions with them contributes to a deeper assimilation of theoretical material in the course of organic chemistry.

During practical (seminar) classes, the main theoretical questions of the section are considered, which allow you to consolidate the knowledge gained as a result of listening to lectures and performing independent work of the student in preparation for the lesson.

LESSON № 1

1. **Theme**: Organization and rules of work in the laboratory of organic chemistry. Chemical dishes and appliances. Elemental analysis of organic compounds.

2. **Class duration**: 3 hours.

3. **The purpose of the lesson**: to introduce students with the rules of work in the laboratory and with the method of discovery of the main elements (C, H, N, Halogens) that are part of organic compounds.

4. **Objectives**: by the end of the lesson, the student should know:

4.1. basic rules of organization of work in the laboratory of organic chemistry;

4.2. working procedure in the chemical laboratory;

4.3. general safety rules;

4.4. first aid measures;

4.5. basic methods for determining the composition of organic compounds;

4.6. methods for determining carbon, hydrogen, nitrogen, and chlorine atoms in organic compounds

5. **Basic training questions**.

5.1. Organization of work in the laboratory of organic chemistry.

5.2. The order of work in the chemical laboratory.

5.3. Safety precautions when working in the laboratory.

5.4. Measures to provide first aid.

5.5. Chemical utensils and accessories used in performing laboratory work on organic chemistry.

5.6. Basic operations when working in the chemistry lab.

5.7. Methods for structure elucidation of organic compounds.

5.8. The main chemical and physico-chemical methods of open items.

5.9. Detection of carbon, hydrogen, nitrogen and halogen in organic compounds.

6. **Self-study** (performed in preparation for the lesson).

Physical and chemical methods for studying organic compounds (IR and PMR spectroscopy).

7. **Demonstration**.

Tables, models of molecules, videos of the virtual laboratory: "Determination of nitrogen", "Determination of carbon and hydrogen", "Determination of chlorine".

BASIC RULES AND ORGANIZATION OF WORK IN LABORATORY OF ORGANIC CHEMISTRY

How to work in a chemical laboratory

Organic chemistry is one of the chemical Sciences in which experiment plays the most important role. It is known that the chemical knowledge accumulated to date is obtained by researchers as a result of experiments and analyses. However, it should be remembered that chemical experiments with organic substances are quite dangerous, since they are characterized by a good ability to flame and self-ignition and, therefore, must be performed very carefully and carefully. When performing laboratory work on organic chemistry, you should strictly adhere to the established procedure for working in the laboratory and observe the following precautions.

1. Students who have studied the procedure for working in a chemical laboratory, mastered the section “precautions when performing laboratory work” and listened to safety instructions are allowed to perform laboratory work.

2. In preparation for the laboratory work, the student should:

2.1. pre-work out the relevant sections of the theoretical material for the textbook, lecture notes;

2.2. in the workbook for laboratory work, answer exercises and tasks on the Theme in writing;

2.3. carefully read the methodology for performing laboratory work experiments and prepare the following Protocol of laboratory work in advance, leaving space for recording relevant observations and conclusions that are made after the work is completed.

Protocol for registration of laboratory work

(it is made out on the expanded sheets of the notebook)

№	Name experience	Scheme reactions	Reaction conditions	Observed the result of experience	Conclusion

3. To record the results of experiments, you must have a workbook that indicates the name of the subject, the last name and initials of the student, as well as the faculty and group.

4. All laboratory work is performed by students in small groups under the supervision of a teacher.

5. When performing laboratory work, it is necessary to observe all precautions, consistently perform the operations specified in this manual.

6. After the end of the laboratory work, you should put your workplace in order - wash the dishes, remove the reagents, wipe the table.

General safety rules for working in chemical laboratories

In the laboratory of organic chemistry, students must take into account the specific properties of organic compounds, their toxicity, and fire hazard, which in turn requires extra careful handling and compliance with certain rules:

1. In the laboratory, students work in a lab coat, on the table, in addition to a tripod with test tubes and reagents, there is only a notebook and study material.

2. When performing work, you must be accurate and careful.

3. Before you start performing experiments, you need to carefully study their description, know the properties of the yielding substances.

4. When performing chemical reactions in a test tube during heating, it is necessary to fix it in a tripod in an inclined state so that its opening is directed in the direction opposite to itself and not in the direction of the companions working nearby.

5. When working with a gas outlet tube, the heating of the test tube must be stopped only after removing the end of the tube from the receiver with the liquid. If the heating source is removed prematurely, the liquid from the receiver can be sucked into the reaction tube and it can burst, and the reaction mixture can get on the face and hands.

6. In the laboratory, in any case, you can not taste substances.

7. When determining the smell, the vapors from the test tube or flask are directed to themselves with a movement of the hand.

8. All experiments with substances having a pungent irritating odor, should be undertaken only under fume cupboard.

9. Boiled and flammable liquids (ether, benzene, alcohol) are poured away from the fire, test tubes and flasks with them are heated in a water or sand bath.

10. If clothing catches fire, immediately cover the burning person with a blanket or thick outer clothing.

11. When diluting sulfuric acid with water, sulfuric acid should be added to the water in a thin stream (and not vice versa) with continuous stirring of the solution.

12. It is forbidden to take alkali metals (potassium, sodium, and their hydroxides) with your bare hands, as well as to suck in pipettes with acids, alkalis, and solvents with your mouth.

13. After performing experiments, the remains of flammable liquids, acids, and alkalis should not be poured into the sink, but into special flasks.

14. After finishing work and handing it over to the teacher, students are required to put their workplace in order, check whether electrical appliances, water, gas are turned off.

First aid

In each laboratory for first aid should be a first aid kit with hygroscopic cotton wool, sterile swabs and bandages, band-aid, 3-5% alcohol solution of iodine, 1% solution of acetic acid, 1-3% solution of bicarbonate of soda, 2% solution of boric acid, glycerin, vaseline, ointment for burns, ethyl alcohol, ammonia.

1. burns from fire or hot objects are quickly treated with an ointment for burns, then apply cotton wool with this ointment and loosely bandaged. For pretreatment of the burned area, manganese potassium and alcohol are also used. In case of severe burns, the victim is sent to an outpatient clinic.

2. for chemical burns (acid, alkali or bromine on the skin), the affected area is washed with a large amount of water, then with a 3% solution of bicarbonate of soda, smeared with burn ointment or vaseline and bandaged. The area of the skin that has been exposed to alkali is immediately washed with a large amount of water, then with a 1% solution of acetic acid, smeared with burn ointment or vaseline and bandaged. If bromine gets on the skin, immediately wash it with benzene, gasoline or a saturated solution of hyposulfite.

3. If acid gets into the eye, it is immediately washed with a large amount of water, then with a dilute solution of soda, again with water and immediately send the victim to the outpatient clinic.

4. In case of contact with eyes, alkali immediately washed with plenty of water, then a dilute solution of boric acid and immediately sent the injured to the clinic.

5. clothing fabric that has been exposed to acid or alkali is washed with a large amount of water, then treated with a 3% solution of bicarbonate of soda (in case of acid) or 1% solution of acetic acid (if alkali is present).

6. cuts of hands with glass are washed with a strong stream of water, fragments are removed from the wound, filled with an alcoholic solution of iodine and bandaged.

ELEMENTAL ANALYSIS OF ORGANIC COMPOUNDS

Organic chemistry is one of the main independent and main branches of chemistry. It studies organic compounds, their structure, and chemical processes involving organic compounds.

Organic compounds contain elements such as carbon, hydrogen, oxygen, and, relatively rarely, nitrogen, sulfur, Halogens, phosphorus, and other elements.

The belonging of organic substances to certain classes is established by characteristic reactions in functional groups, their purity – by chromatography, and their structure – by all existing physical and chemical research methods, taking into account the method of preparation.

A set of methods that allow you to determine what elements an organic compound consists of determines the ***qualitative element analysis***. Organic compounds in most cases are not electrolytes and do not give characteristic reactions to the elements contained in them. Therefore, to determine the elemental composition, organic matter is destroyed, converted to simple inorganic by complete combustion or oxidation. In this case, simpler substances are formed, such as CO_2 and H_2O, which are easily discovered by conventional analytical methods.

For qualitative analysis of an organic compound into functional groups, choose those reactions that cause a change in color or phase separation (precipitation, gas release).

PRACTICUM

Experience 1. The detection of carbon

Reagents: sucrose, sodium chloride

A few sucrose crystals (or any other organic substance) are placed on the tip of a scalpel or metal spatula and carefully heated in a burner flame. Sucrose melts, darkens, charred and completely burns. For comparison, a similar experiment is carried out with sodium chloride. Sodium chloride introduced at the tip of the scalpel into the flame of the burner, even with prolonged heating, does not undergo any changes.

Experience 2. Detection of carbon and hydrogen

Reagents: glucose, lime water, anhydrous copper (II) sulfate, copper (II) oxide powder.

In test tube 1 (Fig.1), copper (II) oxide powder is placed at a height of 10 mm, an equal amount of glucose is added and thoroughly mixed. In the upper part of the test tube 1, a small ball of cotton wool is placed, on which a thin layer of white powder of anhydrous copper (II) sulfate is poured. Test tube 1 is closed with a plug with a gas outlet tube so that one end of it almost touches the cotton wool, and the second is immersed in a test tube with 1 ml of barite (lime) water. Carefully heat the upper layer of the mixture of the substance with copper (II) oxide in the burner flame first, then the lower layer.

In the presence of carbon, turbidity of calcareous water is observed due to the formation of barium carbonate sediment. After precipitation, tube 3 is removed, and tube 1 is continued to be heated until the water vapor reaches anhydrous copper (II) sulfate. In the presence of water, a change in the color of copper (II) sulfate crystals is observed due to the formation of crystallohydrate $CuSO_4 \cdot 5H_2O$.

$$C_6H_{12}O_6 + 12CuO \longrightarrow 12Cu + 6CO_2 + 6H_2O$$

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4 \cdot 5H_2O$$

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

Отформатировано: русский

Отформатировано: русский

Отформатировано: русский

Experience 3. Detection of chlorine (the reaction of Beilstein)

Отформатировано: английский (США)

Reagents: chloroform

The copper wire is pre-cleaned: wetted in hydrochloric acid and calcined in the burner flame until the flame color disappears. Copper is covered with a black coating of oxide. After cooling, a small amount of the test substance is placed on the tip of the wire, rolled up in the form of a loop, and introduced into the flame of the burner. In the presence of halogen, the flame is painted in a beautiful green color.

$$2CHCl_3 + 5CuO \rightarrow CuCl_2 + 4CuCl + 2CO_2 + H_2O$$

Control question

1. What you can do if in the lab has been the source of fire?
2. What is the first aid for burns first degree?
3. What heating devices are allowed to be used when heating flammable liquids?
4. What rules must be observed when working with alkaline metals?
5. Why use a fume hood?
6. How is a dilute solution of sulfuric acid prepared?
7. How should the smell of organic substances be determined?
8. What methods for determining the elemental composition of organic compounds do you know?
9. What is the principle of conducting a qualitative analysis of organic compounds?

10. Which inorganic compounds are converted to carbon-, hydrogen - and chlorine-containing organic compounds for the qualitative determination of the corresponding elements?

11. What is the easiest way to determine the carbon content of organic compounds?

12. What is the role of copper (II) oxide and anhydrous copper (II) sulfate in determining carbon and hydrogen in organic compounds?

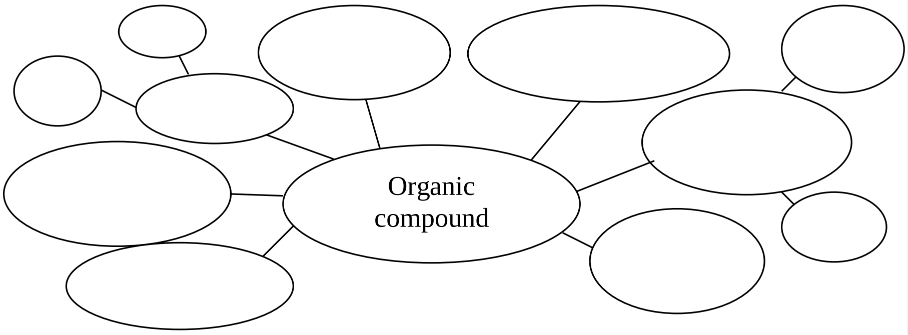
13. What happens to lime water when determining carbon in organic compounds? Explain the reasons.

14. If you encounter any of the elements use the sample of Beilstein? What is the essence of the method?

15. Why does the copper wire darken during calcination?

Task 1: Create a cluster on the Theme "Organic compounds".

The cluster should be created in the following order: the keyword is written in the center of the workbook sheet, and the words"satellites" associated with this word are assigned around the keyword.



Task 2: Determine the correct order of operations and changes observed in the determination of carbon and hydrogen in glucose.

“Blitz survey”

The name of the operation	The student's answer	Correct answer
the test tube is placed in a tripod		
the test tube is closed with a plug with a gas outlet tube		
copper (II) oxide powder is placed in a test tube at a height of 10 mm)		
a small ball of cotton is placed in the upper part of the test tube		
glucose is added in an amount equal to the amount of		

copper (II) oxide)		
a thin layer is filled with a white powder of anhydrous copper (II) sulfate.		
color change of copper (II) sulfate crystals)		
the end of the gas outlet tube is immersed in a test tube with lime water		
turbidity of lime water		
a test tube with a mixture of glucose and copper (II) oxide is heated in a burner flame)		

LESSON № 2

1. **Theme**: Structure, structural and stereoisomer, nomenclature of organic compounds.

2.Class duration: 3 hours.

3.The purpose of the lesson: To form students ' knowledge of classification features, structural and spatial isomerism, and nomenclature of organic compounds.

4.Objectives: by the end of the lesson, the student should be able to:

4.1. determine the classification characteristics of organic compounds;

4.2. determine the types of isomerism of organic compounds.

4.3. write structural and spatial isomers of organic compounds;

4.4. name compounds by international, rational, and radical-functional nomenclature;

4.5. write structural formulas of organic compounds according to their names;

5. Basic training questions.

5.1. Structure of the carbon skeleton and functional group are the main classification features of organic compounds.

5.2. The main classes of organic compounds.

5.3. Isomerism of organic compounds – structural (chains, positions, by functional group) and spatial (geometric and optical).

5.4. The nomenclature of organic compounds is international, radically functional, rational, and trivial.

5.5. Name hydrocarbons, halogenated derivatives of hydrocarbons, alcohols, amines by substitution nomenclature and writing structural formulae of the compounds of these classes by the names of substitutive nomenclature.

5.6. Writing the structural formulas of hydrocarbons, alcohols, and halogen-derived hydrocarbons by the name of the rational nomenclature and the name of the rational nomenclature of the structural formulas of these classes.

5.7. Name alcohols, amines, ketones were radical-functional nomenclature and writing structural formulae of the compounds of these classes by the names were radiculo-functional item.

5.8. Seniority of characteristic groups of organic compounds and determination of the parent structure.

6. Self-study.

Spatial isomerism of organic compounds.

7. Demonstration.

Table "Seniority of characteristic groups of organic compounds", multimedia – "Optical isomerism".

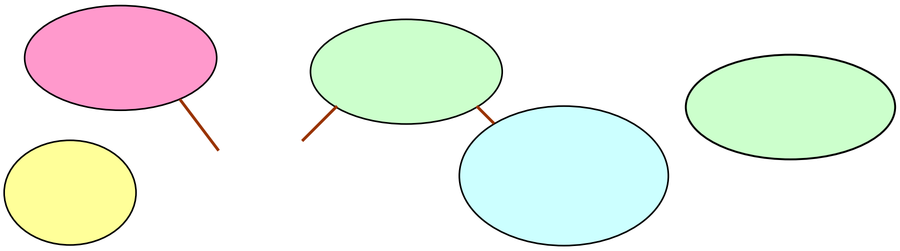
Control question

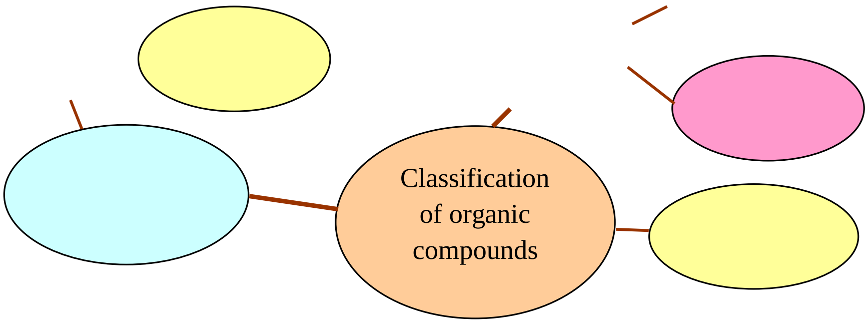
1. What does organic chemistry study?
2. On what grounds can we classify organic compounds?
3. Formulate the basic provisions of theory of chemical structure of organic compounds of a. M. Butlerov.
4. What is the chemical structure of substances?
5. What is a homological series? Homologues? Give examples.
6. What is isomerism? What compounds are called isomers?
7. Which classes of organic compounds are characterized by isomerism chain, position and functional group?
8. What types of spatial isomerism do you know? Give an example.
9. What is the difference between conformational isomers and configuration isomers?
10. Which compounds are characterized by geometric and optical isomerism?
11. What is the chemical nomenclature and what types of it do you know?
12. Formulate the rules of modern nomenclature, known as " IUPAC nomenclature" (International Union of Pure and Applied Chemistry).
13. What is the parent structure?
14. Which group is called the characteristic group of organic compounds?

Task: Create a cluster on the Theme "classification of organic compounds".

The cluster should be created in the following order: the keyword is written in the center of the workbook sheet, and the words "satellites" associated with this word are assigned around the keyword.

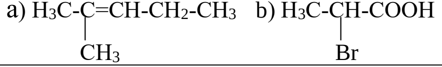
Cluster "classification of organic compounds"



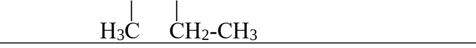


Typical individual tasks on the Theme

Option 1

№	Task	Answers
1	Write all possible structural formulas for compounds whose gross formula is C_4H_8.	
2	Name the given connections.  a) $H_3C-\underset{\substack{\vert\\CH_3}}{C}=CH-CH_2-CH_3$ b) $H_3C-\underset{\substack{\vert\\Br}}{CH}-COOH$	
3	Write the structural formula: a) 2,2,4-trimethylpentane, b) 2-chloropropene.	
4	Using Newman's projection formulas, give the conformational isomers of 2-chloroethanol.	

Option 2

№	Task	Answers
1	Write all possible structural formulas for compounds whose gross formula is C_3H_7C1.	
2	Name the given connections.  a) $CH_3-CH_2-\underset{\substack{\vert\\H_3C}}{C}=\underset{\substack{\vert\\CH_2-CH_3}}{C}-CH_3$ b) $H_2C=CH-C\equiv C-CH_3$	
3	Write the structural formulas for the following compounds: a) 2-methyl-butene-2, b) methylacetylene.	
4	Using Newman's projection formulas, give the conformational isomers of 1,2-dibromoethane.	

LESSON № 3

1. Theme: Chemical bonds, the mutual influence of atoms. Building models of organic molecules.

2. Duration: 3 hours.

3. The purpose of the lesson: to Form knowledge about the electronic structure of aliphatic, cyclic systems with conjugated bonds, to determine the value of electronic effects on the reactivity of organic compounds.

4. Objectives: by the end of the lesson, the student should be able to:

4.1. determine the types of chemical bonds in the molecules of organic compounds;

4.2. determine the type of interface (*p*,π-; π,π-) in molecules of organic compounds;

4.3. specify electronic effects.;

4.4. determine the nature of the substituent (electron donor or electron acceptor).

5. Basic training questions.

5.1. types of hybridization of the carbon atom.

5.2. formation of σ- and π-bonds using examples of the electronic structure of methane, ethylene, and acetylene.

5.3. Types of chemical bonds, principles of their formation.

5.4. Characteristics of covalent bonds (length, energy, polarity, polarizability).

5.5. The mutual influence of atoms in organic compounds.

5.6. The inductive effect caused by the presence in molecules of atoms with different electronegativity.

5.7. Types of mates (*p*,π-; π,π-) in the molecules of organic compounds. Electronic structure of butadiene-1,3, vinyl chloride, benzene, phenol, and aniline.

5.8. Mesomeric effect caused in the molecule of the conjugate system, which includes the substituent.

5.9. The electron-donor and electron-deficient substituents.

6. Self-study.

Determination of electron-donating and electron-acceptor substituents in organic compounds.

7. Demonstration.

Tables, models of molecules, multimedia "structure of the carbon atom, types of hybridization".

PRACTICUM

Production of models of hydrocarbon molecules and their halogen derivatives

Purpose of work: Make models of hydrocarbon molecules and their halogen derivatives from plastic rods, study their spatial structures, identify the type of hybridization, and determine the valence angle.

Equipment: demonstration Board, plastic rods for modeling molecules.

Progress of work:

Study the structure of methane. Identify the type of hybridization in the molecule. Use plastic rods to build a molecule. What is the valence angle?

Structure of ethane and propane molecules. Study the structure of molecules, identify the type of hybridization. With the help of equipment to build a molecule of ethane and propane. Write down the structural formulas of molecules, identify the valence angle.

To study the structure of 1-chloropropane and 2-chloropropane molecules. Construct molecules, identify the type of hybridization, and the valence angle. What bonds do these molecules contain?

On the demo Board, show sp -, sp^2-, sp^3-hybridizations.

What is the structure of the molecules of alkanes and their halogen derivatives? The results obtained are recorded in a notebook. Draw the structure of molecules. Answer questions.

Control question

1. Describe the electronic structure of carbon.

2. What is the hybridization of the electron clouds?

3. What types of hybridization of carbon are typical in organic compounds? Give examples.

4. Describe the types of hybridization of the carbon atom.

5. What is a chemical bond?

6. Explain the formation of σ - and π-bonds in organic molecules.

7. What types of chemical bonds in molecules of organic compounds do you know? Give them definitions.

8. Give the characteristic of covalent bonds (length, energy, polarity, polarizability).

9. What explains the mutual influence of atoms in the molecules of organic compounds.

10. What is the inductive effect and what is it like? Given example.

11. What is the mesomeric effect and when does it occur? Given example.

12. What kinds of mates you know? Given example.

13. What are the criteria, the deputy is considered to be a donor?

14. When is a substituent considered an electron acceptor?

15. Explain the effect of substituents on the reactivity of organic compounds.

Task: Make a table of the categorical review.
The task is performed by students in small groups.

