AZERBAIJAN REPUBLIC

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SYSTEM OF WORK ON THE ORGANIZATION OF CHEMISTRY EXPERIMENTS IN GENERAL EDUCATİON SCHOOLS

Speciality: 5801.01 - Theory and methodology of training and education
(Methods of teaching chemistry)

Field of science: Pedagogy

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ABSTRACT

of the dissertation for the degree of PhD in Pedagogy

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The dissertation work was carried out in the Institute of Education of the Republic of Azerbaijan.

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GENERAL CHARACTERISTICS OF THE STUDY

Relevance and development of the topic. After gaining independence, fundamental reforms were launched in the field of education in the Republic of Azerbaijan. Reconstruction of education in our country on a national basis and in accordance with European standards, which is one of the most relevant and important areas, is an important task for the education system.

Major updating of the content of education is an important part of the state's education policy. The first direction of the "State Strategy for the Development of Education in the Republic of Azerbaijan" approved by the President of the Republic of Azerbaijan on October 24, 2013 envisages the creation of the content of personality-oriented education, development of curricula for all levels of education.

Today, the new education reform in our schools serves to provide students with quality knowledge. The normative legal documents adopted in recent years in connection with education state that the education of mentally, morally, ethically, aesthetically developed, physically healthy and vital students is an important condition today.

We live in a world where the events around us, science, techinique and technology are changing rapidly. Such changes place new demands on the development of the school personality. In order to adapt to constantly changing conditions, people must be ready for the necessary life skills, agile thinking, self-development and self-improvement, and strive to realize their potential. Naturally, these qualities are instilled in students in general education schools. It is difficult to instill life skills in students in a teacher-led learning process. In the process of learning based on explanatory-illustrative memory, the teaching of theoretical issues prevails, the content of the lesson is not adapted to the needs of life. In the learning process, some teachers do not take into account the personal experience, abilities and individual characteristics of students. At present, the content of education should be defined in such a way that it serves to develop children's understanding, understanding the causes of events and the ability to make the right decisions. For this reason, the learning process should be in accordance with the interests and needs of students, the level of knowledge, opportunities and abilities, and the application of active learning methods in the classroom should be preferred. Only in this way it is possible to develop in students the skills that are necessary for life. Creating a learning process based on modern learning principles will help students acquire the following skills: acquire the most important information, interact, do individual work, acquire knowledge independently through research, collect information, enforce the knowledge and skills they have acquired, etc. .

The main problem of modern training is to update the structure of training, its forms and methods. Interactive teaching methods and new learning technologies are currently being used in schools. However, our observations and surveys show that most school teachers are not able to use active learning methods. One of the main reasons for this is the lack of knowledge of our teachers about the features of active learning, the lack of scientific and methodological literature on this problem, the lack of serious scientific research. The understanding of the theoretical foundations of chemistry manifests itself in the experimental application of its laws and regularities. To date, several books have been published explaining the theoretical foundations of chemistry, but no scientific research or books have been published on the organization and conduct of chemical experiments. It is not possible to check on a daily basis by chemical experiment how a student has mastered the theoretical foundations of chemistry due to the volume of textbooks in general education schools' chemistry textbooks, the lack of class hours, and the poor organization of laboratories. Therefore, we have begun to research the existing dissertation in order to create such an option to solve this problem.

No research has been conducted on the application of active learning methods to the application of the theoretical foundations of chemistry from chemistry to experiments, and experiments in this field have not been generalized. Therefore, the school attracts attention by studying the theoretical and practical problems of the application of modern teaching methods in the teaching of chemistry, generalizing existing experiences, giving recommendations to teachers. Therefore, we consider it important to write a dissertation on "The system of work on the organization of experiments in chemistry in general education schools."

The main issue that confirms the relevance of the research is the implementation of the following standards and sub-standards in the content / line of experimentation and modeling.

Content line: experiment and modeling

Standard

3.1. Conducts experiments on chemical phenomena and their regularities.

Substandard

3.1.1. Conducts practical work on chemical compounds and polymers (large-molecule compounds) and prepares presentations.

Standard

3.2. Model the structure of the molecule, chemical processes.

Substandard

3.2.1Carries out the structure of chemical compounds and polymers (large-molecule compounds), their chemical phenomena.

The aim of the research is to modernize the teaching of chemistry by organizing and conducting experiments on chemistry in general education schools, to improve the quality of teaching, to determine the advantages of extracurricular activities in mastering the theoretical foundations of chemistry through experiments, to summarize the results and develop recommendations for practice.

Research objectives. The main objectives of the research are:

– to analyze scientific-pedagogical and methodical literature on the problem;

– to learn the school experience to solve the problem;

– to determine the ways of applying the methods of organizing and conducting experiments in mastering the theoretical foundations of chemistry;

– to organize and conduct experiments on chemistry using active learning methods in extracurricular activities;

– to prove the effectiveness and reliability of the modern methodology we apply through school experiments.

The scientific novelty of the research is that for the first time in VII-XI grades of general education schools the possibilities and ways of using modern learning technologies in organizing and conducting chemistry experiments in teaching chemistry and extracurricular activities for mastering the theoretical foundations of chemistry were identified and a system of work has been created by identifying ways to use them effectively.

Provisions submitted for defense:

– formation of a new educational infrastructure created by the application of ways of organizing and conducting experiments in chemistry;

– increase the interest in the subject in low-achieving students through the use of methods of organizing and conducting experiments in chemistry in extracurricular activities in the teaching process, impact on better mastering of the subject;

– the impact of the resources developed for the organization and conduct of experiments on chemistry on the effective use of students' knowledge and the development of students' attention, logic, memory and speed of information reception;

– creation of a favorable system between the theoretical foundations of chemistry and practical application.

The theoretical significance of the research is that revealing the possibilities of using modern teaching methods to organize and conduct chemistry experiments in the teaching of chemistry in general education schools, identifying ways of application, giving the necessary recommendations to practitioners can enrich the methodology of teaching chemistry with new scientific provisions.

The practical significance of the research. The results of the research can be used in universities that train chemistry teachers, in lectures and seminars on modern courses, in the preparation of methodical aids related to active learning, in the teaching of chemistry in accordance with modern requirements in grades VII-XI of general education schools. When the results of the research are applied, the pupils or students clearly understand the connection between practice and theory, take into account in their lifestyle by studying the relationship of chemistry to everyday life. If pupils and students master chemistry better by conducting experiments on chemistry in extracurricular activities, their creative activity will expand.

Approbation of the research results was carried out with the application of teaching and methodological aids, methodical recommendations and instructions, conclusions, suggestions and recommendations in various general education schools. Reports and speeches on the results of the research were made at International scientific-methodical and scientific-practical conferences, pedagogical lectures, in front of teachers of city and district schools, subject methodological associations.

The results of the research are reflected in 16 scientific-methodical articles and 5 theses.

The organization where the dissertation work is carried out. Institute of Education of the Republic of Azerbaijan.

The structure and volume of the dissertation. The dissertation consists of an introduction, 3 chapters with 25 paragraphs, a conclusion and a list of references.

Introduction - 5, Chapter I - 27, Chapter II - 71, Chapter III - 24, result - 1, list of used literature - 12 pages, the dissertation consists of a total of 211,000 characters.

MAIN CONTENT OF THE RESEARCH

In the introductory part of the dissertation the relevance of the topic is substantiated, methodological bases, purpose, object, working hypothesis, tasks, stages are defined, scientific novelty, theoretical and practical significance of the work, results are explained, main provisions are shown.

Chapter I of the dissertation "The essence, content, organization and implementation of experiments in chemistry in general education schools" examines the scientific results of research conducted in general education schools in 1960-2017, analyzes and summarizes the practical results of research.

The half chapter 1.1 of chapter I explains the essence of chemistry experiments in general education schools.

Chemistry, which is one of the general education subjects, plays an important role in the implementation of the important issues of the

Education Law of the Republic of Azerbaijan adopted in 2009. In order to carry out these tasks, chemistry teachers use both the lesson, which is the main organizational form of training, and auxiliary forms: association sessions, chemistry evenings, question-and-answer evenings, chemistry games, chemistry experiments, etc. should be used as a powerful means of influence.