Topics for the event categorical review

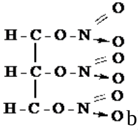
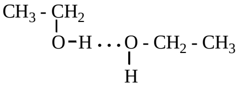
- **Chemical bonds**
- **Types of carbon atom hybridization**
- **Inductive and mesomeric effects**

Categorical table

Theme of the categorical review	Types			
Categories (types)				
Signs				
Examples				

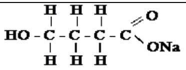
Typical individual control tasks on the Theme

Option 1

№	Task	Answers
1	Select the types of chemical bonds in the following compounds: a)  b) 	
2	Draw atomic-orbital models and specify the number of s - and sp^3-hybrid orbitals in the propane molecule.	
3	Show graphically the manifestation of the inductive effect of substituents in the following organic compounds, indicating the electrodonor and electroacceptor substituents: a) CH_3-CH_2-C1 b) CH_3-CH_2-COOH	
4	Determine the types of conjugation and show the electron density distribution in the molecules of the following compounds: a) $CH_3-CH=CH_2$b) $CH_2=CH-CH=CH_2$	

Option 2

№	Task	Answers
1	Select the types of chemical bonds in the following compounds:	

	a) $CH_3 - C \equiv N$ b)  $HO-CH_2-CH_2-CH_2-C(=O)ONa$	
2	Draw atomic-orbital models and specify the number of s-, p-, sp^2-, sp^3-hybrid orbitals in the propene molecule.	
3	Show graphically the manifestation of the inductive effect of substituents in the following organic compounds, indicating the electrodonor and electroacceptor substituents: a) $CH_2=CH-C \equiv CH$ b) $CH_3-C(O)H$	
4	Coupled systems with open and closed circuits. Determine the types of conjugation and show the electron density distribution in the molecules of the following compounds:a) $CH_2=CH-C1$ b) $CH_3-CH=CH-COOH$	

LESSON № 4

1. Theme: Alkanes and cycloalkanes. Synthesis and properties of alkanes.

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge about the reactivity of alkanes and cycloalkanes in relation to their structure.

4. Objectives: by the end of the lesson, the student should know:

4.1. names of alkanes according to systematic and rational nomenclature;

4.2. types of isomerism of alkanes and cycloalkanes;

4.3. methods for obtaining alkanes and cycloalkanes

4.4. chemical properties of alkanes and cycloalkanes.

4.5. mechanism of radical substitution in the tetragonal carbon atom.

5. Basic training questions.

5.1. Saturated hydrocarbons – alkanes, cycloalkanes, structure.

5.2. Isomerism and nomenclature of alkanes and cycloalkanes.

5.3. methods for producing alkanes (Wurtz reaction, pyrolysis of carboxylic acid salts) and cycloalkanes (Gustavson synthesis).

5.4. Conformations of alkanes and cycloalkanes. Conformation of ethane and cyclohexane (bath, chair), axial and Equatorial connections.

5.5. the mechanism of radical substitution by the example of bromination of alkanes and cycloalkanes of the formula C_nH_{2n}, where $n > 5$.

5.6. chemical properties of alkanes:

5.6.1. Reactions of radical substitution (halogenation, nitration, sulfochlorinated).

5.6.2. Oxidation of alkanes.

5.7. Chemical properties cycloalkanes:

5.7.1. Addition reactions in small cycles (halogenation, hydrogenation, hydrohalogenation).

5.7.2. Substitution reactions at secondary cycles (halogenation).

5.7.3. The electronic structure of cyclopropane.

6. Self-study (performed in preparation for the lesson).

Methods for obtaining alkanes and cycloalkanes (chemical transformations). Bi **-** and polycyclic alkanes.

7. Demonstration.

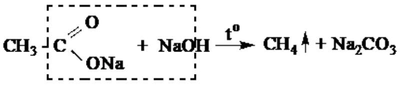
Videos virtual lab – "the production of methane and its combustion," "Ratio of methane to a solution of potassium permanganate and bromine water," "the Explosion of methane with oxygen", "the Combustion of liquid and solid hydrocarbon".

PRACTICUM

Experience 1. The production of methane and to study its properties

Reagents: sodium acetate, sodium lime (a mixture of NaOH and CaO),
bromine water, 1% solution of potassium permanganate.

In a dry test tube at a height of 10 mm, a mixture of sodium acetate and sodium lime carefully ground in a mortar in a ratio of 1:2 is placed. the test Tube is closed with a plug with a gas outlet tube, installed in a tripod and heated in a burner flame. Methane gas is released.



$$CH_3-C(=O)ONa + NaOH \xrightarrow{t^o} CH_4\uparrow + Na_2CO_3$$

The resulting methane is alternately passed into separate tubes with bromine water and a 1% solution of potassium permanganate. Under the conditions of experience, no visible changes are observed. Without stopping heating, the gas released from the exhaust pipe is ignited. Methane burns with a bluish flame:

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + Q$$

Experience 2. Chemical properties of alkanes

Reagents: gasoline, concentrated sulfuric and nitric acids, bromine water,
1% solution of potassium permanganate

1. Interaction with concentrated sulfuric acid. 1 ml of gasoline (a mixture of extreme hydrocarbons) is placed in a test tube, an equal volume of concentrated sulfuric acid is added, carefully mixed, then shaken. The reaction mixture is heated. The test tube is cooled with water. Gasoline does not change, which indicates the inertia of the limiting hydrocarbons.

2. Interaction with concentrated nitric acid. To 1 ml of gasoline, add 1 ml of concentrated nitric acid, shake gently at first, and then vigorously for a few minutes. The color of gasoline does not change: the ultimate hydrocarbons do not react with nitric acid under these conditions.

3. Interaction with bromine water. To 1 ml of gasoline, add bromine water drop by drop, shaking the test tube all the time. The color of free bromine does not change. Due to the better solubility of bromine in gasoline, when shaken, it is possible to extract bromine with gasoline and color it yellow.

4. Interaction with the potassium permanganate. To 1 ml of gasoline, add a few drops of 1% solution of potassium permanganate, with strong shaking, the purple color does not disappear.

Control question

1. What hydrocarbons are called alkanes?
2. Give all possible isomers of 2,4-dimethyl-3-ethylpentane and name them according to the international and rational nomenclature.
3. What are the methods of obtaining alkanes you know? Write them on the example of obtaining 2-methylpentane.
4. Why are alkanes less reactive?
5. What chemical reaction is able to enter alkanes? What is the mechanism of these reactions?
6. Using the example of propane halogenation, explain the mechanism of radical substitution in a tetragonal carbon atom.
7. What hydrocarbons are called cycloalkanes?
8. How many isomers has a cyclopentane? Write them down and name them.
9. Which of the cyclopentane isomers has geometric isomers?
10. Describe the methods for obtaining cycloalkanes and give them an example of obtaining methylcyclohexane.
11. What are the chemical properties characteristic of cycloalkanes?
12. What type of reactions is typical for small cycloalkanes? Explain the reasons and mechanism.
13. What reactions are typical for medium cyclones? What is the reason for their occurrence and what is the mechanism?
14. Explain the structure of the cyclopropane molecule.
15. What is observed when methane passes through a solution of potassium permanganate and bromine water?

16. What is the color of the flame when methane is burned?

LESSON № 5

1. Theme: Alkenes and alkadiene. Synthesis and properties of ethylene.

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge of the reactivity of double and conjugated double carbon-carbon bonds to electrophilic addition.

4. Objectives: by the end of the lesson, the student should know:

4.1. types of isomerism, the nomenclature of alkenes and alkadiens;

4.2. main methods for producing alkenes (dehydrohalogenation of monohalogen-derived hydrocarbons, dehydration of monatomic alcohols) and alkadiens (dehydrohalogenation of dihalogen-derived hydrocarbons);

4.3. addition reactions in alkenes, the mechanism of electrophilic addition;

4.4. causes of reactions in alkenes according to the Markovnikov rule (static and dynamic approach);

4.5. joining in unsaturated compounds not according to the Markovnikov rule (Harash effect), mechanism;

4.6. oxidation of alkenes under soft and hard conditions, ozonation.

5. Basic training questions.

5.1. Alkenes.

5.1.1. Nomenclature, structural and spatial (π-diastereomer-dence) isomerism.

5.1.2. Methods for the preparation of mono - and dihalogenoalkane hydrocarbons, from Monohydric alcohols.

5.1.3. Reactions of electrophilic accession (AE) mechanism.

5.1.4. Hydrohalogenation, Markovnikov's rule, static (distribution of electron density in an alkene molecule) and dynamic (comparison of stability of carbcations) factors.

5.1.5. Joining against the Markovnikov rule (radical hydrohalogenation), the Harash effect.

5.1.6. Reactions of radical substitution.

5.1.7. The oxidation (hydroxylation, ozonation ehpoksidirovaniya, oxidation in acidic medium).

5.1.8. The reaction of polymerization.

5.2. Alkadiene.

5.2.1. Classification alkadienes.

5.2.2. Methods for the preparation of alcohols (Lebedev reaction) and dehalogenating hydrocarbons.

5.2.3. features of electrophilic addition reactions in conjugated dienes (hydrogenation, halogenation, hydrohalogenation).

5.2.4. Diels-alder reaction characteristic of conjugated dienes. Concepts of dienophiles.

6. Self-study (performed in preparation for the lesson).

Alkadiene – classification, preparation, reactivity.Natural and synthetic rubbers.

7. Demonstration.

Videos of the virtual laboratory – "ethylene production and Gorenje", "interaction of ethylene with a solution of potassium permanganate", "interaction of ethylene with bromine water"; multimedia – "Markovnikov's rule".

PRACTICUM

Experience 1. Obtaining ethylene and the study of its properties

Reagents: ethyl alcohol, concentrated sulfuric acid, bromine water, 1%
solution of potassium permanganate, concentrated sulfuric acid

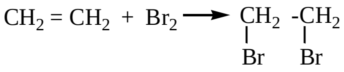
About 5 ml of a mixture consisting of one part of ethyl alcohol and three parts of concentrated sulfuric acid is poured into a test tube with a gas outlet tube, and a few grains of aluminum oxide are added. The test tube is closed with a plug with a gas outlet tube and carefully heated in the burner flame until the gas is evenly released from the reaction mixture. The mixture is carefully heated.

Heating of ethyl alcohol with concentrated sulfuric acid is accompanied by intramolecular dehydration with the formation of ethylene:

$$CH_3\text{-}CH_2\text{-}OH \xrightarrow{\text{cons. } H_2SO_4\text{, t}} CH_2{=}CH_2 + H_2O$$

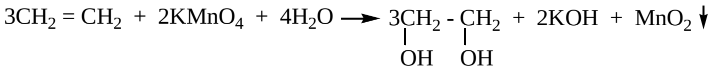
The end of the gas outlet tube is alternately lowered into 3 pre-prepared test tubes containing 1) bromine water solution, 2) 1% aqueous solution of potassium permanganate, 2) 1% aqueous solution of potassium permanganate with concentrated sulfuric acid.

When ethylene is passed through a solution of bromine water, a rapid discoloration of the yellow-brown color of the solution is observed:



$$CH_2=CH_2 + Br_2 \rightarrow \underset{Br}{CH_2}-\underset{Br}{CH_2}$$

When ethylene is passed through a 1% solution of potassium permanganate of pale pink color, the original color of the solution disappears, and in the case of an excess of potassium permanganate, a floccular brown precipitate-manganese oxide (IV):



$$3CH_2=CH_2 + 2KMnO_4 + 4H_2O \rightarrow 3\underset{OH}{CH_2}-\underset{OH}{CH_2} + 2KOH + MnO_2\downarrow$$

When ethylene is passed through a 1% solution of potassium permanganate in the presence of concentrated sulfuric acid, rapid discoloration of the solution is observed, brown flakes are not formed:

$$CH_2=CH_2 + KMnO_4 + H_2SO_4 \longrightarrow H_2C=O + K_2SO_4 + MnSO_4 + H_2O$$

Continuing to heat, the ethylene gas is quickly ignited at the end of the gas outlet tube. Ethylene burns with a glowing flame.

$$C_2H_4 + O_2 \rightarrow 2CO_2 + 2H_2O$$

Experience 2. Character of unsaturated rubber

Reagents: 5% solution of rubber in gasoline, a solution of bromine in gasoline

Pour 2 ml of the rubber solution in gasoline into the test tube and pour the bromine solution in gasoline with a pipette, shaking the test tube vigorously after each addition of bromine. Bromine discoloration occurs due to its attachment at the site of double bonds to the rubber molecule.

The rubber solution in gasoline is prepared in advance. Tiny chopped rubber (devulcanized) is placed for several days in a cylinder with a lapped cork. Rubber dissolves in gasoline and forms a colloidal solution.

Rubber is a natural polymer consisting of residues of diene hydrocarbons. It has unsaturated bonds, the presence of which is proved by bromine discoloration.

$$[-CH_2-\underset{CH_3}{C}=CH-CH_2-]_n + Br_2 \longrightarrow [-CH_2-\underset{CH_3}{C}Br-CHBr-CH_2-]_n$$

Отформатировано: Шрифт: 7 пт

Отформатировано: английский (США)

Отформатировано: английский (США)

Control question

1. What hydrocarbons are called alkenes?
2. What is the General formula and type of hybridization in alkenes?

3. What types of isomerism are characteristic of alkenes? Write and name the alkenes corresponding to the formula C_5H_{10}.

4. Name the natural sources of alkenes.

5. Give synthetic methods of producing alkenes.

6. What type of reactions characteristic of alkenes?

7. What kinds of reactions typical of alkenes joining?

8. For example, the halogenation reaction and explain the mechanism of accession to alkane.

9. Formulate the Markovnikov rule and explain the reasons for its implementation (static and dynamic factors).

10. In which cases do the joining reactions go against the Markovnikov rule? Explain the mechanism.

11. What types of oxidation reactions are typical for alkenes?

12. What is polymerization?

13. What hydrocarbons are called alkadiens?

14. What kinds of are classified alkadiene?

15. What types of reactions are typical for alkadiens?

16. Explain the connection in kongugirovannah diene hydrocarbons.

17. What compounds are dienophiles?

18. What reaction is called the Diels-alder reaction?

19. What are rubbers?

20. What types of rubbers do you know?

Task: Answer questions about the Assessment technology.

Отформатировано: Отступ: Первая строка: 0 см, Поз.табуляции: 0 см, по левому краю + нет в 6,47 см

TEST	**SITUATIONAL ISSUE**
1. What sequence of reactions leads to the production of butene-2 from butene-1? 1. KOH (water) 2. HBr 3. Br_2 4. KOH (alcohol) A. 2,1 B. 3,1 C. 2, 4 D. 3,4 2. In which of the following reactions does the Markovnikov rule not matter? 1. 2-methylhexene-2 + HJ → 2. Hexen-3 + HJ → 3. Buten-2 + HJ → 4. Isobutylene + HJ → A.1,2 B. 2,4 C. 2,3 D. 3,4	It is known that the following compounds were formed during hydrolysis of the alkene ozonation product: methyl ethyl ketone and propanal. Give the structural formula of the alkene, name it. Write the reaction of its ozonation followed by hydrolysis.

GLOSSARY	PRACTICAL SKILL
1. Markovnikov's Rule: **2. Polymerization -**	Which of the following reagents can be used to distinguish ethane from ethylene? 1. Br_2 2. $KMnO_4+H_2O$ 3. $K_2Cr_2O_7+H_2SO_4$ 4. HBr What is observed when they interact?

LESSON № 6

1. Theme: Alkynes. Synthesis, properties of acetylene, CH-acidity.

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge about the reactivity of triple carbon-carbon bonds to electrophilic addition and CH-acidity of alkynes.

4. Objectives: by the end of the lesson, the student must:

4.1–. write reactions of alkynes and explain the mechanism of electrophilic addition;

4.2. explain the Eltekov rule in the hydration reaction characteristic of alkynes;

4.3. explain the CH-acidity of alkynes;

4.4. write di-and trimerization reactions of alkynes;

4.5. create equations of reactions of chemical transformations in the production of alkynes.

5. Basic training questions.

5.1. reactions of electrophilic addition of alkynes – halogenation, hydrohalogenation, hydrogenation.

5.2. Comparing the reactivity of alkynes in the reactions of electrophilic accession (AE) with altname.

5.3. Hydration of alkynes – reaction Kucherov. The concept of keto-enol tautomerism. Eltek's Rule.

5.4. CH-acidity of alkynes. Formation of acetylenides (interaction with Na, ammonia solutions of silver oxide and copper (I) salts).

5.5. The obtaining of homologues of acetylene.

6. Self-study (performed in preparation for the lesson).

Methods for obtaining alkynes, their di - and trimerization reactions.

7. Demonstration.

Videos of the virtual laboratory – "acetylene production and burn", "interaction of acetylene with bromine water and potassium permanganate solution", "production of silver and copper acetylenides", "fragility of metal acetylenides"; multimedia – "Alkynes", "Acetylene hydrocarbons".

PRACTICUM

Отформатировано: Цвет шрифта: Авто

Experience 1. Production of acetylene combustion

Reagents: calcium carbide

The experiment is conducted in a fume cupboard!

In a test tube, pour 2-3 ml of water, add a few small pieces of calcium carbide. Quickly close the opening of the test tube with a plug with a gas outlet tube. The interaction of calcium carbide with water proceeds energetically - acetylene is released:

Отформатировано: По ширине

$$CaC_2 + 2H_2O \rightarrow C_2H_2\uparrow + Ca(OH)_2$$

The gas is ignited at the opening of the test tube. Acetylene burns with a glowing, slightly smoky flame:

Отформатировано: Цвет шрифта: Авто

Отформатировано: Цвет шрифта: Авто

Отформатировано: Цвет шрифта: Авто

Отформатировано: По ширине

$$2HC\equiv CH + 5O_2 \xrightarrow{t^o} 4CO_2 + 2H_2O$$

Experience 2. Study of the chemical properties of acetylene

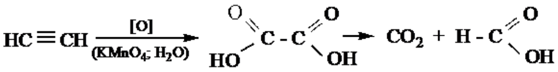
Reagents: acetylene, 1% potassium permanganate solution, bromine water, copper (I) chloride

ammonia solution, silver oxide ammonia solution

Отформатировано: По ширине, Отступ: Слева: 1 см, Выступ: 2,25 см

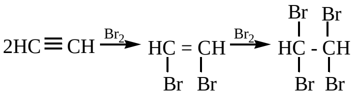
The end of the exhaust pipe (previous experience) is alternately passed into three pre-prepared test tubes containing 1) 1% solution of potassium permanganate, 2) bromine water, 3) ammonia solution of copper (I) chloride.

1. when passing acetylene through a 1% solution of potassium permanganate, discoloration of the solution is observed:



2. when passing acetylene through a solution of bromine water, as in the case of potassium permanganate, discoloration of the solution is observed:

Отформатировано: По ширине



$$2HC\equiv CH \xrightarrow{Br_2} \underset{Br}{HC}=\underset{Br}{CH} \xrightarrow{Br_2} \overset{Br}{\underset{Br}{HC}}-\overset{Br}{\underset{Br}{CH}}$$

3. By passing acetylene through an ammoniacal solution of copper chloride (I) to observe the deposition of red precipitate of copper acetylenide:

$$HC\equiv CH + 2CuCl + 2NH_3 \longrightarrow Cu\text{-}C\equiv C\text{-}Cu + 2NH_4Cl$$

Acetylene should be passed into an ammonia solution of copper (I) chloride, since in an aqueous solution, the resulting hydrochloric acid decomposes copper acetylenide and the reaction goes in the opposite direction:

Отформатировано: По ширине

$$Cu\text{-}C{\equiv}C\text{-}Cu + 2HCl \longrightarrow CH{\equiv}CH + Cu_2Cl_2$$

In dry form, silver and copper acetylenides are explosives. They explode on impact or heat. To avoid accidents after the experiment, acetylenides must be destroyed by the action of dilute hydrochloric acid.

Отформатировано: По ширине

To test the explosive properties of copper acetylenide, it is filtered out. A wet filter with sediment is placed on another filter, then on an asbestos net or sand bath (held under a draft) and carefully heated. As it dries, there is a slight crackling sound at first, followed by a loud but safe explosion.

Control question

Отформатировано: По ширине

1. Some hydrocarbons are called alkynes?
2. What types of isomerism are characteristic of alkynes? Is CIS-or TRANS-isomerism possible for them?
3. Write the structural formula of isomers of gecina and name them in a systematic and rational nomenclature.
4. What are the main ways to get alkynes you know? Write them on the example of getting propin.
5. What is the difference in chemical properties of acetylene series hydrocarbons: a) from limit hydrocarbons, b) from ethylene series hydrocarbons? Confirm the answer with the reaction equations.
6. What type of typical reactions for alkynes?
7. How does the color of a solution of potassium permanganate and bromine water change when acetylene is passed through them?
8. What is the color of the flame during combustion of acetylene? Write the equation of the reaction of flame acetylene in air.
9. What reactions can distinguish alkynes from alkenes?
10. What are the qualitative reactions for alkynes? Explain that the CH-acidic properties of alkynes and the reasons for their manifestation.
11. Explain the hydration reaction of alkynes, Eltekov's rule.
12. What are the main applications of alkynes?

Task: To carry out the comparative characteristic of alkynes with elkanemi and alkadiene.

Отформатировано: По ширине

Technique "Cinkvain"

Option 1

Representatives	Structure	Synthesis	Joining reactions	Main common feature	Main difference
Butin-1					

Butin-2					

Option 2

Representa-tives	Structure	Synthesis	Joining reactions	Main common feature	Main difference
Butin-1					
Butadiene-1,2					

Option 3

Representa-tives	Structure	Synthesis	Joining reactions	Main common feature	Main difference
Butene-1					
Butin-1					

~~**Homework:**~~

~~Aromatic hydrocarbons.Nitration, sulfonation, bromination, toluene oxidation.~~

~~*Exercises* №1, 5, 7, 8, 9, 13, 14, 15 (pp. 72-74).~~

~~*Experiments* №24, 25, 27, 28, 31.~~

~~**Literatures:** 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 198-234~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. –~~

~~T.: "EXTREMUM", 2010. – p. 71-79.~~

LESSON №7

1. Theme: Aromatic hydrocarbon. Nitration, sulfonation, bromination,toluene oxidation

Отформатировано: По ширине

2. Class duration: 3 hours.

3. The purpose of the lesson: To develop the ability to predict the reactivity of aromatic compounds in electrophilic substitution reactions in relation to the electronic effects of substituents as a basis for understanding reactions of this type in the synthesis of drugs

4. Objectives: by the end of the lesson, the student should be able to:

4.1. write reactions of electrophilic substitution of arenes;

4.2. explain the mechanism of electrophilic substitution reactions;

4.3. compare the reactivity of arenes in electrophilic substitution reactions in relation to their substituents;

4.4. explain the effect of the substituent on the direction of the electrophilic substitution reaction;

4.5. description of electrophilic substitution reactions in the synthesis of substituted arenes;

4.6. chemical reactions of side chains of alkylbenzenes.

5. Basic training questions.

5.1. Aromaticity, criteria of aromaticity - the Hückel rule.

5.2. electrophilic substitution (S_E) reactions in the aromatic core, mechanism (π- and σ-complexes).

5.3. ways of occurrence of an electrophilic particle in the reactions of nitration, sulfonation, halogenation, alkylation and acylation. Catalytic role.

5.4. Orientants of type I and II, their influence on the direction of the electrophilic substitution reaction.

5.5. comparison of the reactivity of benzene and toluene, benzene and phenol, benzene and nitrobenzene, benzene and benzoic acid in electrophilic substitution reactions.

5.6. Consistent and inconsistent orientation.

5.7. use of electrophilic substitution reactions in the synthesis of substituted arenes - halogenation, nitration, sulfonation, Friedel-crafts reactions (alkylation and acylation).

5.8. Reactions of the side chains of alkylbenzenes - oxidation, radical substitution in the side chain).

6. Self-study (performed in preparation for the lesson).

Electrophilic substitution reactions in condensed arenes.

7. Demonstration.

Videos of the virtual laboratory – "Gorenje benzene", "Bromination of benzene and toluene", "Nitration of benzene", "the ratio of benzene to bromine water and potassium permanganate solution", "chlorination of benzene (production of hexachlorane)".

PRACTICUM

Experience 1. ~~preparation~~ Preparation of benzene and its nitration

Reagents: sodium benzoate, sodium lime, concentrated nitric and sulfuric acids

In a mortar, carefully grind 2 g of sodium benzoate and 2 g of sodium lime (NaOH + CaO), the mixture is mixed well before grinding, the mixture is poured into a test tube, which is closed with a plug with a gas outlet tube. The lower end of the tube enters the tube with 2 drops of concentrated nitric acid and 3 drops of concentrated sulfuric acid. The test tube is placed in a tripod and begin to heat - first carefully, then more strongly.

Отформатировано: По ширине

$$C_6H_5COONa + NaOH \rightarrow C_6H_6 + Na_2CO_3$$

After a few minutes, a dark drop of nitrobenzene is observed in the test tube above the nitrating mixture layer. Heating is stopped. 8-10 drops of water are added to the test tube with the nitrating mixture and the resulting solution is shaken. Determine the presence of nitrobenzene by smell, feel the smell of bitter almonds, confirming the formation of nitrobenzene.

Отформатировано: По ширине

$$C_6H_6 + HNO_3\,(H_2SO_4) \rightarrow C_6H_5NO_2 + H_2O$$

After opening the test tube with the starting substances, they smell benzene.

Отформатировано: По ширине

Experiment 2. Burn benzene

Отформатировано: английский (США)

Reagents: benzene

The experiment is carried out in the fume hood!

A small amount of benzene is poured into a porcelain Cup or crucible and set on fire with a burning splinter or rolled paper. Benzene ignites and burns with a highly smoky flame.

Отформатировано: По ширине

Experience 3. Bromation of benzene and toluene

Reagents: benzene, toluene, bromine water, bromine, iron shavings

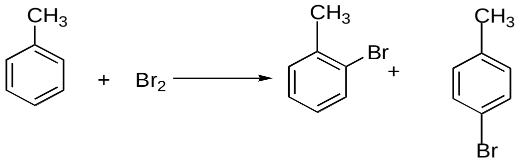
Отформатировано: По ширине

1. Equal volumes of benzene and bromine water are poured into the test tube. The mixture is shaken. After settling, the benzene floats above the water, the lower water layer discolors, and the benzene turns yellow. There is a dissolution of bromine in benzene, the incorporation of bromine at double bonds does not occur.

But after the addition of iron shavings (catalyst), the hydrogen substitution reaction of benzene occurs to form brombenzene (heavy liquid) and p-dibromobenzene (solid).

$$C_6H_6 + Br_2 \xrightarrow{Fe} C_6H_5Br + HBr$$

2. Put 2 ml of toluene in a test tube and add a few drops of bromine solution. After shaking, the orange color of the bromine water disappears and the release of hydrogen bromide is observed, which can be detected at the opening of the test tube by the redness of the litmus paper moistened with water.

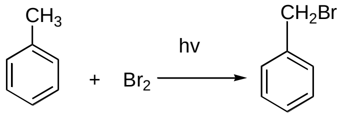


Toluene, due to the presence of a radical, more easily enters into substitution reactions.

Отформатировано: По ширине

3. pour 5 ml of toluene and 1 ml of bromine into a test tube fixed in a tripod. The upper half of the column of the reaction mixture is wrapped in black paper, and the lower half is illuminated with an electric lamp at a distance of several centimeters. After a few minutes, stop lighting and remove the black paper. Where the liquid was exposed to light rays, the bromine discolored, and the color remained in the upper part of the test tube.

Bromination of toluene when heated and exposed to light results in the substitution of side chain hydrogen to form benzyl bromide.



Experience 4. The action of potassium permanganate in benzene and toluene

Reagents: benzene, toluene, xylene, 0.1% solution of potassium permanganate, 10% solution of sulfuric acid

Отформатировано: Отступ: Слева: 0 см, Выступ: 2 см

1. In a test tube with 2-3 ml of benzene, add 0.5 ml of a 0.1% solution of potassium permanganate and 1-2 drops of 10% sulfuric acid. When shaken and heated, the color does not change, which indicates the stability of the benzene core with respect to oxidants.

2. Pour 1-2 ml of toluene (xylene) into a test tube, add 0.5 ml of a 0.1% solution of potassium permanganate and 1-2 drops of 10% sulfuric acid. When shaken and heated, the color of the solution disappears and manganese dioxide is released. The side chain is then oxidized to a carboxyl group and benzoic acid is formed.

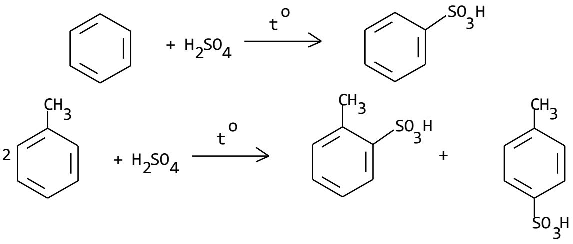
$$C_6H_5CH_3 + [O] \rightarrow C_6H_5COOH$$

Experience 5. Sulfonation of benzene and toluene

Reagents: benzene, toluene, concentrated sulfuric acid

Separately, 1 ml of benzene and toluene is poured into two dry test tubes, then 4 ml of concentrated sulfuric acid is added to each tube. Test tubes are heated in a water bath with frequent vigorous shaking. A test tube containing benzene is heated more carefully so that it does not evaporate.

The gradual disappearance of the emulsion in the test tubes and the formation of homogeneous solutions are observed. After cooling the reaction mass, the contents of each test tube are poured into glasses of cold water. There is no organic layer above the water, which indicates complete sulfonation of hydrocarbons (sulfonic acids are highly soluble in water).



Control question

1. Which hydrocarbons are called arenas?

2. What types of isomerism are possible for arenes? Give the isomers of ethylbenzene and name them.

3. What methods of obtaining benzene and its homologues do you know? Write the corresponding reaction equations.

4. What chemical reaction is able to enter the arena?

5. Explain the mechanism of electrophilic substitution reactions in arenes, the formation of σ - and π-complexes.

6. Explain the effect of substituents on the reactivity of arenes in electrophilic substitution reactions.

7. Which substituents are orientants of the first kind? Explain to them directing the action.

8. Which substituents are orientants of the second kind? Explain to them directing the action.

9. Explain the rules orientation in the benzene derivatives.

10. Use the example of the halogenation of toluene, benzene, and nitrobenzene to explain the effect of substituents on the properties of arenes.

11. What is observed during the halogenation of benzene and toluene? What explains these observations?

12. What is observed during nitration of benzene and toluene?

13. What products are formed during sulfation of benzene and toluene?

14. Explain the ratio of benzene and its homologues to a solution of potassium permanganate. What compound is formed during the oxidation of benzene homologues?

15. What are the main areas of application of arenas?

Task: Select the reactions and specify their sequence, which can be used to obtain from acetylene a) p-nitrobenzoic acid, b) m-brombenzoic acid.

"Blitz survey"

obtaining p-nitrobenzoic acid from acetylene

Name of the reaction	Student response	Correct answer
The oxidation of toluene		
Nitration of benzene		
Nitration of toluene		
Alkylation of benzene by Friedel-Crafts		
Friedel - Crafts alkylation of nitrobenzene		
Oxidation of p-nitrotoluene		
Trimerization of acetylene		

Preparation of m-brombenzoic acid from acetylene

Name of the reaction	Student response	Correct answer
Trimerization of acetylene		
Bromination of benzene in the presence of $FeCl_3$		
Bromination of toluene in the presence of $FeCl_3$		
Bromination of benzoic acid in the presence of $FeCl_3$		
Alkylation of benzene by Friedel-Crafts		
Friedel - Crafts alkylation of brombenzene		
Bromination of toluene in the presence of $FeCl_3$		
The oxidation of toluene		
Oxidation of m-bromotoluene		

~~**Homework:**~~

~~Aliphatic and aromatic hydrocarbons, their derivatives.~~

~~**Literature:** 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic~~

~~chemistry. – Kh.: Original, 2007. – 224-234p.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. – T.: "EXTREMUM", 2010. – p. 47-79.~~

LESSON № 8

1. Theme: Aliphatic and aromatic hydrocarbons and their derivatives.

Отформатировано: английский (США)

2. Class duration: 3 hours.

3. The purpose of the lesson: to Test the level of students ' knowledge on the reactivity of aliphatic and aromatic hydrocarbons.

Отформатировано: По ширине

4. Target tasks: the student must answer test questions and individual tasks in writing.

5. Basic training questions.

5.1. Structure, isomerism and nomenclature of organic compounds.

5.2. Types of chemical bonds and mutual influence of atoms in organic compounds.

Отформатировано: По ширине

5.3. Reactions of radical substitution from tetragonal carbon atoms (alkanes and cycloalkanes).

5.4. Reactivity of alkenes and alkadienes.

5.5. Reactivity of alkynes.

5.6. Reactivity of arenes.

6. Self-study is submitted by the student in the form of an abstract on one of the topics given in the Chapter "Structure of organic compounds and condensed arenas" of the training manual for performing independent work in organic chemistry and is estimated at 2 points.

Отформатировано: По ширине

7. Handout.

Tickets that include theoretical questions and tests.

In term control questions

Alkanes

1. Write the formulas for the structural isomers of the C_6H_{14} composition, and indicate the primary, secondary, tertiary, and Quaternary carbon atoms. Name the compounds by systematic and rational nomenclature.

Отформатировано: По ширине

2. Write the formulas for the structural isomers of the C_5H_{10}composition, specify the type of isomerism in the given compounds and name them according to the systematic and rational nomenclature. Write the reaction of halogenation to dimethylethylamine.

3. Write the reaction of obtaining 2,5-dimethylhexane, isobutane: a) hydrogenation of the corresponding alkenes, b) decarboxylation of the

corresponding carboxylic acids. When obtaining a compound by the Wurz method, by - products are formed?

4. Write the reaction of obtaining isobutane by the Wurtz reaction and give the reactions of its halogenation, nitration, and sulfonation. Explain the reaction mechanism.

5. Give three methods for obtaining 2-methylpropane: a) by hydrogenation of an alkene, b) by decarboxylation of a carboxylic acid salt, and C) by the Wurtz reaction. Write the halogenation, nitration, and sulfonation reactions for 2-methylpropane.

6. Radical substitution reactions for a tetragonal carbon atom in alkanes, mechanism (for example, the isobutane halogenation reaction). Representation of the chain process.

Cycloalkane

1. Write all possible structural formulas of cycloalkanes with the General formula C_5H_{10} and name them. Give the reaction of 1,1-dimethylcyclopropane and cyclopentane with Cl_2.

Отформатировано: По ширине

2. Give the reaction of obtaining 1,1-dimethylcyclopropane by the Gustavson reaction, write the reaction of its interaction with a) H_2, b) HBr, C) Br_2. Compare its chemical properties with cyclohexane.

3. Cycloalkanes. Structure of small and simple cyclic alkanes, their specific properties: addition (for example, methylcyclopropane) and substitution (for example, cyclohexane). Explain the answer.

4. Write the hydrogenation, halogenation, and hydrohalogenation reactions for Methylcyclopentane and methylcyclopropane. Explain the nature of the reactions.

5. Give all possible isomers for cyclopentane, name them. Write the reaction of ethyl cyclopropane and cyclopentane with a) $C1_2$, b) HC1. Explain the reaction mechanism.

Alkenes

1. What types of isomers are characteristic of compounds of the ethylene series? Give the isomers of SIM. Methylethylamine and name them according to international and rational nomenclatures. Specify the ratio of isomers to each other.

Отформатировано: По ширине

2. Write all possible structural formulas of alkenes corresponding to the formula C_5H_{10}, name them according to the international and rational nomenclature. What reactions can distinguish pentene-1 from cyclopentane? Give the reaction equations.

3. Write the hydrobromination reactions of butene-1 in the presence and absence of hydrogen peroxide. Analyze the reaction mechanisms. In a reaction, the accession goes according to Markovnikov's rule?

4. For example, the propylene hydrohalogenation explain reactions of electrophilic accession alkene. Markovnikov's rule (static and dynamic approach).

5. Write the reaction for obtaining butene-1 from the corresponding Halocarbon and give the schemes of its interaction with the specified reagents: a) Br_2 (CCl_4), b) HBr, c) $KMnO_4$+ H_2O, d) $KMnO_4$+ H_2SO_4, e) O_3, H_2O.

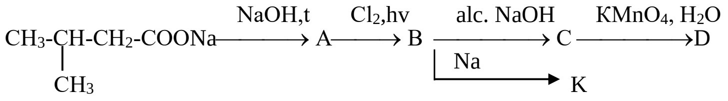
6. Write the reaction of 2-methylpropene with a) chlorine, b) hydrogen chloride, c) water.

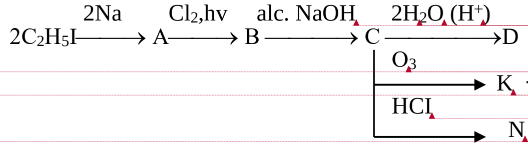
7. On the example of propylene, give the oxidation reactions of alkenes: a) $KMnO_4(H_2O)$, b) $KMnO_4(H_2SO_4)$, c) O_2 (Ag_2O), d) O_3, followed by hydrolysis. Name the resulting reaction products.

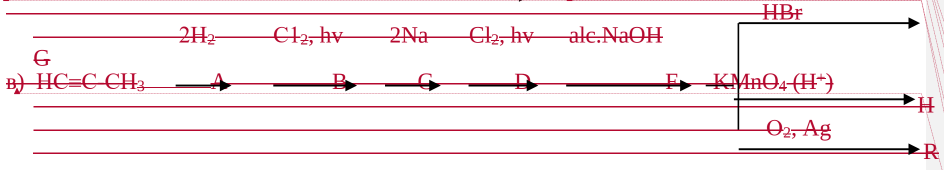
8. What reactions can be used to produce 2-methylbutene-2 from propane? For 2-methylbutene-2, write the reaction of interaction with a) HBr, b) Br_2, explain the Markovnikov rule.

9. Give the reaction of obtaining 2-methylpropene from the corresponding Halocarbon and write the reaction of its interaction with a) Br_2 (CCl_4), b) Br_2 (t), c) HBr, d) O_3, followed by hydrolysis.

10. Make up the reaction equations according to the scheme and name the resulting reaction products.

a) 

б) 



Alkynes

1. Get isopropylacetylene from the corresponding dihalogenocarbon and write the reactions of its interaction with a) H_2O, b) HBr, c) Ag_2O (NH_3) and d) hydration. Explain the mechanism (~~s~~a) of the reaction. Eltek's Rule.

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Отформатировано: По ширине

2. Write the structure of trimethylisopropylmethane, ethylethylene, and methylacetylene, and name them according to the international nomenclature. What reactions can be used to distinguish these compounds from each other? Give the appropriate reaction equations.

3. What reactions can distinguish pentane, pentene-1, and pentine-1 from pentine-2? Explain the answer with the corresponding reaction equations.

4. What sequence of reactions can produce Butin-1 from acetylene? Give the corresponding reaction equations and for butine-1 write the reaction reactions with the following reagents: a) Cu_2Cl_2 (NH_3), b)H_2O ($HgSO_4$), c) Br_2.

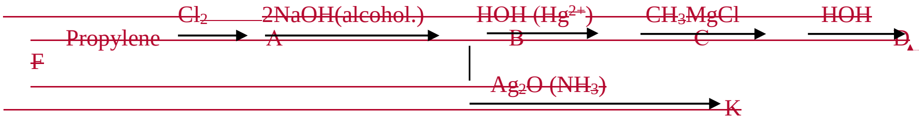
5. Write the reaction equations that can be used to perform the chemical conversion of acetylene to butine-2. What reactions can distinguish acetylene from butine-2?

6. CH-acidic nature of alkynes. Write the corresponding reaction equations. For methylethylacetylene, give the reactions of a) hydrobromination, b) Kucherov, C) bromination.

7. From Butin-1, get Butin-2. With some reactions it is possible to distinguish these two compounds. Give all appropriate responses. Explain the CH-acidity of alkynes.

8. Give all possible isomers for butylacetylene, name them according to international and rational nomenclature. Write the reaction of butylacetylene with a) HCl, b) H_2O (Hg^{2+}).

~~9. Make the reaction equations according to the scheme and name the resulting reaction products.~~



Отформатировано: английский (США)

Alkadiene

1. Give the structural formulas of alkadiens with the General formula C_5H_8 name them according to the international nomenclature. Specify the types of dienes. Write the reaction of pentadiene-1,3 with a) bromine, b) hydrogen bromine.

Отформатировано: По ширине

2. The types of diene hydrocarbons. Specific properties of conjugated dienes (for example, halogenation, hydrogenation, and hydrohalogenation of pentadiene-1,3).

3. List all possible isomers of pentadiene-1,3 and name them by systematic nomenclature. Cumulated, conjugated, and isolated dienes.Their commonality and differences. Explain the answer using the appropriate responses.

4. Give all the possible isomers for 2-methylbutadiene-1,3, name them according to the international nomenclature. For 2-methylbutadiene-1,3, give the reaction with a) Cl_2, b) HCl, c) maleic anhydride (Diels-alder reaction).

Aromatic hydrocarbon

1. Criteria of aromaticity in the ring the Huckel rule. Write the reaction of benzene and toluene with a) Cl_2 ($FeCl_3$), b) CH_3Cl ($FeCl_3$). Using toluene as an example, explain the effect of the CH_3 group in electrophilic substitution reactions.

Отформатировано: По ширине

2. Criteria of aromaticity Huckel limiting law were. Give the reaction of halogenation of benzene, toluene and benzoic acid. Explain the effect of substituents on piercing the electrophilic substitution reaction.

3. System with closed-loop interface circuit. Structure of benzene.Aromaticity and its criteria. Huckel's Rule. Give the mechanism of the reaction of nitration of benzene.

4. Proceeding from benzene and other reagents necessary, propose the scheme of synthesis of p-chloronitrobenzene. Explain the orientation in the resulting compound and write the reaction of its halogenation.

5. Give methods for obtaining ethylbenzene by a) the Wurtz-Fittig reaction and b) Friedel-Crafts. Write the reactions of alkylation and acylation of ethylbenzene, explain the role of the catalyst in these reactions.

6. Give a method for obtaining isopropylbenzene by the Friedel-Crafts reaction. Under what conditions should isopropylbenzene bromination reactions be performed to introduce a halogen atom into the aromatic core and side carbon chain? Give the appropriate schemes and mechanisms of the reaction.

7. Influence of electron-donating and electron-acceptor substituents on the reactivity of the aromatic ring in electrophilic substitution reactions (for example, sulfonation and halogenation of phenol and benzoic acid).

8. Consistent and inconsistent orientation in the arenas. Give the reaction for the nitration of p-hydroxybenzaldehyde and m-methylbenzoic acid. Explain the reason for the formation of the resulting products, and indicate the inductive and mesomeric effects in the above compounds.

9. Using the example of the halogenation of phenol, benzene, and benzoic acid, explain the effect of substituents in the electrophilic substitution reactions of aromatic hydrocarbons. Orientati I, type II.

10. Write the reaction of toluene with a) Cl_2 ($FeCl_3$), b) CH_3COCl ($FeCl_3$), the reaction mechanism. Explain the influence of the CH_3 group in electrophilic substitution reactions.

~~**Homework:**~~

~~Organic halogen-containing compounds. Preparation of ethyl chloride, iodoform, and chloroform and their properties.~~

~~*Exercises* №2, 3, 5, 7, 8, 11, 12, 13, 14 (pp. 83-84).~~

~~*Experiments*№32, 33, 36, 37.~~

~~**Literatures**: 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 250-277.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. –~~

~~T.: "EXTREMUM", 2010. – p. 79-89.~~

LESSON № 9

Отформатировано: английский (США)

1. Theme: Organic halogen-containing compounds. Synthesis of ethyl chloride, iodoform, and chloroform and their properties.