Among the auxiliary forms of teaching chemistry, mass forms of extracurricular activities are very important. To date, no research has been conducted on the organization and conduct of mass forms of extracurricular (extracurricular) work in chemistry, and no guidance materials have been written for teachers.

Auxiliary forms of chemistry training mainly include training excursions, optional classes (interest classes), chemistry evenings (extracurricular activities). These three important forms of chemical experiments (laboratory experiments, practical work) serve the deep mastery of chemistry.

Ways to organize and conduct chemistry experiments are important in terms of deepening and expanding students' knowledge on chemistry, preparing students for practical activities. Experiments in chemistry are based on students' independent work methods, natural creative desires, teaching interests in chemistry, are organized and conducted in various forms.

The semi-title 1.2. of chapter I of the dissertation explains the ways of the organization and conduct of chemistry experiments in general education schools.

This semi-title provides ways to use other forms of extracurricular activities (such as chemistry games, question and answer evenings, chemistry olympiads, etc.) to conduct more experiments in chemistry and how to conduct them.

In order for students to carry out practical work, first of all, it is necessary to follow the general rules of work in the laboratory:

- behave test tubes, measuring cups, tripods, alcohol lamp or gas stove;
- dissolve solids, heat, filter;
- behave with acids and alkali solutions;
- to prepare solutions of the required percentage and molar

concentration;

- to follow safety rules.

Before starting work, the teacher checks the theoretical and practical knowledge of students about the practical work to be carried out. Gives additional advice on the main stages of the experiments and the preparation of a report that students will prepare in tabular form.

Writing a practical work in a student’s notebook includes the following:

- date of the month;
- serial number of practical work;
- job title;
- purpose of work;
- resources;
- the report on the implementation of the work is prepared in tabular form.

The following is a methodological recommendation for conducting practical work on the topic «Preparation of a solution of the required concentration» by the method of interactive training.

Purpose:

- students' knowledge of important chemical concepts (mass of solution, mass fraction of soluble substance, saturated and unsaturated solutions, liquid and solid solutions) is strengthened;
- to teach concentration with percentages by repeating knowledge of measured quantities;
- solve computational problems by combining theoretical and practical knowledge;
- to accustom students to laboratory practice, to teach to weigh, to use solid and liquid substances in carrying out work;
- conducting experiments in the laboratory, teaching to observe and draw conclusions.

At the end of the lesson, the student should know and be able to:

- to follow safety rules in the laboratory;
- methods for expressing the concentration of solutions;
- rules for working with reagents, containers, scales used to prepare solutions in the laboratory;
- install and work with a simple device;

- to perform theoretical calculations to prepare a solution in a certain concentration;

- determine the mass fraction of solute in solution;

- to prepare solutions of various substances in molar concentration;

- to prepare a report of practical work in the form of a table;

- calculation of percentage and molar concentration of the solution.

Experience shows that learning the instructions for practical training at home is less effective. At each stage of the practical training, the task should be briefly stated and the implementation mechanism should be clearly written.

The teacher's activity during the practical training, which will be performed by students, consists of several stages;

1) Preparation for the practical training to be carried out;

2) Study of theoretical and technical aspects of practical training;

a) Study of the subtleties of chemical reactions to be carried out in a practical training, the characteristics of the device to be used. Drawing up a work schedule according to the following example.

The name of work.

The purpose of the work.

Reagents and accessories. Picture of the device (if necessary).

Technical safety.

b) Supervise students' practical work with clear and short tasks during the practical training according to the given instructions;

c) Technical preparation for work - providing all groups of students with the necessary equipment and reagents;

d) Preparation of students for work in the form of homework;

1) Carrying out practical work in the classroom.

2) Analysis and evaluation of students' practical work.

Students' written reports are often evaluated to check their practical work. In order to evaluate the practical skills of students, the process of implementation of this work should be organized. To do this, the teacher must determine what practical skills are formed in the students in the given work. She then writes the names of the operations performed by the students on the registration sheet and notes the grades she gave them. A new chemistry teacher warns 2-3 students in advance that they will evaluate their practical skills.

Laboratory work allows students to consciously master knowledge-related skills, as well as knowledge of chemistry.