Отформатировано: По ширине

Отформатировано: английский (США)

2. Class duration: 3 hours.

3. The purpose of the lesson: To develop the ability to predict the reactivity of halogen-derived hydrocarbons depending on the structure of the radical and the type of reaction.

Отформатировано: По ширине

4. Objectives: by the end of the lesson, the student should be able to:

4.1. write reactions for obtaining halogen-derived hydrocarbons;

4.2. write the reaction of substitution of halogenated derivatives of hydrocarbons;

4.3. chemical reactions of elimination of halogen-derived hydrocarbons;

4.4. explain the mechanisms of monomolecular and bimolecular substitution and elimination;

4.5. predict the reactivity of halogen-derived hydrocarbons;

4.6. predict the stereochemical result of the substitution reaction.

5. Basic training questions.

5.1. classification of halogen-derived hydrocarbons depending on the nature of the hydrocarbon, the nature of the halogen, the number of halogen atoms and the type of carbon atom associated with the halogen.

5.2. distribution of the electron density of the carbon-halogen bond, the ability of the carbon atom to be attacked by a nucleophilic reagent.

5.3. Molecular weight of the reaction. Mechanism of bimolecular nucleophilic substitution (S_N2) on the example of ethyl chloride hydrolysis reaction.

5.4. The mechanism of unimolecular nucleophilic substitution (S_N1), for example, the hydrolysis of tert.butyl chloride.

5.5. Factors determining the reaction mechanism for S_N1 and S_N2: the structure of the radical, nature nucleophile and solvent.

5.6. nucleophilic substitution reactions: hydrolysis, alcoholism, ammonolysis, aminolysis, acetolysis, formation of nitriles, nitro compounds, Grignard reagents, indicating the most likely reaction mechanism and stereochemical result.

5.7. Elimination. Mechanism E_1 and E_2.Zaitsev's Rule.

5.8. competitiveness of elimination and nucleophilic substitution reactions: factors determining the preferred direction of the reaction.

5.9. explanation of the different reactivity of vinyl chloride and allyl chloride, chlorobenzene and benzyl chloride in nucleophilic substitution reactions based on the mutual influence of atoms.

6. Self-study (performed in preparation for the lesson).

Halogen derivatives of aliphatic and aromatic hydrocarbons – isomerism, nomenclature, methods of preparation (halogenation of alkanes, cycloalkanes, benzene and its homologues, alkenes; hydrohalogenation of alkenes, alkynes; alcohol substitution reactions; haloform reaction), their significance for the synthesis of various classes of organic compounds.

7. Demonstration.

Video of the virtual laboratory – "obtaining chloroform", multimedia – "Bimolecular nucleophilic substitution".

Отформатировано: По ширине

PRACTICUM

Experience 1. Getting chlorethane from ethanol

Reagents: ethyl alcohol, concentrated sulfuric acid, sodium chloride.

Sodium chloride is placed in a test tube at a height of about 3 mm and 5 drops of ethanol are added. After wetting the salt with ethanol, 4 drops of concentrated sulfuric acid are added. The test tube is closed with a plug with a gas outlet tube and carefully heated on a low flame of the burner, avoiding rapid release of hydrogen chloride. Periodically, the opening of the test tube is brought to the burner flame. The released chloroethane lights up, forming a green ring (typical for lower haloalkanes).

Отформатировано: По ширине

$$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

$$C_2H_5OH + HCl \rightleftarrows C_2H_5Cl + H_2O$$

Experience 2. Getting iodoform

Reagents: ethyl alcohol, iodine solution in potassium iodide, 10% sodium hydroxide solution.

In a small conical flask, add 1 ml of ethyl alcohol, 1 ml of a solution of iodine in potassium iodide and 2-3 ml of a 10% solution of sodium hydroxide. The reaction mixture is slightly heated. At the same time, the color of iodine disappears, a characteristic smell is felt, and a pale yellow haze appears. When the solution is cooled, yellow needle-like crystals of iodoform fall out. If the turbidity disappears, another 1-2 ml of iodine solution is added to the warm reaction mixture while stirring.

Отформатировано: По ширине

$$CH_3CH_2OH + I_2 + NaOH \xrightarrow{\qquad} CHI_3 + HCOONa + H_2O + NaI$$

Experience 3. Properties of chloroform

Reagents: chloroform, solution of iodine in potassium iodide, resorcinol, 10% solution of sodium hydroxide

1. In a test tube, mix 1 ml of chloroform with 1 ml of water. Close the tube with a cork and shake thoroughly. When settling, 2 layers are formed, since chloroform is practically insoluble in water.

Отформатировано: По ширине

2. Pour 1 ml of chloroform into a test tube and add a few drops of iodine solution in potassium iodide, shake the mixture, and after a while the lower layer turns pink. Chloroform is a good solvent for many substances. It dissolves iodine well, so when shaken, the iodine passes from the water layer to chloroform, staining it pink.

3. Put 2-3 ml of water, 0.5 ml of chloroform, several resorcinol crystals and 1 ml of a 10% solution of sodium hydroxide in a test tube. When boiling, the reaction mass turns red. This reaction is qualitative to chloroform.

Control question

1. What compounds are called halogen derivatives of hydrocarbons?

Отформатировано: По ширине

2. What are the criteria for classifying halogen-derived hydrocarbons?
3. What compounds are formed during the halogenation of alkanes, cycloalkanes and aromatic hydrocarbons? Give the reaction equations and name the substances obtained.
4. What compounds are formed during the halogenation and hydrohalogenation of alkenes, alkadiens and alkynes? Give the reaction equations and name the substances obtained.
5. Explain the distribution of the electron density of the carbon-halogen bond and the ability of the carbon atom to be attacked by a nucleophilic reagent.
6. What types of reactions are typical for haloalkanes?
7. Name the factors that Cause the reaction to proceed by the S_N1 and S_N2 mechanism.

8. Explain the mechanism of bimolecular nucleophilic substitution (S_N2) using the example of ethyl chloride hydrolysis.

9. Explain the mechanism of monomolecular nucleophilic substitution (S_N1) by the example of tert hydrolysis.butyl chloride.

10. What are the reactions of halocarbons related to the nucleophilic substitution reaction? Given example.

11. What is elimination? Explain its mechanism.

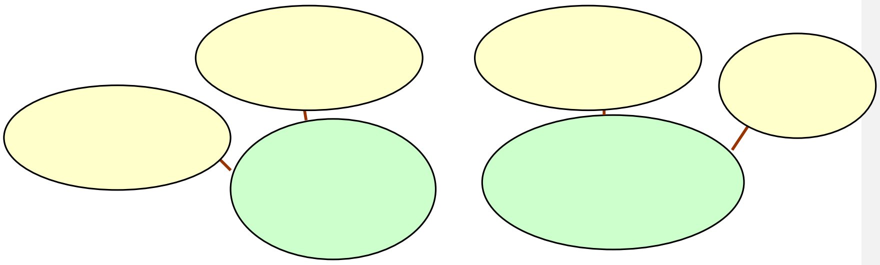
12. What are the factors that determine The preferred direction of nucleophilic substitution and elemination reactions?

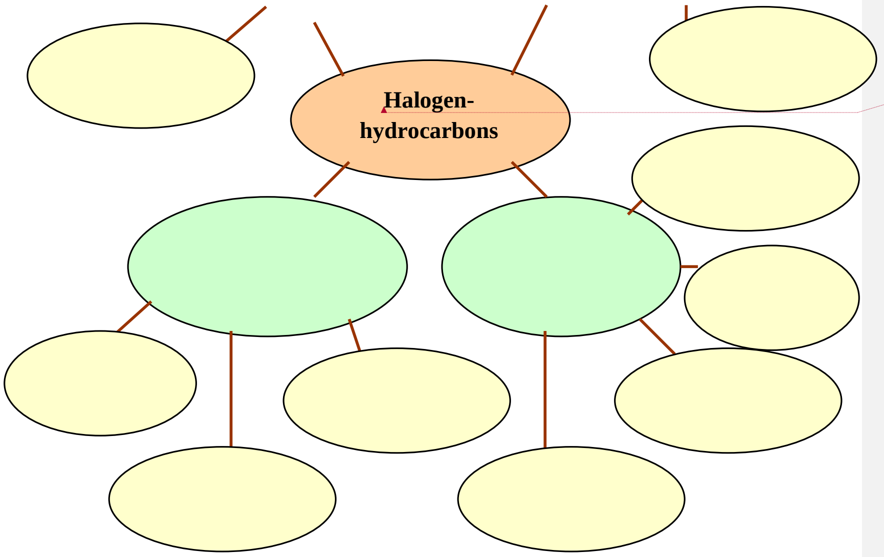
13. What is the reactivity of the halogen in the vinyl chloride and allyl chloride molecules?

14. How does halogen affect the electrophilic substitution reactions in the benzene ring? Its orienting action.

Task: Create a cluster on the topic "classification of halogen-derived hydrocarbons»

Отформатировано: По ширине





~~**Homework:**~~
~~Alcohols and esters.Properties of ethyl alcohol, glycerol, and diethyl ether.~~
~~*Exercises* №2(a,b), 5, 10, 15, 18(b) (p. 92); 2, 4, 10, 14 (p. 98).~~
~~*Experiments* №44, 45, 46, 47, 48, 49, 51, 54, 55.~~

~~**Literature:** 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 332-347, 363-376.~~
~~2. Karimov A., Chinibekova N. Practicum on organic chemistry.~~

~~T.: "EXTREMUM", 2010. – p. 89-106.~~

Lesson № 10

1. Theme: Alcohols and esters. Properties of ethyl alcohol, glycerol, and diethyl ether.

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form knowledge of the reactivity of monatomic alcohols and phenols in relation to their structure, knowledge of acidity and basicity, which determine many physical, chemical and biological properties of organic compounds.

4. Objectives: by the end of the lesson, the student should know:

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Отформатировано: английский (США)

Отформатировано: По ширине

Отформатировано: английский (США)

4.1. the main provisions of the theory of acids and bases of Brensted and Lewis;

4.2. comparative acid-base properties of monatomic alcohols and phenols;

4.3. reactions for obtaining monatomic alcohols and phenols;

4.4. General and distinctive chemical properties of monatomic alcohols and phenols;

4.5. qualitative reactions to determine the presence of phenolic hydroxyl.

5. Basic training questions.

5.1. The concept of acid-base properties of organic compounds. The theory of Bronsted-Lewis acids and bases Lewis.

5.2. Hydrogen bonding and its effect on the physical properties of alcohols.

5.3. Chemical properties of Monohydric alcohols.

5.3.1. Acid-base properties of monatomic alcohols.

5.3.2. The reaction of esterification. Comparison of the nucleophilic properties of primary, secondary and tertiary alcohols.

5.3.3. The reaction of nucleophilic substitution of alcohols with hydrohalic acids. Monomolecular and bimolecular mechanisms of the nucleophilic substitution reaction.Factors contributing to the reaction by the S_N1 and S_N2 mechanism.

5.3.4. the Lucas test is the reaction of alcohols with a solution of zinc chloride in hydrochloric acid, which makes it possible to distinguish between primary, secondary and tertiary alcohols.

5.3.5. Interaction of alcohols with halides of phosphorus.

5.3.6. Of intermolecular and intramolecular dehydration of alcohols.

5.3.7. The oxidation of alcohols.

5.4. Chemical properties of Monohydric phenols.

5.4.1. The acidic properties of phenols compared with alcohols.

5.4.2. Receiving a simple phenyl esters by the reaction of phenolates with halogenated derivatives of hydrocarbons.

5.4.3. Qualitative reactions on the phenolic hydroxyl.

5.4.4. Reactions of electrophilic substitution of phenols (halogenation, nitration, sulfonation).

6. Self-study (performed in preparation for the lesson).

Methods for obtaining monatomic alcohols and phenols.Unsaturated aliphatic and aromatic alcohols.

7. Demonstration.

Videos virtual lab – "Interaction of alcohols with metallic sodium", "Interaction of ethanol with bromovalerate", "positive reaction to ethanol", "ethanol Combustion", "Oxidation of alcohols", "Interaction of phenol with sodium hydroxide", "Interaction of phenol with bromine in water", "Qualitative reaction for phenol"; multimedia "Monohydric alcohols", "Phenol".

PRACTICUM

Experience 1. Obtaining the alcoholate of sodium

Reagents: absolute ethyl alcohol, metallic sodium.

In a dry test tube pour 2-3 ml of absolute ethyl alcohol, add a piece of metallic sodium, pre-dried with filter paper and close the opening of the test tube with a plug with a gas outlet tube. Rapidly released hydrogen is collected by covering the test tube with a cork:

Отформатировано: По ширине

$$2CH_3CH_2OH + 2\ Na \longrightarrow 2\ CH_3CH_2ONa\ + H_2\uparrow$$

Отформатировано: английский (США)

Отформатировано: английский (США)

The test tube is brought to the burner flame through the hole. Gorenje mixture of hydrogen and air is accompanied by a characteristic sound – a pop.

At the end of the reaction, water is added to the alcohol solution and the solution is tested on red litmus paper, which turns blue when the alcoholates decompose with water due to the formation of alkali.

$$CH_3CH_2ONa\ +\ HOH \longrightarrow CH_3CH_2OH + NaOH$$

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Отформатировано: английский (США)

Experience 2. Oxidation of ethyl alcohol

Reagents: ethyl alcohol, 1% solution of potassium permanganate, sodium hydroxide solution, chromium mixture (10% solution of sulfuric acid and 5% solution of potassium bichromate), fuchsinsernic acid.

Отформатировано: По ширине, Отступ: Слева: 1 см, Выступ: 2 см

In three test tubes and pour 1-2 ml of ethyl alcohol, then in the first test tube add 2 drops of 1% alkaline potassium permanganate solution, the second 1 ml of chromic mixture, in the third – down a spiral of copper wire heated in flame before the appearance of the black coating of the oxide of copper.

Отформатировано: По ширине

The black surface of the spiral dropped into the third tube immediately turns Golden due to the reduction of copper oxide. At the same time, there is a characteristic smell of acetic aldehyde (the smell of apples).

$$CH_3CH_2OH + CuO \xrightarrow{t^0} CH_3CHO + Cu\downarrow + H_2O$$

Отформатировано: Шрифт: 12 пт

Отформатировано: английский (США)

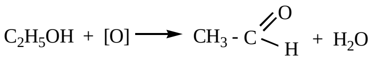
Отформатировано: Шрифт: 12 пт

The first and second test tubes are heated over the burner flame. You can smell acetic aldehyde.

Отформатировано: По ширине

In the first test tube, the solution discolors and a brown precipitate of manganese dioxide falls out.

$$KMnO_4 \xrightarrow{H_2O} \downarrow MnO_2 + KOH + [O]$$



$$C_2H_5OH + [O] \longrightarrow CH_3-C\overset{O}{\underset{H}{<}} + H_2O$$

In the second test tube, the orange color of the mixture quickly turns green.

$$K_2Cr_2O_7 + H_2SO_4 \longrightarrow KCr(SO_4)_2 + H_2O + [O]$$

$$CH_3CH_2OH + [O] \longrightarrow CH_3CHO + H_2O$$

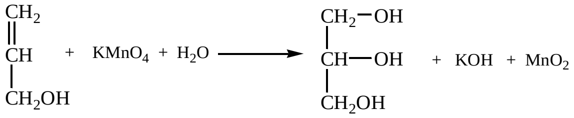
To confirm the formation of acetic aldehyde, 2-3 drops of fuchsin-sulfuric acid are added to all three test tubes. A pink-purple color appears (color reaction to aldehyde).

Experience 3. Interaction of allyl alcohol with bromine water and potassium permanganate

Reagents: ethyl, allyl alcohols, bromine water, 0.5% solution of potassium permanganate

In two prepared test tubes with 1) 1 ml of bromine water and 2) 1 ml of potassium permanganate solution, add a few drops of a highly dilute aqueous solution of allyl alcohol.

$$CH_2=CH-CH_2OH + Br_2 \longrightarrow CH_2Br-CHBr-CH_2OH$$



$$CH_2=CH-CH_2OH + KMnO_4 + H_2O \longrightarrow CH_2OH-CHOH-CH_2OH + KOH + MnO_2$$

Solutions in test tubes are instantly discolored, which proves the unsaturated nature of allyl alcohol.

Experience 4. The formation of sodium phenolate and the decomposition of acid on it

Reagents: crystalline phenol, 10% sodium hydroxide solution, 10% hydrochloric acid solution

About 0.5 g of crystalline phenol is placed in a test tube and 5 ml of 10% sodium hydroxide solution is added. The phenol is completely dissolved to form a clear solution of sodium phenolate.

$$C_6H_5OH + NaOH \longrightarrow C_6H_5ONa + H_2O$$

Phenol is a weak acid, so it is easily soluble in alkalis.

In a test tube with a clear solution of sodium phenolate, add 1-2 drops of a 10% solution of hydrochloric acid, observe the turbidity of the liquid due to the release of free phenol:

Отформатировано: английский (США)

Отформатировано: английский (США)

Отформатировано: По ширине

Отформатировано: По ширине

Отформатировано: По ширине

Отформатировано: По ширине, Отступ: Слева: 1 см, Выступ: 2,25 см

Отформатировано: По ширине

$$C_6H_5ONa + HCl \rightleftarrows C_6H_5OH + NaCl$$

Phenolates, as compounds formed by a weak acid, are decomposed by stronger acids.

Experiment 5. Color reaction of phenol with iron (III) chloride

Reagents: 1% aqueous solution of phenol, 1% solution of iron (III) chloride~~,~~

2 ml of 1% aqueous solution of phenol is placed in a test tube and several drops of 1% solution of iron (III) chloride are added. A solution of phenol forms an intense purple staining.

Отформатировано: По ширине

$$C_6H_5OH + FeCl_3 \longrightarrow (C_6H_5O)_3Fe$$

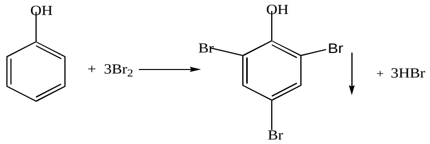
The reaction with iron (III) chloride is a qualitative reaction to phenols.

Experience 6. The interaction of phenol with bromine

Reagents: phenol,bromine water

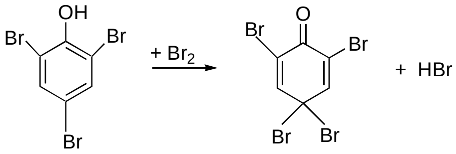
A bromine solution is added drop by drop to several phenol crystals in a dry test tube. The release of a white precipitate of 2,4,6-tribromphenol is observed, bromine quickly discolors in the cold and hydrogen bromide is released in copious amounts:

Отформатировано: По ширине



With the subsequent addition of excess bromine water, the white precipitate is transformed into light yellow-due to the oxidation of 2,4,6 - tribromphenol and the formation of 2,4,4,6-tetrabromocyclohexadiene-2,5-one-1.

Отформатировано: По ширине



The hydroxyl group in the phenol molecule, exerting a strong electron-donating effect, activates the benzene ring in the bromination reaction and promotes simultaneous substitution of hydrogen atoms at positions 2,4,6 in the absence of a catalyst. This reaction is used to identify phenols with free o - and p-positions.

Отформатировано: По ширине

Experience 7. The action of potassium permanganate on phenol

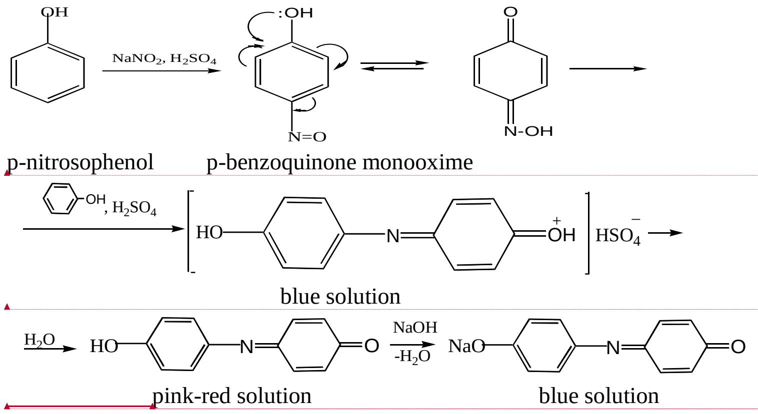
Reagents: 1% phenol solution, 5% sodium carbonate solution, 1% potassium permanganate solution

To the solution of phenol in a test tube, add half the amount of 5% sodium carbonate solution and, with vigorous shaking, dig in a solution of potassium permanganate. The solution quickly discolors due to the easy-going liquefaction of the phonol to form a complex mixture of oxidation products.

Experience 8. Nitroso reaction on phenols (reaction Liebermann)

Reagents: 10% phenol solution, 10% sodium nitrite solution, concentrated sulfuric acid, 5% sodium hydroxide.

0.5 ml of concentrated sulfuric acid, 2-3 drops of 10% phenol solution and 1 drop of 10% sodium nitrite solution are placed in a test tube. When shaken, the mixture turns blue-purple. The colored mixture is poured into a glass with 5 ml of water – a pink-red color of the solution appears. When a 5% solution of sodium hydroxide is added, the solution turns blue:



The reaction is based on the condensation of phenol (p-benzoquinone monooxime) with an excess of phenol in the presence of concentrated sulfuric acid. The resulting indophenol belongs to the group of quinonimine dyes and changes color depending on the pH of the medium. The Liebermann reaction is typical for phenols unsubstituted in the o - and p-positions.

Experience 9. The interaction of phenol with diluted nitric acid

Reagents: phenol, dilute nitric acid.

Отформатировано: По ширине, Отступ: Слева: 1 см, Выступ: 2 см

Отформатировано: По ширине

Отформатировано: По ширине, Отступ: Слева: 1 см, Выступ: 2 см

Отформатировано: По ширине

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

Отформатировано: английский (США)

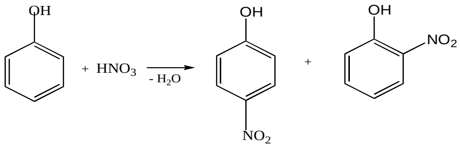
Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

Отформатировано: По ширине

Отформатировано: По ширине

In a test tube with water, a small amount of phenol is dissolved until a homogeneous oily liquid is formed. In another test tube, 2 ml of concentrated nitric acid and 3 ml of water are mixed during cooling. Dilute (1:1) acid very slowly, then drop by drop, is added to the phenol, all the time strongly shaking and cooling the test tube. The reaction is strong. Adding all the acid, pour the reaction mixture into three times the volume of water, shake. At the bottom of the Cup, a heavy oil is released, which is a mixture of o - and p-nitrophenols.



Отформатировано: По ширине

The substitution reaction of phenols is easier than that of aromatic hydrocarbons. Therefore, the phenol nitration reaction also occurs under the action of dilute nitric acid.

Control question

1. What compounds are called Lewis acids and bases?
2. Formulate the theory of Bronsted-Lewis.
3. What compounds are called alcohols?
4. What groups are alcohols divided into?

Отформатировано: По ширине

5. What types of isomers are characteristic of Monohydric alcohols? Write isomers for butyl alcohol and name them according to all possible nomenclatures.
6. What methods of obtaining monatomic alcohols do you know?
7. What chemical properties are characteristic of monatomic alcohols?

Отформатировано: По ширине

8. What reactions can be used to prove the acid-base properties of monatomic alcohols? Give your reactions.
9. How do the acid-base properties change in a number of primary, secondary and tertiary alcohols?
10. How can primary, secondary and tertiary alcohols be distinguished from each other?
11. How does the rate of the esterification reaction change in a number of primary, secondary and tertiary alcohols?
12. What is the mechanism of the substitution reaction in monatomic alcohols?
13. What compounds are formed when alcohols react with copper (II) oxide, potassium permanganate solution, and chromium mixture? What process is observed in this case?
14. With the help of what reagent it is possible to determine the presence of double bond in unsaturated alcohols?

15. What is the sequence of reactions that allows you to obtain phenol by the cumol method?

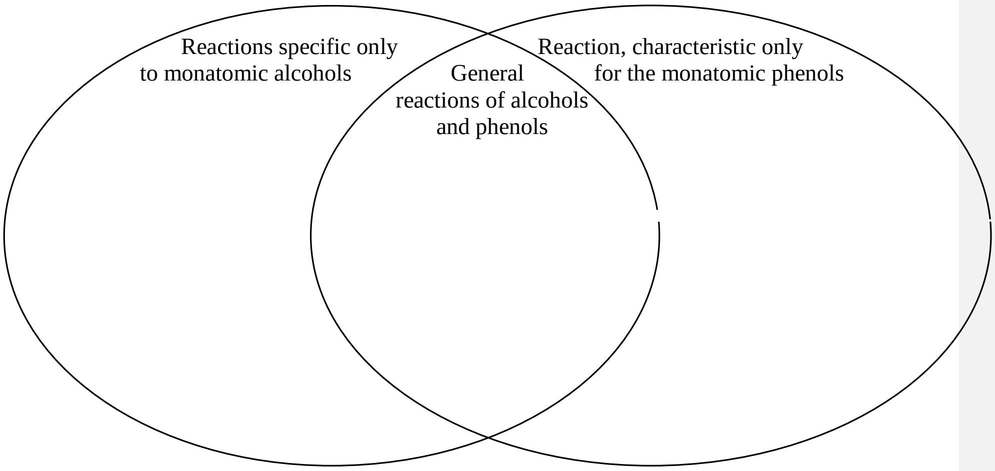
16. Compare the acidic properties of phenols with alcohols.

17. What are the qualitative reactions to phenol?

18. How does phenolic hydroxyl affect the electrophilic substitution reactions of the benzene ring?

19. What compounds are formed when nitrating phenol with concentrated and dilute nitric acid?

Chemical properties of alcohols and phenols



~~Homework~~:

~~Phenols.Properties of phenols.~~

~~*Exercises* №6, 13, 14, 16, 18(C) (page 93); 15, 17 (page 99); 5, 6, 8 (page 108).~~

~~*Experiments* №50, 54, 56, 64, 66,~~

~~Literature~~: ~~1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 348-357, 377-380, 384-390.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry.~~

~~T.: "EXTREMUM", 2010.   p. 89-111.~~

LESSON № 11

Отформатировано: английский (США)

1. Theme: Phenols. Properties of phenols.

Отформатировано: английский (США)

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form knowledge of the reactivity of polyatomic alcohols, phenols and esters in relation to their structure.

Отформатировано: По ширине

4. Objectives: by the end of the lesson, the student should be able to:

4.1. write reactions for obtaining polyatomic alcohols, phenols, and esters;

Отформатировано: По ширине

4.2. qualitatively compare the acid-base properties of polyatomic alcohols, phenols, and esters;

4.3. describe the chemical properties of polyatomic alcohols, phenols, and esters;

4.4. be able to perform characteristic and specific reactions of polyatomic alcohols, phenols, and esters.

5. Basic training questions.

5.1. Polyatomic alcohols.

5.1.1. comparison of acidic properties of polyatomic alcohols with monatomic alcohols: reactions with sodium and copper (II) hydroxides (qualitative reaction to polyatomic alcohols).

Отформатировано: По ширине

5.1.2. The reaction of polyhydric alcohols with mineral (HNO_3, H_2SO_4) and carbonic acids.

5.1.3. substitution reaction characteristic of polyatomic alcohols, interaction with HCl, HBr, PCl_5, PCl_3.

5.1.4. The reaction of intramolecular dehydration and oxidation of ethylene glycol and glycerol.

5.2. Polyatomic phenols.

5.2.1. Acidic properties of polyhydric phenols. Compare acidic properties of Monohydric phenols.

5.2.2. Reactions of electrophilic substitution in a polyatomic phenols.

5.2.3. Oxidation of dihydric phenols.

5.3. Simple ethers.

5.3.1. The basic properties of ethers. Formation of oxonium salts. Comparison of the main properties of esters and alcohols.

5.3.2. cleavage of esters with hydroiodic acid. Dependence of the direction of substitution on the structure of radicals.

5.3.3. The interaction of ethers with Na, H_2SO_4 and oxidation reaction.

6. Self-study (performed in preparation for the lesson).

Methods for obtaining polyatomic alcohols, phenols, and esters. Picric acid.

Отформатировано: английский (США)

7. Demonstration.

Videos of the virtual laboratory – "interaction of glycerol with sodium", "Qualitative reaction to polyatomic alcohols", "interaction of glycerol with potassium permanganate crystals", "production of plastics from resorcinol and formalin", "production of boroethyl ether"; multimedia – "Polyatomic alcohols".

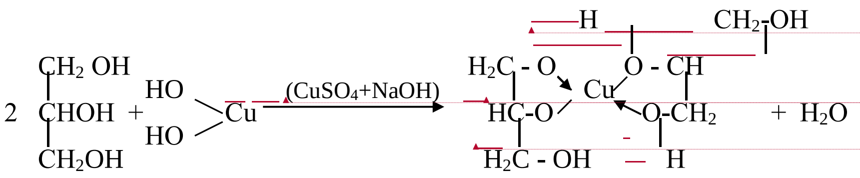
PRACTICUM

Experience 1. Interaction of polyatomic alcohols with copper (II) hydroxide

Reagents: glycerol, 5% copper sulfate solution, 10% sodium hydroxide solution.

Pour 0.5 ml of a 5% solution of copper (II) sulfate into the test tube and add 1 ml of a 10% solution of sodium hydroxide. A blue precipitate of copper (II) hydroxide falls out. When a drop of glycerol is added to the resulting mixture and shaken, the copper hydroxide precipitate dissolves, and the liquid becomes intensely blue. The dissolution of the precipitate and the change in the color of the liquid is the result of the formation of copper glycerate.

Отформатировано: По ширине



Отформатировано: русский

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

Отформатировано: английский (США)

Отформатировано: Шрифт: 7 пт

Отформатировано: Шрифт: 8 пт

Отформатировано: Шрифт: 7 пт

Отформатировано: Шрифт: 8 пт

Отформатировано: По ширине

This reaction is qualitative for polyatomic alcohols containing a α-glycol fragment in their structure. The chelate complex formed does not decompose during boiling.

Experiment 2. Color reactions of phenols with iron (III) chloride

Reagents: 1% aqueous solutions of phenols (pyracatechin, pyrogallol, hydroquinone), iron (III) chloride.

In three test tubes, 2 ml of 1% aqueous solutions of resorcinol, pyrogallol, and hydroquinone are placed and a few drops of 1% solution of iron (III) chloride are added to each tube.

Отформатировано: По ширине

In vitro with resorcinol, there is an intense violet colour in the test tube with a solution of pyrogallol – brownish-red staining, and in vitro hydroquinone – solution first turns green, then turns brown.

Experience 3. Oxidation of phenols by oxygen in alkaline medium

Reagents: 1% aqueous solutions of phenols (pyracatechin, resorcinol, pyrogallol, hydroquinone), 5% solution of sodium hydroxide.

Отформатировано: По ширине, Отступ: Слева: 1,25 см, Выступ: 2,25 см

On a strip of filter paper (20x4), apply 1-2 drops of phenol solutions (pyracatechin, resorcinol, pyrogallol, hydroquinone) at regular intervals. In the center of the resulting spots, add 1 drop of sodium hydroxide solution. In the center of each spot there is a staining: in pyrocatechin – green, in pyrogallol – dark brown, in hydroquinone – yellow with a green border. Resorcinol forms a brown colored spot after some time.

Отформатировано: По ширине

Under the influence of air oxygen, phenols can be oxidized to form a very complex mixture of colored products. The alkaline environment greatly facilitates and accelerates this process. Oxidants act simultaneously on the functional group and the benzene core of phenols, which leads to profound changes in the phenol molecule. You can't select specific products.

The ease with which the aromatic core is oxidized is the result of the influence of the hydroxyl group (benzene is oxidized with difficulty). When it interacts with the mobile π-electron system of the benzene core, the free oxygen electron pair is partially drawn into the core, increases the electron density in it, and therefore facilitates the entry into the electrophilic substitution reaction and, in particular, the oxidation reaction.

Experience 4. Preparation of diethyl ether and study of its solubility

Reagents: ethyl alcohol, concentrated sulfuric acid.

1. A mixture of equal volumes of ethyl alcohol and concentrated sulfuric acid is poured into a dry test tube. The test tube is heated in a sand bath to 130-140~~0~~° and alcohol is added very carefully, drop by drop. At the same time, the smell of diethyl ether is felt.

Отформатировано: По ширине

$$CH_3CH_2OH + HOSO_2OH \rightleftarrows CH_3CH_2OSO_2OH + H_2O$$

$$CH_3CH_2OSO_2OH + HOCH_2CH_3 \xrightarrow{130^0} CH_3CH_2OCH_2CH_3 + H_2SO_4$$

Отформатировано: английский (США)

Отформатировано: английский (США)

2. Pour 1 ml of water into one of the two test tubes, 1 ml of alcohol into the other, and add 1 ml of ether. In the first test tube, the ether floats, and in the second a homogeneous solution is formed.

Ether is lighter than water, almost does not dissolve in it. With alcohol, it is mixed in any ratio.

3. Add 0~~.~~,5 ml of vegetable oil and 2-3 ml of ether to the test tube. When shaken, the oil is easily dissolved. Ether is a good solvent. It is widely used for dissolving many organic substances. substances'.

Experience 5. Determination of the purity of diethyl ether

Reagents: live clean (standard package), the air is polluted, a solution of potassium iodide, puccinellia acid.

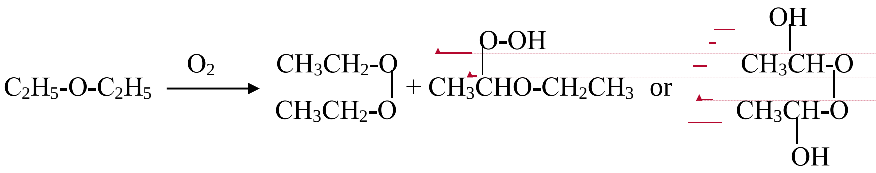
The experiment is carried out with clean and polluted ether. The ether is mixed in a test tube with a solution of potassium iodide. In this case, the contaminated ether turns yellow due to the release of iodine.

~~KJ~~ KI + HOH → H~~J~~I + KOH

~~HJ~~ HI + $C_2H_5O\text{-}C_2H_5$ → ~~J_2~~ $I_2 + H_2O + (C_2H_5)_2O$

The ether is mixed in a test tube with a solution of fuchsin sulfuric acid, if the ether is clean, staining does not appear (no acetic aldehyde).

When stored in the light for a long time in the presence of air, ethyl ether, like other esters, easily undergoes self-oxidation (auto-oxidation). The process proceeds slowly with the participation of molecular oxygen in the air, and peroxide and hydroperoxide compounds are formed.



$$C_2H_5\text{-}O\text{-}C_2H_5 \xrightarrow{O_2} \begin{matrix} CH_3CH_2\text{-}O \\ | \\ CH_3CH_2\text{-}O \end{matrix} + CH_3\overset{O\text{-}OH}{\overset{|}{C}}HO\text{-}CH_2CH_3 \text{ or } \begin{matrix} OH \\ | \\ CH_3CH\text{-}O \\ | \\ CH_3CH\text{-}O \\ | \\ OH \end{matrix}$$

Control question

1. What are the polyhydric alcohols are called? Name the appropriate connections.

2. What are the methods for producing ethylene glycol and glycerin, you know? Give the corresponding reaction equations.

3. What qualitative reaction can be used to distinguish polyatomic alcohol from monatomic alcohol?

Отформатировано: По ширине

Отформатировано: английский (США)

Отформатировано: По ширине

Отформатировано: русский

Отформатировано: русский

Отформатировано: По ширине

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Отформатировано: русский

Отформатировано: По ширине

4. What compounds are formed during the dehydration of polyatomic alcohols?

5. How do the acidic properties of the following compounds change: 1) ethyl alcohol, 2) ethylene glycol, 3) glycerol?

6. Name the phenols that belong to polyatomic phenols.

7. Compare the acidic properties of the following phenols: 1) phenol, 2) p-cresol, 3) resorcinol.

8. What reaction can be used to distinguish glycerol from resorcinol?

9. Give methods for obtaining pyrocatechin and resorcinol from benzene.

10. Explain the directing effect of hydroxyl groups of hydroquinone and resorcinol in the reactions of electrophilic substitution.

11. What organic compounds are called esters?

12. What is the name of simple ethers by substitution nomenclature?

13. Under what conditions is diethyl ether formed from ethyl alcohol?

14. With the help of what reagent it is possible to obtain diethyl ether by the reaction of Williamson?

15. Explain the acid-base properties of esters.

16. Explain why esters, having a higher molecular weight, have a lower boiling point than their corresponding alcohols?

17. What chemical properties are characteristic of esters?

18. What products are formed when splitting esters with hydroiodic acid in the cold and when heated?

Task: to conduct a comparative characterization of alcohols, phenols, and esters.

Отформатировано: По ширине

Technique "Cinquain»

Compound	Structure	Synthesis	Acid-base properties	The main common feature	Main difference
Glycol					
Resorcinol					
diethyl ether					

Отформатированная таблица

~~**Homework**:~~

~~Oxo compounds. Synthesis, oxidation and properties of aldehydes.~~

~~*Exercises* №3, 7, 9, 10, 11, 12, 15, 16, 17 (pp. 114-116).~~

~~*Experiments* №69, 70, 72, 74, 75, 77, 80, 83.~~

~~**Literatures**: 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic~~

~~chemistry. – Kh.: Original, 2007. – p. 391-423.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry.~~

~~– T.: "EXTREMUM", 2010. – p. 111-122.~~

LESSON № 12

1. Theme: Oxo compounds. Synthesis, oxidation and properties of aldehydes.

Отформатировано: По ширине

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form knowledge about the reactivity of oxo compounds depending on their structure.

Отформатировано: По ширине

4. Objectives: by the end of the lesson, the student should be able to:

4.1. write reactions for obtaining aldehydes and ketones;

4.2. explain the mechanism of nucleophilic addition of oxo compounds;

4.3. compare the reactivity of aldehydes and ketones in nucleophilic addition reactions;

4.4. compare the reactivity of aldehydes and ketones in oxidation, condensation and polymerization reactions.

4.5. write qualitative reactions to aldehydes.

5. Basic training questions.

5.1. Electronic structure of oxogroup. Comparative characteristics of C=C and C=O groups, electrophilic character of carbon.

5.2. Chemical properties of aldehydes and ketones.

5.2.1. Nucleophilic additional reactions of hydrogen, HCN, water, alcohols, sodium hydrosulfite, and the reaction mechanism.

5.2.2. reactivity of chloral, formaldehyde, acetaldehyde, dimethyl ketone, benzaldehyde and acetophenone in nucleophilic addition reactions.

5.2.3. nucleophilic addition-cleavage reactions (preparation of oximes, hydrazones, phenylhydrazones, semicarbazones, Schiff bases).

5.2.4. oxidation reactions of aldehydes and ketones (with an ammonia solution of silver oxide and copper (II) hydroxide). Reactivity of aldehydes and ketones in oxidation reactions. Popov's Rule.

5.2.5. The polymerization reaction of aldehydes, for example acetaldehyde and formaldehyde.

5.2.6. reactions related to the mobility of hydrogen in α-carbon (haloform reaction, aldol and Croton condensation).

5.2.7. The reaction of disproportionation of formaldehyde - a reaction of Cannizaro.

5.2.8. Ester condensation.

5.3. Unsaturated aldehydes, reactions of electrophilic accession.

5.4. Aromatic oxo compounds, electrophilic substitution reactions. Directing and deactivating effect of oxogroup in the reactions of S_E.

5.5. The specific properties of aromatic aldehydes.

6. Self-study (performed in preparation for the lesson).

Nomenclature, isomerism, and methods for producing aldehydes and ketones.Unsaturated aldehydes.Quinone.

Отформатировано: По ширине

7. Demonstration.

Videos of the virtual laboratory – "reaction to aldehydes with copper (II) hydroxide", "reaction of aldehydes with fuchsinsernic acid"; multimedia – "Aldehydes".

Отформатировано: По ширине

PRACTICUM

Experience 1. Obtaining formic aldehyde

Reagents: methyl alcohol

In a test tube, pour 1 ml of methyl alcohol. In the flame of the burner, red-hot copper wire is twisted into a tube. Then it is quickly lowered into a test tube with methyl alcohol. In this case, the copper oxide is reduced to metallic copper (the black surface of the spiral immediately turns Golden) and the methyl alcohol is oxidized to formic aldehyde, the presence of which is felt by smell.

Отформатировано: По ширине

$$CH_3\text{-}OH + CuO \longrightarrow H\text{-}C(O)H + Cu + H_2O$$

Paper moistened with a solution of fuchsine sulfuric acid is colored red from the formaldehyde vapors formed.

Отформатировано: По ширине

Experience 2. Obtaining acetic aldehyde and its conversion into iodoform

Reagents: ethyl alcohol, chromium mixture, fuchsin sulfuric acid, iodine solution in potassium iodide, 10% sodium hydroxide solution

In a test tube, pour 2 ml of the chromium mixture and add 1 ml of ethyl alcohol. Close the tube with a stopper with a gas outlet tube, fix it in the tripod clip and carefully heat it.

Отформатировано: По ширине

The end of the exhaust pipe is lowered into a test tube with fuchsinsernistoy acid: the solution of fuchsinsernistoy acid is colored in red-purple color and a characteristic smell of aldehyde is felt.

$$K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow 2KCr(SO_4)_2 + 4H_2O + 3O$$
$$CH_3\text{-}CH_2OH + O \longrightarrow CH_3\text{-}C(O)H + H_2O$$

Then the vapors of acetic aldehyde are passed into a test tube with a solution of iodine in potassium iodide, discolored with a 10% solution of sodium hydroxide. The characteristic smell of iodoform is felt and the formation of a lemon-yellow precipitate is observed.

Отформатировано: По ширине

$$3I_2 + 3NaOH \longrightarrow 3NaI + 3IOH$$
$$CH_3CHO + 3IOH \longrightarrow CI_3CHO + 3H_2O$$
$$CI_3CHO + NaOH \longrightarrow CHI_3 + HCOONa$$
$$CH_3CHO + 3I_2 + 4NaOH \longrightarrow CHI_3 + 3NaI + H_2O + HCOONa$$

Experience 3. Qualitative reaction for formaldehyde

Reagents: formalin, 0.5% resorcinol solution, concentrated sulfuric acid

In a wide test tube, mix 1 ml of a freshly prepared 0.5% aqueous solution of resorcinol with 1 ml of formalin. From a pipette that reaches the bottom of the test tube, 0.5-1 ml of sulfuric acid is dropped. A crimson ring is immediately formed at the boundary of the contact of liquids.

Отформатировано: По ширине

Experiment 4. Effect of copper (II) hydroxide on aldehydes

Reagents: formalin, acetic aldehyde, benzaldehyde, 5% copper (II) sulfate solution, 10% sodium hydroxide solution

In three test tubes, pour 1 ml of formalin, acetic aldehyde and benzaldehyde, add 1 ml of sodium hydroxide solution and a drop of copper (II) sulfate solution until a blue precipitate is formed.

Отформатировано: По ширине

Carefully heat the upper part of the contents of the test tubes. First , a yellow precipitate of copper (I) hydroxide appears, then a red precipitate of copper (I) oxide, and in a test tube with formalin, free copper is released, forming a copper mirror.

$$CuSO_4 + 2NaOH \longrightarrow Cu(OH)_2 + Na_2SO_4$$

1) $HCHO + 2Cu(OH)_2 \xrightarrow{t^0} HCOOH + H_2O + 2CuOH$

$$2CuOH \longrightarrow H_2O + Cu_2O \longrightarrow Cu$$

2) $CH_3CHO + 2Cu(OH)_2 \xrightarrow{t^0} CH_3COOH + H_2O + 2CuOH \xrightarrow[-H_2O]{} Cu_2O$

3) $C_6H_5CHO + 2Cu(OH)_2 \xrightarrow{t^0} C_6H_5COOH + H_2O + 2CuOH \xrightarrow[-H_2O]{} Cu_2O$

Отформатировано: Шрифт: 12 пт
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Experience 5. Oxidation of benzaldehyde

Reagents: benzaldehyde, 0.1% solution of potassium permanganate, 10% solution of sulfuric acid, ethyl alcohol

1) A few drops of benzaldehyde are placed on a slide and left in the air. After some time, crystals of benzoic acid appear in the drop, which are poorly soluble in cold water and well – in hot water.

$$C_6H_5CHO \xrightarrow{[O]} C_6H_5COOH$$

Aromatic aldehydes during storage is extremely easy, easier than the aldehydes of the fatty series, are oxidized to acids. Oxidation is accelerated by light.