The teacher increases the efficiency of laboratory work by following a number of requirements:

– The teacher clarifies the topic, course, and result of the laboratory work in advance, executes it in a short time before the lesson and checks the result;

– The teacher informs students about the topic, purpose, stages of practical training (laboratory work), reminds safety rules;

– The teacher closely monitors the progress of the practical training conducted by students, guides students in difficulties, helps them to develop practical skills;

– The teacher supervises the summarization of the results of the practical training and the preparation of reports.

No method other than laboratory work has the ability to organize and manage independent research. Analysis of school experience shows that the organization of practical classes (laboratory work) in groups or in pairs is more effective.

In the third paragraph of Chapter I, it was determined that its proper organization was more effective before practical work was carried out.

The fourth paragraph of Chapter I defines the role of laboratory work and discussion of its results in the mastery of chemistry.

In the fifth and sixth paragraphs of Chapter I, the methodology of organizing and conducting experiments on various topics in chemistry is given.

Skills gained in laboratory work and chemistry practicums help to solve problems encountered in life. Depending on its character, laboratory work can be organized in school laboratories, subject classrooms, school grounds, production facilities.

It is a well-known fact that chemistry, taught in general education schools has more opportunities to develop both empirical and theoretical thinking and to shape existing ones than other subjects. Empirical knowledge about objects and events is acquired with the help of sensory organs and is expressed in concepts (declarative knowledge). Empirical thinking is based on methods such as observation, experiment, comparison, description, systematization, develops and improves the life skills gained through these methods. Theoretical thinking, unlike empirical thinking, is based on the methods of analysis, idealization, abstraction, modeling, inference, analogy - similarity.

Students' knowledge and skills are tested with the help of experimental assessment tools. At the same time, students gain conceptual knowledge and acquire certain skills through this assessment. Experimental assessment tools also form an algorithm for conducting demonstrations and laboratory experiments in students.

Analysis of the results of in-school assessment shows that the systematic implementation of experimental tasks in the process of teaching chemistry overshadows the formation of theoretical physical thinking. In this case, the results obtained during the assessment of students' knowledge and skills can be formal. In the development of assessment tools, it is important to prioritize the testing of personality-oriented skills such as observation, comparison, classification, grouping, and analysis of results in accordance with the requirements of the standards.

Chapter II of the dissertation presents experiments on general chemistry and problem-solving methods.

Some schools (lyceums and gymnasiums) in the big cities of the country have chemistry laboratories. Although some general education schools have chemistry laboratories, they do not have the necessary equipment and materials to conduct experiments. Some schools do not have chemistry laboratories at all. Therefore, in order to increase students' interest in chemistry in such schools, it is more convenient to use chemistry problem-solving methods in association classes and chemistry evenings.

In the important state document on the main directions of general education and vocational school has been noted that one of the most important tasks of a general education school is to provide students with long-term knowledge of the basics of science, to instill in them the skills and habits to apply this knowledge in practice.

In addition to the lesson, extracurricular activities on the organization of chemical experiments and the application of chemical problem-solving methods among the auxiliary forms of chemistry teaching play an important role in the successful implementation of these important tasks for the modern era.

The main purpose of experiments in chemistry, problem-solving methods is to deepen students' knowledge, worldview, increase their interest in chemistry, develop their independence and creativity.

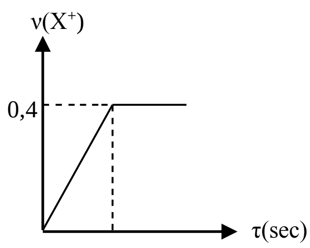
We consider it expedient to conduct chemical experiments, problem-solving methods in the following forms and types, depending on the content: group, mass, individual work.

Chemistry association classes currently plays an important role in the implementation of polytechnic education in our schools. Because it is impossible to find a production area that is not related to chemistry and does not use chemical processes.

Due to the limited time of class, students are not able to learn enough about vital issues. Therefore, in the process of organizing chemistry circles, serious attention should be paid to the fact that students learn practical issues such as the application of chemistry to production. In our opinion, in cases where it is not possible to conduct experiments (laboratory experiments) in chemistry circles, students' interest in chemistry will be even higher if they apply methods to solve problems in chemistry.