2) in a test tube, mix 1 ml of a 0.1% solution of potassium permanganate and 2-3 drops of benzaldehyde. Heat the test tube in a water bath until the smell of benzaldehyde disappears. Excess potassium permanganate is destroyed by adding a few drops of alcohol. The precipitate of manganese oxide is filtered out through a small filter. When the resulting alkaline solution is acidified with sulfuric acid, benzoic acid crystals fall out.

$$C_6H_5CHO \xrightarrow{KMnO_4+HOH} C_6H_5COOK$$

$$C_6H_5COOK + H_2SO_4 \longrightarrow C_6H_5COOH + KHSO_4$$

Experience 6. The interaction of the benzoic aldehyde with the aniline

(formation of the Schiff base)

Reagents: the benzaldehyde, aniline, ethyl alcohol

Mix equal amounts of benzaldehyde and aniline when shaken. The reaction mass is heated, the mixture becomes cloudy, 2-3 ml of alcohol is added and cooled. Allocated sediment benzanilide (azomethine, Schiff base).

$$C_6H_5C(O)H + H_2NC_6H_5 \longrightarrow C_6H_5CH = NC_6H_5 + H_2O$$

Control question

1. What compounds are called oxo compounds?
2. Name the types of isomerism characteristic of oxo compounds.
3. How are the names of oxo compounds made according to the international nomenclature? Give all possible oxo compounds of the General formula C4H8O and name them by all possible nomenclatures.
4. What are the main ways to obtain aldehydes and ketones?
5. What reactions are characteristic of aldehydes and ketones?
6. Explain the reactivity of aldehydes and ketones in nucleophilic addition reactions, in relation to their structure.
7. What types of condensation characteristic of oxo compounds do you know? Given example.

Отформатировано: По ширине
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Отформатировано: По ширине
Отформатировано: По ширине

8. Which of the above compounds can react Cannizzaro: 1) formic aldehyde, 2) acetic aldehyde, 3) benzaldehyde, 4) acetone?

9. What reactions can distinguish aldehydes from ketones?

10. What is the essence of the "silver mirror" reaction, what products are formed in this reaction?

11. Explain the oxidation of ketones, Popov's rule.

12. What products are formed as a result of polymerization of a) formaldehyde, b) acetaldehyde?

13. What is a polycondensation reaction? What products are formed as a result of polycondensation of formaldehyde and phenol?

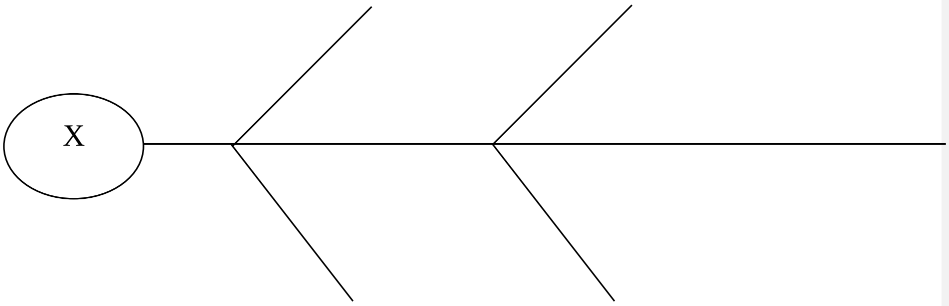
14. Explain the nature of the double bond reactions in unsaturated aldehydes, which are against the Markovnikov rule.

15. Write the reactions that characterize the specific properties of aromatic aldehydes.

16. Explain the effect of the carbonyl group on the reactivity of the benzene ring in electrophilic substitution reactions.

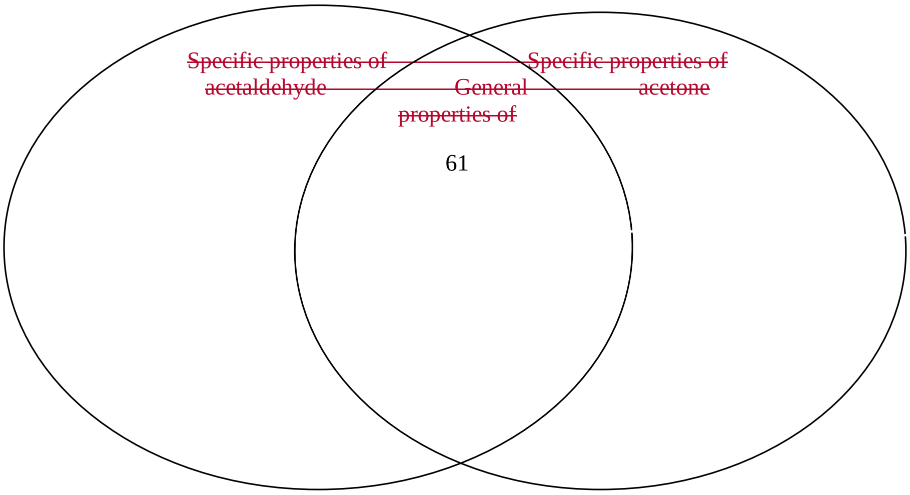
Task: 1. To make the graphic organizer "Skeleton fish".

X – formaldehyde, acetaldehyde, benzaldehyde



~~2. give a comparative description of acetaldehyde and acetone.~~

~~**Venn diagram.**~~



~~acetaldehyde and acetone~~

~~**Homework:**~~

~~Organic halogen-containing compounds, alcohols, phenols, esters, oxo compounds.~~

~~**Literature:** 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 332-420.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. –~~

~~T.: "EXTREMUM", 2010. – p. 79-122.~~

LESSON № 13

1. Theme: Organic halogen-containing compounds, alcohols, phenols, esters, oxo compounds.

Отформатировано: По ширине

2. Class duration: 3 hours.

3. The purpose of the lesson: to Test the level of students ' knowledge on the reactivity of halogen-Derived hydrocarbons, alcohols, phenols, esters and oxo compounds.

Отформатировано: По ширине

4. Target tasks: the student must answer test questions and individual tasks in writing.

5. Basic training questions.

5.1. Halogen derivatives of hydrocarbons – structure, nomenclature, isomerism, methods of production, chemical properties.

5.2. Alcohols – classification, nomenclature, isomerism, production methods, chemical properties.

5.3. Phenols – classification, nomenclature, isomerism, production methods, chemical properties.

5.4. Ethers – nomenclature, isomerism, methods of preparation, chemical properties.

5.5. Oxo compounds – classification, nomenclature, isomerism, methods of preparation, chemical properties.

6. Self-study is submitted by the student in the form of an abstract on one of the topics given in the Chapter "Functional derivatives of hydrocarbons – halocarbons, alcohols, phenols, oxo compounds" of the training manual for performing independent work in organic chemistry and is estimated at 1.5 points.

7. Handout.

Tickets that include theoretical questions and tests.

Questions of interim control of

Halocarbons

1. Give the structural formulas of the following compounds: a) isopentyl bromide, b) tert.pentyl bromide,b) sec. pentyl bromide, d) pentyl bromide, d) sec.isopentyl bromide. Name them by international nomenclature and explain their relationship to each other.

Отформатировано: По ширине

2. Write the structure of the following compounds and name them according to the radical-functional nomenclature: a) 1-iodine-3-methylbutane, b) 2-iodine-2-methylbutane, c) 2-iodopentane, d) 1-iodopentane, d) 2-iodine-3-methylbutane, e) 1-iodine-2,2-dimethylpropane. What connections are they in relation to each other?

3. What halogen derivatives are formed when interacting: a) propene and HCl, b) butadiene-1,3 and Cl_2, c) isobutane and Cl_2, d) propine and HCl, give the corresponding reaction equations and name the products obtained.

4. Give the reaction of obtaining 2-brompentane from the corresponding: a) alkene, b) cycloalkane, c) alkane, d) alcohol. Specify the mechanism of reactions.

5. Give the reaction of obtaining 2-chlorobutane from the corresponding a) alcohol, b) alkene, c) alkane, d) cycloalkane. Specify the mechanism of piercing reactions.

6. Give the reaction of propyl bromide and tert.pentylbromide with a water and alcohol solution Paon. Explain the mechanism of reactions.

7. Write the reaction of 2-bromo-3-methylbutane with the following reagents: a) NaOH (water), b) NaOH (alcohol), c) Na, d) C_6H_5ONa, e) CH_3COONa. Name all received connections.

8. Write the reaction of toluene with a) Br_2 ($FeBr_3$) and b) Br_2 (hv), name the products obtained and compare their reactivity in nucleophilic substitution reactions. Explain the answer using the appropriate reaction equations.

9. Compare the mobility of bromine in benzyl bromide and p-bromotoluene. Write the reaction of benzyl bromide with the following reagents: a) NaOH (H_2O), b) NaCN, c) CH_3ONa.

10. Get isobutyramide from the corresponding a) alcohol, b) unsaturated hydrocarbons are reacted its interaction with a) Na, b) C_2H_5ONa, c) CH_3COONa d) NaOH (water.).

11. Give the reaction for producing vicinal Gemini and dibromethane, write reactions of their interaction with a) KOH (water.), b) KOH (alcohol).

Mono - and polyhydric alcohols

1. Give all the possible isomers for isopentanol alcohol and name them according to the international, rational and radical-functional nomenclature.

Отформатировано: По ширине

2. Write the structural formulas of the following compounds: a) 2-methylpentanol-3, b) 3-ethylhexanediol-2,3c) propantriol-1,2,3, d) isoamyl alcohol, d) dimethylethylcarbinol, g) methylvinylcarbinol, h) allyl alcohol, K) TRANS-butene-2-ol-1. Compare the acidic properties of monatomic and diatomic alcohols. Give the corresponding reaction equations.

3. Write the reaction of obtaining isobutyl alcohol from the corresponding: a) alkene, b) Halocarbon, c) aldehyde, and d) using the Grignard reagent.

4. What compounds are formed when the following compounds interact: a) propene and H_2O, b) isopropylmagnesium iodide and methanal, followed by hydrolysis, c) 2-chlorobutane and an aqueous solution of NaOH, d) benzyl chloride and an aqueous solution of NaOH. Give the corresponding reaction equations and name the resulting products.

5. Some of the aldehydes with the Grignard, it is possible to obtain the following alcohols: a) isopropyl, b) sec.butyl, C) tert.pentyl. Compare the acidic properties of the resulting alcohols, explain the answer.

6. Write the reaction of propyl alcohol with the following reagents: a) HBr, b) Na, c) CH_3COOH and give the reaction of dehydration: d) $t=140^0C$ (H_2SO_4), e) t › 140^0C (H_2SO_4). Explain the mechanism (s) of the reaction.

7. Give the methods of synthesis glycerin of: a) propylene, b) three halocarbons. Compare the acidic properties of glycerol with propanol.

8. Give the reaction of glycerol with the following reagents: a) CH_3CH_2COOH, b) HNO_3, c) Na, d) HBr, v) $Cu(OH)_2$.

9. Give three ways to obtain propanediol-1,2 and compare its acidic properties with propyl alcohol, explain the answer using the appropriate reactions.

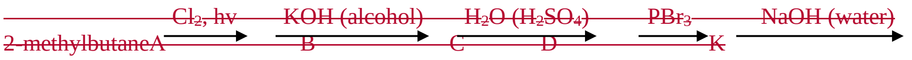
Отформатировано: По ширине

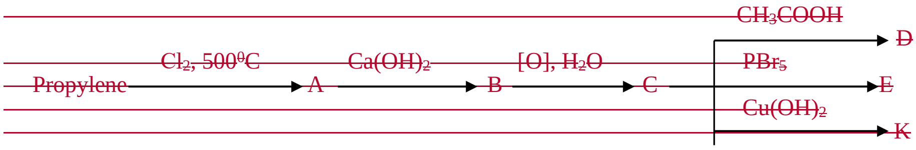
10. Write the reaction of obtaining propanediol-1,2 and the reaction of its interaction with a) PCl_5, b) ethyl alcohol, C) acetic acid, d) $Cu(OH)_2$.

11. Give methods for obtaining from ethylene a) ethanol, b) ethylene glycol and write the reactions of their interaction with a) Na, b) CH_3COOH (H^+). By what reactions it is possible to distinguish ethanol from ethylene glycol? Give the corresponding reaction equations.

12. Compare the acid-base properties of ethanol and phenol. Explain the answer using the appropriate responses. Give the reactions of halogenation, nitration and sulfonation of phenol.

~~13. Make up the reaction equations according to the scheme and name the resulting reaction products:~~





Mono - and polyatomic phenols

1. Provide a method of producing phenol from benzene, and write the reaction of phenol with a) Br_2, b) NaOH c) HNO_3 (conc.), g) HNO_3 (dilution).

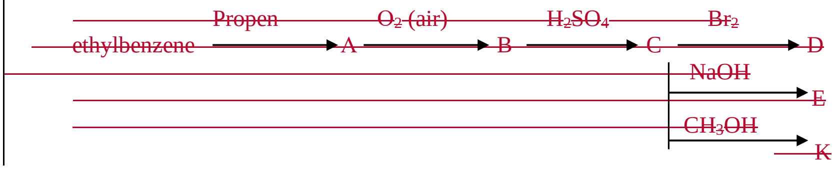
2. With the help of some of the reactions from benzene to obtain p-nitrophenol, write reaction between p-nitrophenol with a) NaOH, b) $FeCl_3$, C) Br_2 ($FeBr_3$).

3. Reactions of electrophilic substitution on the example of phenol (halogenation, nitration, and acylation), mechanism. Explain the effect of the hydroxyl group.

4. Preparation of phenol by cumol method. Explain the effect of the hydroxyl group in electrophilic substitution reactions. Write the reaction with a) Br_2, b) HNO_3 (conc.), c) HNO_3 (dilution).

5. Give a method for obtaining resorcinol (1,3-dioxybenzene) using sulfuric acid and write the reaction of its interaction with a) NaOH, b) Br_2, C) CH_3Cl.

~~6. Make up the reaction equations according to the scheme and name the resulting reaction products:~~



Отформатировано: По ширине

Ether

1. Give all possible isomers for diethyl ether, name them by international and radical-functional nomenclature.

Отформатировано: По ширине

2. Give a method for obtaining ethylisopropyl ether by the Williamson reaction and write the reaction of its interaction a) Na (t), b) HJ (t), c) HJ (cool), d) HCl.

3. Give a method for obtaining methylpropyl ether by the Williamson reaction and write the reaction of its interaction a) HJ (t), b) HJ (cool), c) HCl.

4. Make up the reaction equations according to the scheme and name the resulting reaction products:

$$\text{Propyl alcohol} \xrightarrow{PBr_3} A \xrightarrow{Mg} B \xrightarrow{(CH_3)_2C{=}O} C \xrightarrow{H_2O} G \xrightarrow{Na} D \xrightarrow{CH_3Cl} E$$

Aldehydes and ketones

1. Give all possible formulas of oxo compounds corresponding to the General formula $C_5H_{10}O$.Name them by international, rational, and trivial nomenclature.

Отформатировано: По ширине

2. Write the structural formulas of the above compounds and name them according to the rational nomenclature: a) 2-methylpentanal, b) 2-methyl-2-phenylbutanal, C) 3,3-dimethylbutanone, d) 2,5-dimethylhexanone-3, d) 2-ethoxybutane.

3. What compounds are formed when the following compounds interact: a) 2,2-dichlopropane with an aqueous solution of NaOH, b) benzene with CH_3COCl ($FeCl_3$), c) 3-methylbutine-1 with H_2O (Hg^{2+}), d) butene-2 with O_3, followed by hydrolysis, e) during the oxidation of isobutyl alcohol. Write the corresponding reaction equations and name the resulting products.

4. Obtain m-methylbenzaldehyde from the corresponding Halocarbon and write the reactions of its interaction with a) NH_2NH_2, b) HCN, C) Cl_2 ($FeCl_3$) and d) the Cannizaro reaction. Explain the effect of substituent b (b) of the reaction.

5. Give 2 methods for obtaining methylethyl ketone and write the reaction of its interaction with a) CH_3CH_2OH, b) $NaHSO_3$, C) NH_2NH_2, d) oxidation.

6. Give the reaction of obtaining propionic aldehyde from a) propyl alcohol, b) propionic acid and write the reaction of its interaction with: 1) $NaHSO_3$, 2) C_2H_5OH, 3) NH_2NH_2, 4) CH_3CHO (OH^-).

7. Usingthe example of methylpropyl ketone, explain the oxidation of ketones. Popov's Rule. Write the reaction of the interaction of methylpropyl ketone with a) HCN, b) NH_2OH,c) NH_2NH_2.

8. Write the structure of methylacetic and trimethylacetic aldehydes, name them according to the international nomenclature. Which of these compounds may enter into the reaction of aldol condensation? Explain the answer using reactions. Give the reaction of interaction of methylacetic aldehyde with a) HCN, b) H_2.

9. Write the reaction of interaction of dimethylacetic aldehyde with the following reagents: a) HCN, b) $NaHSO_3$, c) NH_2NH_2, d) Cl_2 and e) give the reaction of aldol condensation.

10. Write the reaction of obtaining butanone from the corresponding a) alcohol, b) alkyne, c) alkene, and d) dihalocarbon.

11. Write the reaction of interaction of propanal with the following reagents: a) H_2, b) C_2H_5OH, c) NH_3, d) $NH_2NHC_6H_5$, d) $C1_2$ (P).

12. Write the reaction of methyl ethyl ketone with the following connections: a) HCN, b) CH_3OH, c) NH_2OH, g) $NH_2NHC_6H_5$, d) oxidation.

13. Write the reaction of benzaldehyde with the following compounds: a) NH_3, b) $CH_3C(O)H$, c) $(CH_3CO)_2O$, g) $C_6H_5C(O)H$ (KCN), e) $C1_2$.

14. Give the reaction of p-methylbenzaldehyde with the following reagents: a) HCN, b) $NaHSO_3$, c) NH_2NH_2, d) Cl_2 ($FeCl_3$), e) KOH (60%).

~~**Homework:**~~
~~Monocarboxylic acids.Production of carboxylic acids, formation of salts.~~
~~*Exercises* №2, 5, 6, 8, 9, 16 (a-b) (pp. 143-144).~~
~~*Experiments* №101, 103, 104, 105, 107, 108, 109, 110.~~

~~**Literature:** 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 424-443.~~
~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. – T.: "EXTREMUM", 2010. – p. 140-152.~~

LESSON № 14

1. Theme: Monocarboxylic acids. Production of carboxylic acids, formation of salts.

Отформатировано: По ширине

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge of the laws and features in the chemical behavior of monobasic carboxylic acids in relation to their structure.

Отформатировано: По ширине

4. Objectives: by the end of the lesson, the student should be able to:

4.1. write reactions for obtaining monobasic carboxylic acids;

4.2. compare the acidic properties of limit, unsaturated, aromatic monobasic carboxylic acids;

4.3. predict the reactivity of monobasic carboxylic acids depending on their structure;

4.4. conduct characteristic and specific qualitative reactions to monobasic carboxylic acids.

5. Basic training questions.

5.1. electronic structure of the carboxyl group.

5.2. The acidic properties of aliphatic and aromatic monobasic carboxylic acids.

5.3. The reaction of esterification, the mechanism of nucleophilic substitution. Dependence of the reactivity of alcohols and acids on the structure of the radical (spatial difficulties).

5.4. Education functional derivatives of monobasic carboxylic acids: salts, esters, halides, anhydrides, amides, substituted amides, and hydrazides.

5.5. CH-acidity of the α-carbon atom of limiting monobasic carboxylic acids. The Gell-Folgard-Zelinsky Reaction.

5.6. chemical properties of α,β-unsaturated monobasic carboxylic acids associated with the presence of a double bond (hydrobromation, hydroxylation, bromination, diene synthesis reaction).

5.7. Aromatic monobasic carboxylic acid. Deactivating and orienting influence of the carboxyl group in electrophilic substitution reactions.

6. Self-study (performed in preparation for the lesson).

Classification, isomerism, nomenclature, and methods for obtaining monobasic carboxylic acids.Unsaturated monobasic carboxylic acids.

7. Demonstration.

Videos of the virtual laboratory – "interaction of acetic acid with metals, alkalis, sodium carbonate, copper (II) hydroxide", "interaction of oleic acid with bromine water", "production of benzoic acid", "oxidation of formic acid with potassium permanganate", "production of esters"; multimedia – "Carboxylic acids", "Esters".

PRACTICUM

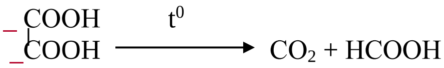
Experience 1. Obtaining formic acid from oxalic acid

Reagents: oxalic acid, glycerin.

About 1 g of oxalic acid and 1 ml of glycerol are added to a wide test tube closed with a gas outlet tube. The test tube is fixed obliquely in a tripod and carefully heated. First, oxalic acid is dissolved. Then begins a plentiful release of

Отформатировано: По ширине

gas. With the appearance of the first drops of distilled liquid from the gas outlet tube, heating is stopped. Slightly cool the test tube and add another 1 g of oxalic acid. Closing the tube opening with a stopper and submerging the discharge tube to the bottom in the receiver - tube with 2 ml of water, continue heating. The receiver is cooled in a glass of water. The reaction mixture is heated to darken and the distilled formic acid is collected in the receiver, which is used in subsequent experiments.



$$\begin{array}{l}COOH\\ |\\ COOH\end{array} \xrightarrow{t^0} CO_2 + HCOOH$$

Dibasic acids, in which the carboxyl groups are located close to each other, are easily subjected to the decarboxylation process when heated. Glycerol acts as a catalyst and promotes the conversion of oxalic acid into formic acid.