Methods for organizing and conducting chemistry experiments on various topics in chemistry and methods for solving problems in chemistry are given in the paragraphs 1-7 of Chapter II. For example, consider the solution of several problems

Task 1.



If the dissociation rate of the X_2CO_3 salt is 40%, calculate the total number of moles of salt dissolved.

Solution: $X_2CO_3 \rightleftarrows 2X^+ + CO_3^{2-}$

$\nu_{(dis)}$=0,2mol 0,4mol

Then from the formula $x = \frac{\nu_{dis}}{\nu_{total}} \cdot 100\%$

$$\nu_{total} = \frac{\nu_{dis} \cdot 100}{\alpha} = \frac{0{,}2 \cdot 100}{40} = 0{,}5 \text{ mol.}$$

Task 2.

Taken salt solution		The mass of evaporated water	In the obtained solution K_h(g/*l*)
$m_{(sol.)}$ (gram)	ω (%)	$m_{(salt)}$+160	x
800	20		

define x:

Solution: In the initial solution $m_{(salt)} = \frac{800 \cdot 20}{100}$ =160 g.

In the same solution $m_{(water)}$=800-160=640g.

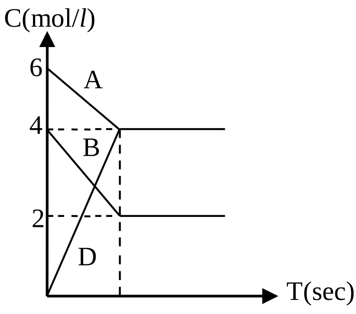
$m_{(water)}$ evaporated =$m_{(salt)}$+160=160+160=320 g.

$m_{(water)}$ remaining =640-320=320g.

$$K_h = \frac{m_{(salt)}}{m_{(water)} \text{remaining}} \cdot 1000 = \frac{160}{320} \cdot 1000 = 500 \text{ g/l}$$

Task 3.

According to the graph, calculate the equilibrium constant of the reaction $A_{(g)} + B_{(g)} \rightleftarrows D_{(g)}$



Solution: $A_{(g)} + B_{(g)} \rightleftarrows D_{(g)}$

t.con. 4 2 4

$$K = \frac{4}{4 \cdot 2} = 0{,}5$$

Task 4.

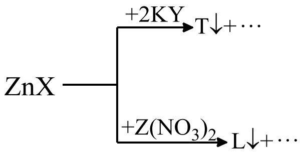
C_x (mol/*l*)	C_y (mol/*l*)	V (mol/*l* · sec.)	Rate constant of the reaction
0,3	1	0,9	k

According to the table, calculate the rate constant (K) of the reaction $X_{(g)} + 2Y_{(g)} \rightarrow 2XY_{2(g)}$.

Solution: According to the formula of the reaction rate depends on the concentration:

$$V = k \cdot C_x \cdot C_y^2; \quad 0{,}9 = k \cdot 0{,}3 \cdot 1^2; \quad k = 3$$

Task 5. Determine compatibility according to the scheme.



1) X^{2-}
2) Y^{-}
3) Z^{2+}

a) OH^{-}
b) Pb^{2+}
c) SO_4^{2-}
d) Cl^{-}
e) Ba^{2+}

Solution: $X^{2-} \Rightarrow c)\, SO_4^{2-} \quad ZnX \Rightarrow ZnSO_4$.

$Y^{-} \Rightarrow a)\, OH^{-}$ can be. d) can not be, because $ZnSO_4$, KCl does not react. $Z^{2+} \Rightarrow$ b) Pb^{2+} and e) Ba^{2+} can be. Now let's check that our choice is correct with the reaction equations.

$$ZnSo_4 + 2KOH \xrightarrow[-K_2SO_4]{} Zn(OH)_2 \downarrow (T)$$

$$ZnSO_4 + Pb(NO_3)_2 \xrightarrow[-Zn(NO_3)_2]{} PbSO_4 \downarrow (L)$$

$$ZnSO_4 + Ba(NO_3)_2 \xrightarrow[-Zn(NO_3)_2]{} BsaSO_4 \downarrow (L)$$

1	2	3
c	a	b, e

Thus, this chapter explains to students the possibilities of mastering the basics of chemistry in depth by demonstrating as many experiments as possible and solving an experimental problem.

Chapter III of the dissertation describes the organization of experiments in inorganic chemistry and methods of solving experimental problems.

Experiment 1._ Obtaining and properties of hydrogen.

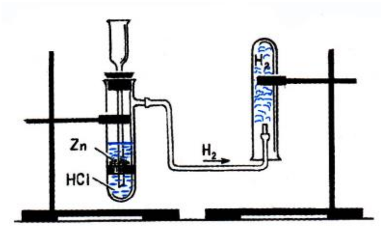


Figure 1. Collection of hydrogen gas by expelling air

Install the device as shown in Figure 1 and check its hermeticity. Place 4-5 zinc pieces in a test tube and add 3-4 ml of chloride acid. Collect the hydrogen by holding the mouthpiece of the test tube with the stopper through which the gas pipe passes. After the reaction stops, pour a few drops of solution on a glass plate and evaporate it. A white crystalline substance remains on the board. Write the answers to the tasks separately.

Task: 1. Unlike oxygen, why is the separated hydrogen collected in a low-lying test tube unlike oxygen?

2. What happens when a test tube containing hydrogen is brought close to the flame?

3. What substance is formed as a result of burning hydrogen? Write the equation of this reaction.

4. Write the equation of the reaction with chloride acid of zinc and write the formula of the substance remaining on the glass plate after the liquid has evaporated. Write the name of that item.

It is not possible for every student to have such an experience. If possible, divide students into 2 groups. If this is not possible, install a device and with the help of a laboratory assistant, allow the most active student to conduct the experiment. Let the other students observe. Then if there are groups, ask groups, if not, ask each student to write the answer to the task in the workbook.

Answer to Question 1: Since hydrogen is lighter than air, you must hold the test tube down to collect it by squeezing the air out of the test tube.

Answer to Question 2: When a test tube containing hydrogen is brought close to the flame, a "pakh" sound or a thundering sound is heard.

Answer to Question 3: When hydrogen burns, water (H_2O) is formed. $2H_2 + O_2 \rightarrow 2H_2O$

Answer to Question 4: $Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$

When the solution evaporates, white $ZnCl_2$ remains on the glass plate. Its name is zinc - chloride.

Experiment 2. Interaction of hydrogen with copper (II) oxide.

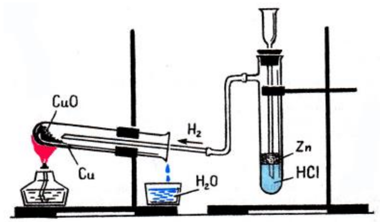


Figure 2. Reduction of copper from copper (II) oxide with hydrogen

Install the device as shown in Figure 2 and check its hermeticity. Add 8-10 pieces of zinc and 5-6 ml of chloride acid solution to the test tube. Close the mouth of the test tube with a stopper through the gas pipe and check the purity of the hydrogen seperated. As shown in Figure 4, the test tube containing CuO should be attached to the tripod slightly inclined so that its mouth is below the bottom, as shown in Figure 4. Heat the test tube from the copper (II) oxide. Stop heating as soon as the powder turns red. A red substance is formed from the black powder of copper (II) oxide and water droplets flow through the walls of the test tube.

Task: 1. Why do people check the purity of hydrogen before heating copper (II) oxide in a hydrogen atmosphere?

2. Why is a test tube containing copper (II) oxide inclined to a tripod?

3. Write the equation of the reaction that occurs.

4. What property of hydrogen does this reaction reflect?

It is possible to install 1 or 2 of such devices in school laboratories. Therefore, if possible, divide your students into two groups. One should be led by a laboratory assistant and the other by a teacher. Because such experiments are very dangerous. If it is not possible to set up two devices, set up one so that all students can observe the experiment and write the answers to the questions in the workbook.

Answer to Question 1: Hydrogen ignites when mixed with oxygen, so its purity must be checked

Answer to Question 2: Attach the test tube to the tripod in an inclined shape, so that the resulting water flows into the chemical glass.