Отформатировано: По ширине

Experience 2. The decomposition of formic acid

Reagents: formic acid, concentrated sulfuric acid

1 ml of formic acid and 1 ml of sulfuric acid (specific gravity 1.184) are poured into a test tube closed with a stopper with a gas-discharge glass tube and slightly heated. Formic acid decomposes with the release of carbon monoxide (II), which burns with a blue flame.

Отформатировано: По ширине

$$HCOOH \xrightarrow{t^0 (H_2SO_4)} CO + H_2O.$$

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

Experience 3. The effects of oxidants on acid

Reagents: formic acid, acetic acid, 1% potassium permanganate solution,
10% sulfuric acid solution, calcareous water.

In a test tube, mix 1 ml of formic acid with 1 ml of a 1% solution of potassium permanganate, close the plug with a gas outlet tube and heat. When heated, the solution discolors, and carbon dioxide is released. It is detected by passing the released gaseous products into calcareous water.

Отформатировано: По ширине

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

$$HCOOH \xrightarrow{KMnO_4, H_2SO_4} CO_2 + H_2O$$

In another test tube, add 2 ml of acetic acid, 10% solution of sulfuric acid and 1% solution of potassium permanganate. The solution does not discolor.

Отформатировано: По ширине

Monobasic limit carboxylic acids are resistant to oxidizing agents. An exception is formic acid, whose easy oxidizability is explained by the absence of a radical in it.

Experience 4. Obtaining acetic acid

Reagents: sodium acetate, concentrated sulfuric acid, litmus paper.

1 g of sodium acetate is placed in a test tube and 1 ml of concentrated sulfuric acid is added. The mixture is stirred and heated. Released acetic acid vapors are detected by the characteristic smell and redness of wet blue litmus paper held to the opening of the test tube.

Отформатировано: По ширине

$$CH_3COONa + H_2SO_4 \xrightarrow{t^0} CH_3COOH + NaHSO_4$$

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

Experiment 5. Obtaining iron salts of acetic and benzoic acids

Reagents: 5% sodium acetate solution, sodium benzoate crystals, 1% iron (III) chloride solution)

In two test tubes, pour: in the first – 2 ml of a 5% solution of sodium acetate, in the second-pour sodium benzoate crystals. In both test tubes, pour 2-3 drops of iron (III) chloride solution.

Отформатировано: По ширине

The solution in the first test tube is colored dark red. When heated, the color of the solution changes to brown, and then a flake-like precipitate falls out. In the second test tube, the solution is colored pink-yellow.

$$9CH_3COO^- + 3Fe^{3+} + 2H_2O \rightleftarrows [Fe_3(OH)_2(CH_3COO)_6]^+ + CH_3COO^- + 2CH_3COOH$$

$$6C_6H_5COO^- + 2Fe^{3+} + 10H_2O \longrightarrow (C_6H_5COO)_3Fe + Fe(OH)_3 + 7H_2O + 3C_5H_3COOH$$

Experience 6. The interaction of acetic acid with sodium bicarbonate

Reagents: acetic acid, sodium bicarbonate, barite water.

1 ml of dilute acetic acid is added to the test tube, a few grains of sodium bicarbonate are added and closed with a stopper with a gas outlet tube. After the start of the reaction, a lighted match is brought to the exhaust pipe – it goes out. Lower the end of the exhaust pipe into a test tube with barite water - a white haze appears.

Отформатировано: По ширине

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COON\ a + CO_2 + H_2O$$

$$CO_2 + Ba(OH)_2 \longrightarrow BaCO_3 + H_2O$$

Отформатировано: русский

Отформатировано: русский

Experience 7. Interaction of oleic acid with bromine water and potassium permanganate

Reagents: oleic acid, bromine water, 1% solution of potassium
permanganate, 10% solution of sodium hydroxide

In two test tubes, pour 1 ml of bromine water and 1% potassium permanganate, add oleic acid drop by drop. The test tubes are shaken vigorously. Solutions in test tubes are discolored, which proves the unsaturated nature of oleic acid.

$$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH + Br_2 \longrightarrow CH_3(CH_2)_7CHBr\text{-}CHBr(CH_2)_7COOH$$

$$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH + [O] + H_2O \longrightarrow CH_3(CH_2)_7CHOH\text{-}CHOH(CH_2)_7COOH$$

Control question

1. What organic compounds are called carboxylic acids?
2. How are carboxylic acids classified?
3. What representatives of carboxylic acids do you know? Call them.
4. Write the structural formulas of pentanoic acid and its isomers, name them by systematic and trivial nomenclature.
5. What are the General methods for obtaining monobasic carboxylic acids?
6. How do I Get formic acid and acetic acid?
7. Specify the structure of formic acid and its properties?
8. What are the derivatives of carboxylic acids do you know? How can I get them?
9. What is the difference in aliphatic and aromatic monobasic carboxylic acids according to their chemical properties?
10. Which reactions can be used to prove the unsaturated nature of unsaturated monobasic carboxylic acids?
11. Explain the acid properties of the following acids: 1) Mura, 2) acetic, 3) acrylic, 4) benzoin.
12. What reactions are characteristic of aromatic acids?
13. How do substituents affect the acidic properties of aromatic carboxylic acids?
14. What compounds are formed when heating benzoic acid?
15. Explain the effect of the carboxyl group on the reactivity of the benzene ring in electrophilic substitution reactions.
16. Determine the application areas of carboxylic acids.

Task: Enter the products that are formed when the corresponding compounds interact.

Отформатировано: По ширине

Отформатировано: Цвет шрифта: Авто

Отформатировано: Цвет шрифта: Авто

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Отформатировано: По ширине

Отформатировано: Шрифт: 8 пт

Reagents	Acids			
	formic	acetic	acrylic	benzoic
NaOH				
$NaHCO_3$				
C_2H_5OH				
NH_3 (t)				
PCl_5				
Br_2 (H_2O)				
$KMnO_4$ (H_2O)				
HBr				
Br_2 (P)				
Cl_2 ($FeCl_3$)				
Ag_2O (NH_3)				
t^0				

~~**Homework:**~~

~~Dicarboxylic acids. Preparation of phthalic anhydride, phenolphthalein, oxalic acid salts.~~

~~*Exercises*№ 13, 14, 15, 16(e), 18(b,C), 19 (p. 143-144).~~

~~*Experiments* №111, 112, 114, 115, 116.~~

~~**Literature**: 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 445-458.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry.~~

~~T.: "EXTREMUM", 2010. – p. 140-152.~~

LESSON № 15

1. Theme: Dicarboxylic acid. Synthesis of phthalic anhydride, phenolphthalein, oxalic acid salts.

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge of the laws and features in the chemical behavior of dibasic carboxylic acids in relation to their structure.

4. Objectives: by the end of the lesson, the student should be able to:

4.1. write reactions for obtaining dibasic carboxylic acids;

4.2. demonstrate knowledge of π-diastereomerism on the example of unsaturated dibasic carboxylic acids;

4.3. compare the acidic properties of monobasic and dibasic carboxylic acids;

Отформатировано: По ширине

Отформатировано: По ширине

Отформатировано: По ширине

4.4. explain the reactivity of dibasic carboxylic acids, their General and specific properties;

4.5. to explain the SN-acid properties of malonic ester and syntheses based on it.

5. Basic training questions.

5.1. Acidic properties of ultimate, unsaturated, aromatic dibasic carboxylic acids.

5.2. Education full and partial derivatives of dibasic carboxylic acids: salts, esters, halides, anhydrides, amides.

5.3. Ultimate dibasic carboxylic acid.

5.3.1. Specific properties – heating, the formation of amides.

5.3.2. Malon ether. CH-acidic properties of Malon ether.

5.3.3. Syntheses of one - and dibasic carboxylic acids using malonic ether.

5.4. Unsaturated dibasic carboxylic acid.

5.4.1. π-diastereomerism.

5.4.2. reactions of bromination, dehydrobromination, mild oxidation and reduction with hydrogen at the time of its release.

5.4.3. Obtaining maleic anhydride, the maleic anhydride in the reaction Diels-alder.

5.5. Dibasic aromatic acids.

5.5.1. Reactions of electrophilic substitution. Orienting and deactivating effect of the carboxyl group. Consistent and inconsistent orientation.

5.5.2. The formation of phthalic anhydride. Preparation of phenolphthalein, its indicator properties.

5.5.3. The acidic properties of aromatic carboxylic acids.

6. Self-study (performed in preparation for the lesson).

Classification, isomerism, nomenclature, and methods for obtaining dibasic carboxylic acids.Phthalic acid and its derivatives – phthalic anhydride, phthalimide.

7. Demonstration.

Videos of the virtual laboratory – "Carboxylic acids – weak electrolytes", "solubility of carboxylic acids", multimedia – "Carboxylic acids".

Отформатировано: По ширине

PRACTICUM

Experience 1. Obtaining oxalic acid

Reagents: concentrated solution of potassium hydroxide, 10% solution of acetic acid, 10% solution of calcium chloride, concentrated hydrochloric acid.

In a porcelain or iron Cup, pour 5 g of sawdust, pour 5 ml of a concentrated solution of potassium hydroxide until a thick mush is formed. The reaction mixture is heated with constant stirring. A few minutes after the start of heating, hydrogen gas bubbles begin to form. After stopping the release of gas bubbles, heating is stopped – the mixture turns into a liquid yellow-brown mass. After cooling, add 10-15 ml of water to the Cup, mix well and filter. To the part of the filtrate (3-4 ml), add a 10% solution of acetic acid to the acid reaction by litmus and 1-2 ml of a 10% solution of calcium chloride. A white precipitate of calcium oxalate falls out.

Отформатировано: По ширине

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

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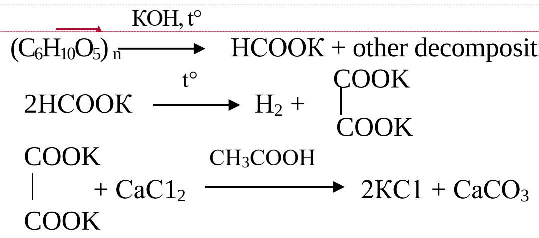


$$(C_6H_{10}O_5)_n \xrightarrow{KOH,\ t°} HCOOK + \text{other decomposition products}$$

$$2HCOOK \xrightarrow{t°} H_2 + \begin{array}{l}COOK\\ |\\ COOK\end{array}$$

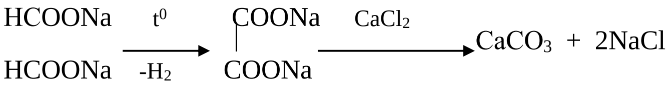
$$\begin{array}{l}COOK\\ |\\ COOK\end{array} + CaC1_2 \xrightarrow{CH_3COOH} 2KC1 + CaCO_3$$

Experience 2. Obtaining salts of oxalic acid

Reagents: formic acid sodium salt, 10% calcium chloride solution

A small amount of formic acid sodium salt is placed in a dry test tube and heated in a burner flame. First, the salt melts, and then decomposes with the release of hydrogen. The test tube is cooled. The smelt is dissolved in water. If the solution is not transparent, it is heated. A few drops of calcium chloride solution are added to the cooled solution - a white precipitate of the insoluble calcium salt of oxalic acid falls out.

Отформатировано: По ширине



$$\begin{array}{l}HCOONa\\ HCOONa\end{array} \xrightarrow[-H_2]{t^0} \begin{array}{l}COONa\\ |\\ COONa\end{array} \xrightarrow{CaCl_2} CaCO_3 + 2NaCl$$

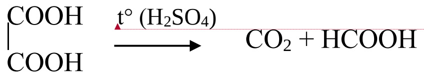
Experience 3. The decomposition of oxalic acid when heated with concentrated sulphuric acid

Reagents: oxalic acid, concentrated sulfuric acid, lime water

1 g of crystalline oxalic acid is placed in a test tube equipped with a triple with a curved gas outlet tube and 1-2 ml of concentrated sulfuric acid is added. After fixing the test tube in the tripod clip, it is carefully heated until gas bubbles

Отформатировано: По ширине

are released. Oxalic acid decomposes with the release of carbon dioxide and formic acid, which, in turn, decomposes into carbon monoxide and water.



$$\begin{matrix}COOH\\ |\\ COOH\end{matrix} \xrightarrow{t^\circ\ (H_2SO_4)} CO_2 + HCOOH$$

Отформатировано: Шрифт: 12 пт

$$HCOOH \xrightarrow{t^\circ\ (H_2SO_4)} CO + H_2O$$

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 10 пт

To detect carbon dioxide, the released gas is passed through lime water. The liquid becomes cloudy **-** calcium carbonate is formed.

Отформатировано: По ширине

$$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$$

When ignited, the gas burns with a bluish flame characteristic of carbon monoxide.

Отформатировано: По ширине

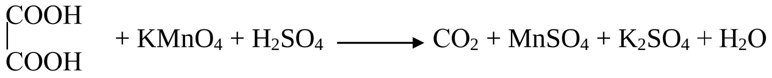
Experience 4. Oxidation of oxalic acid

Reagents: oxalic acid, 1% potassium permanganate solution 10% sulfuric acid solution acid, lime water

2 ml of potassium permanganate solution acidified with sulfuric acid is placed in a test tube closed with a plug with a gas outlet tube and 1 ml of saturated oxalic acid solution is added. Having fixed the test tube in the tripod clip, carefully heat it. Oxalic acid is then oxidized to carbon dioxide and water.

Отформатировано: По ширине

When passing the released gas into lime water, the solution becomes cloudy due to the formation of calcium carbonate.



$$\begin{matrix}COOH\\ |\\ COOH\end{matrix} + KMnO_4 + H_2SO_4 \longrightarrow CO_2 + MnSO_4 + K_2SO_4 + H_2O$$

Experience 5. Obtaining phthalic anhydride

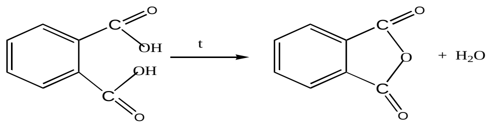
Отформатировано: Шрифт: полужирный, не курсив

Reagents: phthalic acid

A small amount (0.1 g) of phthalic acid in a dry test tube is heated in a burner flame. The acid melts, sublimates, and a white sublimate appears in the colder part of the test tube.

Отформатировано: По ширине

The test tube is cooled. Then heated, the sublimate, holding the tube inclined. Phthalic anhydride melts easily and flows down.

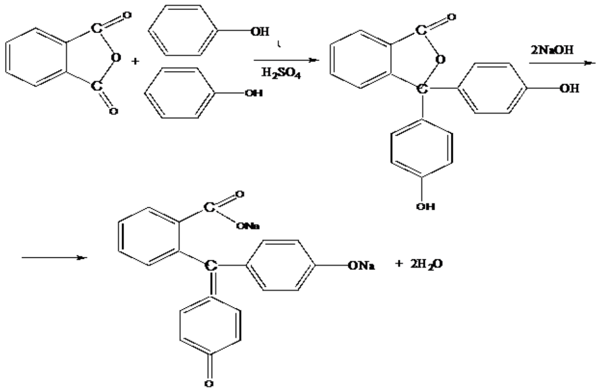


Experience 6. Getting phenolphthalein

Reagents: phthalic anhydride, phenol, 10% sodium hydroxide solution, conc. sulfuric acid, ethyl alcohol

Approximately 0.2 g of phthalic anhydride, 0.5 g of phenol, and 0.5 ml of concentrated sulfuric acid are placed in a test tube. The mixture is slightly heated. Then the test tube is cooled. Add 2 ml of alcohol (to dissolve phenolphthalein), a few drops of the resulting alcohol solution are poured into a test tube with a solution of sodium hydroxide. The solution is colored crimson. When the solution is acidified, the color disappears.

Отформатировано: По ширине



Phenolphthalein is formed by condensation of phthalic anhydride with phenol in the presence of sulfuric acid.

Отформатировано: По ширине

Control question

1. What organic compounds are called dibasic carboxylic acids?

Отформатировано: По ширине

2. Write the structural formulas of the following acids: oxalic, malonic, succinic, glutaric, adipic and explain their relation to heating.
3. What are the methods of obtaining oxalic acid, you know?
4. Specify the structure of Malon ether and its properties? Explain that the CH-acidic properties of malonic ether.
5. What sequence of reactions can be obtained from malonic ether acids?
6. Explain the formation of cyclic amides, for example succinic, maleic and phthalic acids.
7. What is the difference in aliphatic and aromatic dibasic carboxylic acids according to their chemical properties?
8. What reactions can be used to prove the unsaturated character of unsaturated dibasic carboxylic acids?
9. What reaction can be used to distinguish maleic acid from fumaric acid? What connections are they in relation to each other?
10. Explain the acidic properties of monobasic and dibasic carboxylic acids.

11. What reactions are characteristic of aromatic dibasic acids?

12. With some reactions it is possible to distinguish phthalic acid from its isomers isophthalic and terephthalic acids? Compare their acidic properties.

13. Explain the effect of two carboxyl groups on the reactivity of the benzene ring in electrophilic substitution reactions.

14. What sequence of reactions can be obtained from malonic ether succinic acid?

Task 1. Enter the products that are formed when the corresponding compounds interact.

Training "Vertushka»

Отформатированная таблица

Reagents	Acids					
	oxalic	amber	adipine	maleic	phthalic	terephthalic
NaOH						
$NaHCO_3$						
C_2H_5OH						
NH_3 (t)						
PCl_5						
Br_2 (H_2O)						
$KMnO_4$ (H_2O)						
HBr						
Br_2 (P)						
Cl_2 ($FeCl_3$)						
Ag_2O (NH_3)						
t^0						

Task 2. Specify the correct sequence of reagents that can be used to obtain butyric acid from Malon ether.

Отформатировано: По ширине

"Blitz-poll"

Receiving from the malonic ester of butyric acid

Reagents	Student 's answer	Correct answer
C_2H_5ONa		
C_2H_5OH		
C_2H_5Cl		
CH_3Cl		
t^0, H_2O		
cons. NaOH		
H_2O		

t^0		

~~**Homework:**~~

~~Aliphatic and aromatic amines.Basic properties of amines, properties of aniline.~~

~~*Exercises* №1, 3, 6, 8, 9, 12(a,b), 15 (pp. 125-126).~~

~~*Experiments* №86, 87, 88, 91, 95.~~

~~**Literature:** 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 292-315.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. –~~

~~T.: "EXTREMUM", 2010. – p. 122-132.~~

LESSON № 16

1. Theme: Aliphatic and aromatic amines. Basic properties of amines, properties of aniline.

Отформатировано: По ширине

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge about the reactivity of aliphatic and aromatic amines, the mutual influence of the amino group and the associated radical.

Отформатировано: По ширине

4. Objectives: by the end of the lesson, the student should be able to:

4.1. compare the main properties of aliphatic and aromatic amines;

4.2. compare the nucleophilic properties of aliphatic and aromatic amines;

4.3. conduct qualitative reactions that distinguish primary, secondary and tertiary aliphatic and aromatic amines.

5. Basic training questions.

5.1. Classification of amines, nomenclature, isomerism.

5.2. Chemical properties.

5.1.1. Basic properties of amines. Comparison of the main properties of primary, secondary, tertiary aliphatic and aromatic amines.

5.1.2. The reaction of alkylation, acylation (method of protection of amino group), acquisition of Schiff bases. Comparison of the nucleophilic properties of aliphatic and aromatic amines.

5.1.3. Reactions of primary, secondary and tertiary aliphatic and aromatic amines with nitrous acid.

5.1.4. Isonitrile reaction - a qualitative reaction to the primary amino group.

5.1.5. Reactions of electrophilic substitution of aromatic amines. Influence of the amino group on the rate and direction of the electrophilic substitution reaction.

6. Self-study (performed in preparation for the lesson).

Methods for obtaining aliphatic and aromatic amines. Diamines – putrescine, cadaverine.

7. Demonstration.

Videos of the virtual laboratory – "dimethylamine production and its burn", "bromination of aniline", "aniline oxidation with potassium bichromate", "aniline oxidation with bleach".

PRACTICUM

Experience 1. Getting the methylamine from acetamide

Reagents: acetamide, bromine, concentrated hydroxide solution
sodium's.

About 0.2 g of acetamide, 1 ml of water, and a few drops of bromine are placed in a large test tube with a long exhaust pipe. The mixture is shaken, cooled with water, and a concentrated solution of alkali is added drop by drop until the bromine color disappears, and about the same amount of alkali is added.

Отформатировано: По ширине

The test tube is heated and the resulting methylamine is distilled into a receiver with a small amount of water cooled by ice. Distillation is continued until the volume of liquid in the receiver increases by 3-4 times.

The distillate has a characteristic smell of methylamine - raw fish and ammonia.

$$Br_2 + NaOH \longrightarrow NaBrO + NaBr + H_2O;$$

$$CH_3CONH_2 + NaBrO \longrightarrow CH_3NH_2 + CO_2 + NaBr;$$

$$CO_2 + NaOH \longrightarrow Na_2CO_3 + H_2O$$

A solution of methylamine is used for subsequent experiments.

Experience 2. The formation of salts of methylamine

Reagents: methylamine, concentrated hydrochloric acid

A glass rod moistened with concentrated hydrochloric acid is brought to the opening of the gas outlet tube of the device in which methylamine is obtained (previous experience). White smoke appears and a white precipitate of methylamine hydrochloric acid is formed on the glass stick.

Отформатировано: По ширине

$$CH_3NH_2 + HC1 \longrightarrow CH_3NH_2{\cdot}HC1 \quad \text{or} \quad [CH_3NH_3]^+Cl^-$$

hydrochloric acid salt of methylamine — methylammonium chloride

Amines, being derivatives of ammonia, exhibit strong basic properties. These are organic bases. The basicity of amines is due to the presence of an unshielded pair of electrons in nitrogen that does not participate in the formation of a covalent bond, and their ability to attach a hydrogen proton. Amines can react with proton acids and electrophilic reagents due to an unshielded electron pair.

Отформатировано: По ширине

Amines in an aqueous solution are in the form of substituted ammonium hydroxides, which dissociate to form a hydroxyl ion and a substituted ammonium ion.