Answer to Question3:

$$H_2 + CuO \xrightarrow{t} Cu + H_2O$$

black red

Answer to Question 4: This reaction shows the reducing properties of hydrogen.

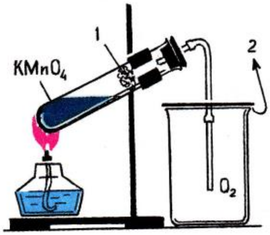


Figure 3. Accumulation of oxygen by expelling air:
1- glass cotton; 2- water

After both experiments, students can be divided into groups. They come to a common opinion. The group representative answers the questions.

Experiment 3. Obtaining and collection of oxygen.

a) Install the device as shown in Figure 3 and check its tightness. Pour about 1/4 of the volume of potassium permanganate into the test tube and place a little grated cotton in the mouth of the test tube. Attach the test tube to the claw of the tripod so that the end of the gas pipe reaches approximately the bottom of the oxygen-collecting cup and cylinder. First, heat the entire test tube. Then gradually move the flame from its bottom to the plug. Check that the glass is completely filled with oxygen with an incandescent stick. Cover the mouth with a cardboard or glass plate as soon as the jar is filled with oxygen.

Task: 1. Why should the mouth of a glass (or cylinder) that collects oxygen be held up?

2. Write the equation for the reaction that occurs when a test tube containing potassium permanganate is heated.

If possible, install 2, if not 1 device. Carry out the experiment with the participation of a laboratory assistant. Ask your students to observe and write the answer to the task on a worksheet.

At the end of the experiment, students are divided into groups and write the answers to the tasks on a worksheet based on their observations. The representative of the group gives a general opinion.

Answer to Question 1: According to the oxygen is heavier than air, the glass (or cylinder) must be held up, so that oxygen can be squeezed out of the air and collected in the glass.

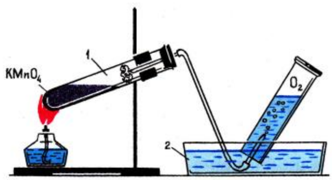


Figure 4. Accumulation of oxygen by squeezing out water: 1- glass cotton; 2- air

Answer to Question 2: $2KMnO_4 \xrightarrow{t} K_2MnO_4 + O_2 \uparrow$

b) Install the device as shown in Figure 4 and check its tightness. Place a test tube containing water (or a cylinder with a glass plate in the mouth) in a container of water. Then insert the end of the evaporator tube into a test tube (cylinder) containing water and heat a large test tube with potassium permanganate. Cover the mouth with a glass plate as soon as the container is filled with oxygen. Save the accumulated oxygen for further experiments.

Task: 1. Why did oxygen accumulate in a test tube filled with water?

The students come to a consensus and one person gives the answer. Like oxygen, gases that do not react with water can be collected in a test tube by squeezing water out.

Experimet 4. Combustion of coal and sulfur in oxygen.

a) Put a small piece of charcoal in an iron spoon and burn it in the fire. Then place the charcoal in a container with oxygen and observe what happens. When the combustion stops, pour a little lime water into the bowl and shake.

Task: 1. Write the equation of the reaction of burning coal.

2. Why did the lime water turn sour? Write the equation of this reaction.

Answers: Students answer questions based on their observations in groups. One group member voices the answer or demonstrates it with a worksheet.

Answer to Question 1: $C + O_2 \rightarrow CO_2$

Answer to Question 2: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3\downarrow + H_2O$.

This means that lime water is turbid due to the white sediment ($CaCO_3$).

b) Put a small piece of sulfur in an iron spoon and burn it on the fire. Observe how sulfur burns in the air. Then insert the burning sulphur to the container containing oxygen.

Task: 1. How does the flame change? Why?

2. Write the equation of the combustion reaction of sulphur.

Answers: Students observe and answer questions as well as an experiment with coal.

Answer to Question 1: When sulfur burns in pure oxygen, the flame intensifies. Answer to Question 2: $S + O_2 \rightarrow SO_2$

Experiment 5. Interaction of metals with salt solutions.