Due to the hydroxyl ion, aqueous solutions of amines have a basic character.

Experience 3. Determination of basicity of a solution of methylamine

Reagents: water solution of methylamine, 1% alcohol solution phenolphthalein, litmus paper

Отформатировано: Отступ: Слева: 1 см, Выступ: 2 см

A few drops of an aqueous solution of methylamine are placed in a test tube, and 1-2 drops of a solution of phenolphthalein are added. Pink coloring appears.

Отформатировано: По ширине

A drop of an aqueous solution of methylamine applied to red litmus paper causes blue staining.

The appearance of blue staining with litmus paper and red with a solution of phenolphthalein is due to the alkaline nature of the aqueous solution of methylamine.

$$CH_3NH_2 + HOH \longrightarrow [CH_3NH_3]^+OH^-$$

methylammonium hydroxide

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 12 пт

Отформатировано: Шрифт: 6 пт

Отформатировано: По ширине

Amines in an aqueous solution are in the form of substituted ammonium hydroxides, which dissociate to form a hydroxyl ion and a substituted ammonium ion. Due to the hydroxyl ion, aqueous solutions of amines have a basic character.

Experiment 4. Isonitrile reaction

Reagents: methylamine solution, ethyl alcohol, chloroform, concentrated sodium hydroxide solution, sulfuric acid

1 ml of methylamine solution is added to the test tube, an equal volume of alcohol is added, 2-3 drops of chloroform and 1 ml of a concentrated alkali solution. The mixture is thoroughly mixed and heated. When heated, the characteristic unpleasant smell of isonitrile is soon detected.

Отформатировано: По ширине

After completing the experiment, the isonitrile is decomposed with a solution of sulfuric acid.

$$CH_3NH_2 + CHCl_3 + NaOH \xrightarrow{t°} CH_3N{\equiv}C + NaCl + H_2O;$$

$$CH_3N{\equiv}C + HOH \xrightarrow{H_2SO_4} CH_3NH_2 + HCOOH$$

The isonitrile reaction is a specific reaction to the primary amino group.

Note. Isonitrile has a persistent unpleasant smell and is extremely toxic. Therefore, it must be obtained in a fume hood.

Отформатировано: Шрифт: 12 пт
Отформатировано: Шрифт: 12 пт
Отформатировано: Шрифт: 12 пт
Отформатировано: Шрифт: 12 пт
Отформатировано: Шрифт: 4 пт
Отформатировано: По ширине

Experience 5. Obtaining salts of aniline

Reagents: aniline, concentrated solutions of sulfuric and hydrochloric acids

In a test tube, mix 1 drop of aniline with 1 ml of water, shake the mixture. A red litmus test and a solution of phenolphthalein check the reaction of the medium in the resulting emulsion, dissolution does not occur.

Отформатировано: По ширине

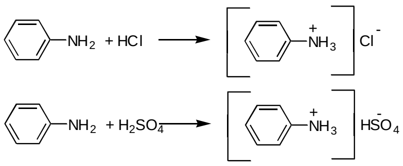
The contents of the test tube are divided into two parts. To the first part, 0.5 ml of a solution of sulfuric acid is added drop by drop, and a precipitate of a hard-to-dissolve aniline sulfuric acid salt is formed. To the other part, add concentrated hydrochloric acid drop by drop until a clear solution is formed. After that, a concentrated solution of sodium hydroxide is added to the resulting solution drop by drop.

Experience 6. Condensation of aniline with formaldehyde

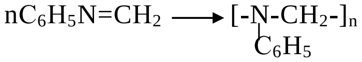
Reagents: aniline water, 10% formalin solution

To 5 ml of aniline water, add 2 ml of 10% formaldehyde solution drop by drop. Gradually, a white precipitate is formed.

Отформатировано: По ширине



$$C_6H_5NH_2 + HC(O)H \longrightarrow C_6H_5N{=}CH_2 + H_2O$$



$$nC_6H_5N{=}CH_2 \longrightarrow [\text{-}\underset{C_6H_5}{\underset{|}{N}}\text{-}CH_2\text{-}]_n$$

This reaction can be used as a qualitative reaction to aniline and formaldehyde.

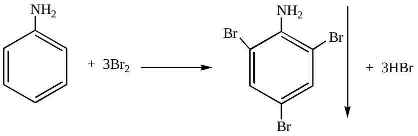
Отформатировано: По ширине

Experience 7. Bromation of aniline

Reagents: aniline water solution, bromine water

In a test tube, pour 5 ml of an aniline water solution and add bromine water drop by drop. Bromine discoloration and precipitation of difficult-to-dissolve 2,4,6-tribromaniline is observed.

Отформатировано: По ширине



Bromination of primary aromatic amines is used in pharmacy for quantitative analysis.

Отформатировано: По ширине

Experience 8. The interaction of amines with nitrous acid

Reagents: ethylamine, aniline, concentrated hydrochloric acid, 5% and 30% solutions of sodium nitrite

A. in a test tube, pour 6 drops of ethylamine, 3 drops of concentrated hydrochloric acid, 5 drops of 5% sodium nitrite solution. Observe the release of gas.

Отформатировано: По ширине

$$NaNO_2 + HCl \longrightarrow HNO_2 + NaCl$$

$$C_2H_5NH_2 + HNO_2 \longrightarrow C_2H_5OH + N_2\uparrow + H_2O$$

B. in a test tube, pour 4 drops of aniline, 2-3 ml of water and 2 drops of concentrated hydrochloric acid, add a piece of ice. The test tube with the solution is placed in a glass with ice and cooled to 0-50C. When shaking, add 5 drops of 30% sodium nitrite solution drop by drop. Primary aromatic amines react with nitrous acid to form diazonium salts.

Отформатировано: По ширине

$$C_6H_5NH_2 + HCl \longrightarrow [C_6H_5NH_3]^+Cl^-$$

$$NaNO_2 + HCl \longrightarrow HNO_2 + NaCl$$

$$[C_6H_5NH_3]^+Cl^- + HNO_2 \longrightarrow [C_6H_5N{\equiv}N]^+Cl^- + 2H_2O$$

Control question

1. What compounds are called amines? What is their classification?
2. Why do amines have basic properties? What reaction can be used to prove the basic properties of amines?
3. What is observed when adding hydrochloric and sulfuric acids to amines?
4. How do the main properties in the series primary, secondary, and tertiary amines change?
5. Make up the structural formulas of all amines of the $C_4H_{11}N$ composition and name them. How many of them are secondary and tertiary amines?
6. Give the main ways to obtain amines.

Отформатировано: По ширине

7. By what reactions it is possible to distinguish aliphatic and aromatic primary, secondary and tertiary amines? Give the corresponding reaction equations.

8. What compounds are formed When primary, secondary, tertiary aliphatic and aromatic amines interact with nitrous acid?

9. What reactions are typical only for primary amines?

10. What is an isonitrile reaction? With the help of what reagent it is?

11. The reaction can be considered to aniline?

12. Explain the effect of the amino group on the reactivity of the aromatic ring in electrophilic substitution reactions.

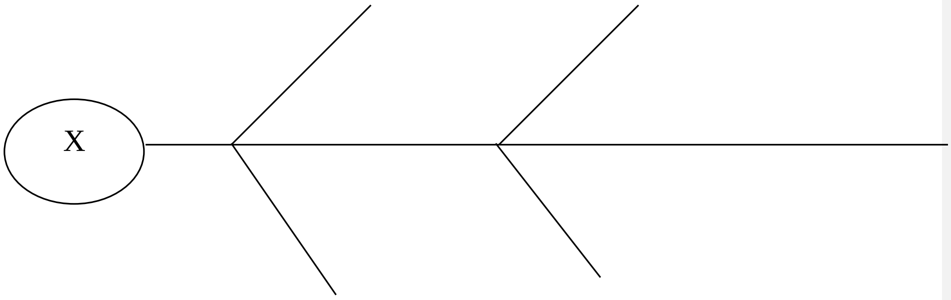
13. Which sequence of reactions of aniline to obtain p-bromoaniline?

14. How does the acylation of an aromatic amino group affect its basicity, direction, and rate of the electrophilic substitution (S_E) reaction in the benzene core?

15. Compare the reactivity of aniline and acetanilide in the reactions of halogenation and nitration. Write the corresponding reaction equations.

Task: Create a graphic organizer "fish skeleton"

X – methylamine, aniline



~~**Homework:**~~

~~Diazo-, azo-compounds.The reaction of diazotization of aniline, the synthesis of methylorange.~~

~~*Exercises* №1, 2, 6, 7, 10, 11, 12, 14 (pp. 134-136).~~

~~*Experiments* №96, 97, 98, 99, 100.~~

~~**Literature**~~: ~~1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 317-328.~~

~~2. Karimov A., Chinibekova N. Practicum on organic chemistry.~~

~~T.: "EXTREMUM", 2010. – p. 132-139.~~

LESSON № 17

1. Theme: Diazo-, azo compounds. The reaction of diazotization of aniline, the synthesis of methylorange.

Отформатировано: По ширине

2. Class duration: 3 hours.

3. The purpose of the lesson: to Form students ' knowledge about the high chemical activity of diazo-, azo compounds.

Отформатировано: По ширине

4. Objectives: by the end of the lesson, the student must:

4.1. know the structure and nomenclature of diazo-, azo-compounds;

4.2. write methods for obtaining diazo - and azo compounds;

4.3. apply knowledge of the reactivity of diazo compounds to plan the synthesis of various classes of aromatic compounds;

4.4. be able to carry out the reaction of diazotization and azo combination.

5. Basic training questions.

5.1. The nomenclature of the diazo - and azo-compounds.

5.2. Obtaining the diazonium salts. Conditions for the diazotization reaction.Reaction mechanism.

5.3. The electronic structure of the diazonium cation. Ion - and covalent-constructed (diazo compounds proper) diazo compounds.

5.4. Chemical properties of diazo compounds.

5.4.1. Acid-base transformations.

5.4.2. reactions of diazo compounds accompanied by the release of nitrogen (substitution of the diazo group for hydroxyl, iodine, bromine, chlorine, cyanogroup, hydrogen, alkoxygroup), production of organometallic compounds.

5.4.3. Reactions of diazo compounds without nitrogen excretion (recovery reaction associatia). Mechanism of the azo combination reaction.

5.4.4. The conditions of the reaction of associatee with phenols and amines. Diazo - and azo-compounding.Synthesis of azo dyes.

5.5. Chemical properties of azo-compounds.

6. Self-study (performed in preparation for the lesson).

Some representatives of azo dyes: methylorange, Congo red, Indigo. The theory of color.

7. Demonstration.

Video of the virtual laboratory – "Indicators".

PRACTICUM

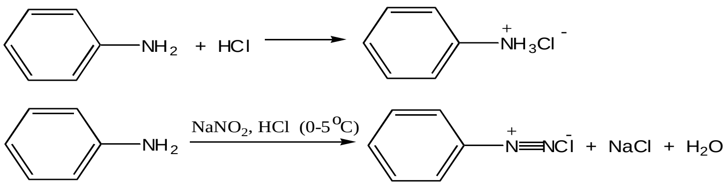
Experience 1. Interaction of aniline with nitrous acid

(diazotization reaction)

Reagents: aniline, 10% sodium nitrite solution, dilute hydrochloric acid (1:2), ice

1 ml of aniline is added to the test tube, dilute (1:2) hydrochloric acid is added until the aniline is completely dissolved, and a few pieces of ice are added. The solution is cooled to 0° and 1 ml of 10% sodium nitrite solution is added drop by drop. The temperature of the mixture should not rise above 5^0C (regulated by adding ice pieces to the reaction mixture):

Отформатировано: По ширине



The liquid remains transparent. The mixture was thoroughly stirred. 1 drop of the reaction mass with a glass rod is placed on an iodine-starch paper (filter paper treated with potassium iodide and starch). When applying a sample containing nitrous acid, free iodine is released, which forms a blue-purple complex with starch.

Отформатировано: По ширине

The appearance of staining on the iodine starch paper indicates the completion of the diazotization reaction:

$$2NaNO_2 + 2HCl \longrightarrow HNO_2 + NaCl$$

~~2KJ~~ 2KI + $HNO_2 \longrightarrow 2NO +$ ~~J_2~~ I_2 + KOH

If the color of the iodine-starch paper does not change, then a few drops of sodium nitrite solution are additionally added to the reaction mixture. The mixture is mixed and the sample is taken again. Diazotization is stopped when an excess of nitrous acid appears in the mixture, which does not disappear when shaken for several minutes.

Отформатировано: По ширине

The test tube with the resulting solution is placed in a mixture of ice and salt and stored for subsequent experiments.

Experience 2. The decomposition of the diazonium salt when heated

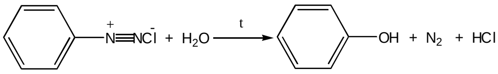
Reagents: phenyldiazonium chloride, iron (III) chloride.

1 ml of the benzoldiazonium chloride solution obtained in the previous experiment is placed in a test tube and slightly heated in a burner flame. There is a

Отформатировано: По ширине

rapid release of gas bubbles – nitrogen, which continues in the future and without heating.

At the end of the reaction vial stoppered with a gas outlet tube, end of which is immersed in a dry test-tube. The solution in the test tube is heated. The phenol formed during the decomposition of the diazonium salt is distilled with water vapor:



Feels the characteristic smell of phenol. When adding 1 drop of iron (III) chloride solution to the phenol solution, purple staining is observed.

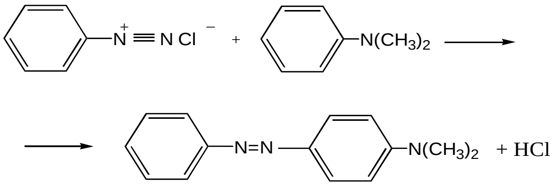
Отформатировано: По ширине

Experience 3. Obtaining aniline yellow

Reagents: phenyldiazonium chloride, 5% sodium acetate solution, dimethylaniline, concentrated hydrochloric acid

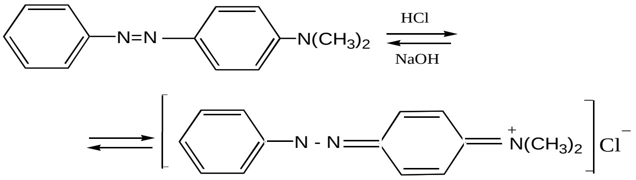
1 drop of dimethylaniline, 5 drops of water are placed in a test tube and concentrated hydrochloric acid is added drop by drop until a clear solution is formed. The mixture is cooled and 1 ml of the phenyldiazonium chloride solution obtained in experiment 1 is added and shaken vigorously. When 2-3 drops of 5% sodium acetate solution are added to the test tube, a yellow-orange precipitate of the main dye, p-dimethylaminoazobenzene, is observed:

Отформатировано: По ширине



A few drops of the resulting azo dye solution and 5-6 ml of water are mixed in a test tube. When a few drops of 10% hydrochloric acid solution are added to the test tubes, the yellow color of the solution disappears and the red color appears. When alkalizing, the yellow color of the solution is restored again:

Отформатировано: По ширине

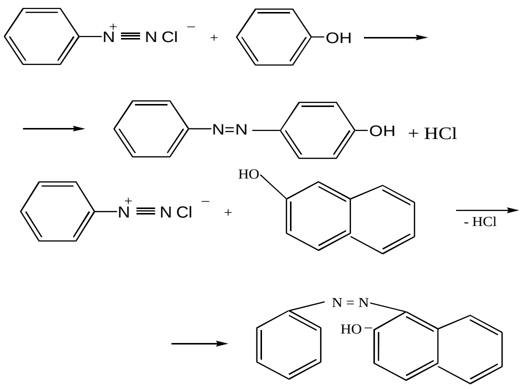


Experience 4. Obtaining aniline orange

Reagents: phenyldiazonium chloride solution, 10% sodium hydroxide solution, phenol, β-naphthol

In one test tube, 1 ml of 10% sodium hydroxide solution and 0.1 g of phenol is mixed, in the other – 1 ml of 10% sodium hydroxide solution and 0.1 g of β-naphthol. In both test tubes, add 1 ml of a solution of phenyldiazonium chloride obtained from experiment 1. In the first, an orange color immediately appears; in the second, an orange precipitate.

Отформатировано: По ширине



Control question

Отформатировано: По ширине, Отступ: Первая строка: 0,75 см

1. What compounds are called diazo compounds? Their classification.
2. Explain the effect of solution ph on the structure of diazo compounds.
3. What reaction is called a diazotization reaction? Given example.
4. What types of chemical transformations are characteristic of diazonium salts? Write the corresponding reaction equations.
5. Explain the mechanism of reactions of diazo compounds that occur with the release of nitrogen.
6. Suggest a scheme for the synthesis of 1,3,5-tribromobenzene from aniline.
7. Using the example of m-methoxybenzene diazonium chloride, explain how you can replace the diazogroup with the following groups: a) -H, b) -OH, c) -Cl, d) -OCH_3, e) -Br, e) -CN, k) -NO_2. Write the reaction equations and name the products.
8. What reaction is called the azo combination reaction? Given example.
9. What compounds are called azo compounds?
10. Why are azo compounds colored?
11. What functional groups belong to auxochromes and chromophores?
12. List the factors that significantly affect the color of compounds. Is the colored substance always a dye? Explain the answer.

Task: Fill in the table ("Assessment").

Diazo-, azo compounds

TEST	**PROBLEM SITUATION**
1. What compound is formed when nitrous acid acts on aniline? A. Unstable salt B. Phenyldiazonium chloride C. Nitrosamine D. Phenol 2. Specify the reaction of the phrase. A. $C_6H_5\text{-}NH_2 + HCI \rightarrow$ B. $[C_6H_5\text{-}N\equiv N]^+CI^- + HOH \rightarrow$ C. $[C_6H_5\text{-}N\equiv N]^+CI^- + C_6H_5N(CH_3)_2 \rightarrow$ D. $[C_6H_5\text{-}N\equiv N]^+CI^- + AgOH \rightarrow$	p-bromo-p'-hydroxyazobenzene was obtained from aniline via a diazo compound. Give the sequence of reactions by which this transformation is possible.
GLOSSARY 1. **Diazo compound** - … 2. **Azo connection** - …	**PRACTICAL SKILL** Which of the following reagents can be used to distinguish diazo compounds from azo compounds. 1. HC1 2. H_2O 3. NaOH 4. burn What is observed in this case?

~~**Homework:**~~

~~The sulfonation.Synthesis of the sodium salt of p-toluene sulfonic acid.~~

~~**Literature**: 1. Chernykh V. P., Zimenkovsky B. S., Gritsenko I. S. Organic chemistry. – Kh.: Original, 2007. – p. 527-535~~
~~2. Karimov A., Chinibekova N. Practicum on organic chemistry. – T.: "EXTREMUM", 2010. – p. 242-243.~~

LESSON № 18

1.Theme: Types of organic compounds, their mechanism.

Отформатировано: По ширине

2. Class duration: 3 hours.

3.The purpose of the lesson: to Form knowledge about the high chemical activity of diazo-, azo compounds.

4. Objectives: by the end of the lesson, the student should know:

1. Types of organic reactions;
2. Addition reactions and their mechanism;
3. Substitution reactions and their mechanism;
4. Cleavage reactions and their mechanism;
5. Reactions of oxidation and reduction.

5.Basic training questions.

1. Types of organic reactions.

2. Addition reactions in compounds with a multiple bond (electrophilic and radical accession) of the mechanism.

3. Addition reactions in exocoetidae (nucleophilic accession) of the mechanism.

4. Substitution reactions in aliphatic (radical substitution) and aromatic hydrocarbons (electrophilic substitution), mechanism.

5. Oxidation and reduction reactions of alcohols, oxo compounds, phenols, and carboxylic acids.

Exercises

1. Radical substitution reactions for a tetragonal carbon atom in alkanes, mechanism (for example, the isobutane halogenation reaction).

Отформатировано: По ширине

2. Write the hydrohalogenation reactions of butene-1 in the presence and absence of hydrogen peroxide. Explain the reaction mechanisms. In a reaction, the accession goes according to Markownikov's rule?

3. Write the reaction of ethyl acetylene with a) HC1, b) H_2O (Hg^{2+}). Explain the reaction mechanism.

4. Under what conditions should isopropylbenzene bromination reactions be performed to introduce a halogen atom into the aromatic core and side carbon chain? Give the appropriate reactions and reaction mechanisms.

5. Give the reaction of propyl bromide and tert.pentylbromide with a water and alcohol solution NaOH. Explain the mechanism of reactions.

6. Write the reaction between propyl and tert.butyl alcohol with hydrogen halide. Explain the reaction mechanism.

7. Write the reaction of propionic aldehyde with: 1) HCN, 2) NH_3. Explain the reaction mechanism.

Control questions

Отформатировано: По ширине

1. What reactions are called organic? Their classification.

2. What is the mechanism of substitution reactions in aliphatic compounds?

3. What type of organic reactions characteristic of alkenes and alkynes? What is their mechanism?

4. Under what conditions does b addition in alkenes proceed by an electrophilic mechanism or by a radical mechanism?

5. What Is the mechanism of hydration of alkynes?

6. Explain the addition in aldehydes and ketones. What is their mechanism?

7. Give examples of reactions of oxidation and reduction of organic compounds. What classes are they typical for?

Recommended literature

1. Черных В.П., Зименковский Б.С., Гриценко И.С. «Органическая химия». Харьков, «Основа».т. 1-3, 1998.
2. Каримов А., Чинибекова Н. «Практикум по органической химии». Ташкент, 2010.
3. Черных В.П., Зименковский Б.С., Гриценко И.С. «Органическая химия». Харьков, «Оригинал». 2007.
4. Черных В.П. и др. «Общий практикум по органической химии». Харьков, «Золотые страницы», 2002.
5. Черных В.П.«Лекции по органической химии», Харьков, «Золотые страницы», 2003.
6. Сборник тестов по органической химии под ред. В.П.Черных, Харьков, «Оригинал», 2003.
7. Chernyukh V.P., Shemchuk L.A. “Organic Chemistry”. Kharkiv, “Original’, 2011.
8. Paula Yurkanis Bruice. “Organic Chemistry”. Santa Barbara, 2011.

~~9. www. Ziyonet.~~