Pour 2-3 ml of copper (II) sulphate into one test tube and the same amount of lead (II) nitrate solution into the other. Insert a thin zinc wire into the first test tube and an iron shavings into the second.

Tasks: 1. What substances are formed in each test tube? 2. What regularities occur in these processes?

Can students do these experiments freely in groups?

At the end of the experiment, after the observation and discussion within the group, they record the general opinions on the worksheet. One representative from each group demonstrates the results of the tasks.

Answer to Question 1:

In the first test bottle: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu\downarrow$

In the second test bottle: $Fe + Pb(NO_3)_2 \rightarrow Fe(NO_3)_2 + Pb\downarrow$

Answer to Question 2: These reactions are based on the order of activity of the metals. Starting with Mg, each metal displaces the next metal from the aqueous solution of the salt.

Experiment 6. Familiarity with important compounds of metals.

a) With the help of incandescent graphite, hold a few small pieces of sodium chloride, potassium chloride, calcium chloride in the flame of a gas lamp. To observe the color of the flame with potassium, it is necessary to look through the blue (cobalt) glass.

Tasks: How can sodium, potassium and calcium salts be distinguished from other salts?

Answer: According to the color of the flame.

Experimental issues.

1) The following crystalline substances were given in four test

tubes for the two variants:

Variant I.: a) calcium - chloride; b) sodium - hydroxide; c) potassium - carbonate; d) barium - nitrate.

Variant II: a) calcium carbonate; b) barium nitrate; c) sodium sulfate; d) potassium chloride

Determine which test tube contains which substance. Write the equations of the corresponding reactions.

Answer: The answer to the variant I: Pour 1 drop of chloride acid into each test tube. Whichever test tube releases gas (c) contains $CaCO_3$. We remove that test tube. b) Add litmus paper to the glass. If the litmus does not change color, then the solution is neutralized. So, b) we also identify and remove the test tube. We add $AgNO_3$ solution to test tubes a and d. If a sediment is obtained, then the test tube contains (a) $CaCl_2$. Add a drop of H_2SO_4 (liquid) to the last (d) test tube to obtain a white $BaSO_4$ sediment.

a) $CaCl_2 + 2AgNO_3 \rightarrow 2AgCl\downarrow + Ca(NO_3)_2$.
b) $NaOH + HCl \rightarrow NaCl + H_2O$
c) $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2\uparrow + H_2O$
d) $Ba(NO_3)_2 + H_2SO_4 \rightarrow BaSO_4\downarrow + 2HNO_3$

The answer to the variant II: Pour a drop of chloride acid into each test tube. Whichever gas is seperated (a), it contains $CaCO_3$. Or we add water to each test tube. If the salt is soluble, then it contains (a) $CaCO_3$. We remove that test tube. Add a drop of $BaCl_2$ to the remaining test tubes. Where white sediment ($BaSO_4$) is obtained, that test tube (c) contains Na_2SO_4. We also remove it. Add $AgNO_3$ solution to the remaining test tubes (b and d). If a white sediment is obtained, then it contains (d) KCl.

a) $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2\uparrow + H_2O$
b) $Ba(NO_3)_2 + HCl \not\rightarrow$ getmir; $Ba(NO_3)_2 + AgNO_3 \not\rightarrow$ getmir
c) $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$
d) $KCl + AgNO_3 \rightarrow AgCl\downarrow + KNO_3$

Experiment 7. Experiments with iron and its compounds

a) Combustion of iron with chlorine. Heat the iron powder in an iron spoon and pour it into a glass jar filled with chlorine (the bottom of the glass jar should be covered with sand).

Tasks. 1. What substance is formed when iron is burned in chlorine?

2. What is oxidizing and reducing in this reaction?

3. Write the equation of the corresponding reaction, indicating the degree of oxidation.

Answers: Students are divided into groups and respond based on their observations. As a result of the general opinion, the group representative voices the answer through the worksheet.

$$\underset{\text{red.}}{2\overset{0}{Fe}} + \underset{\text{oxid.}}{3\overset{0}{Cl_2}} \rightarrow \underset{\text{iron (III) chloride}}{2\overset{+3}{Fe}\overset{-1}{Cl_3}}$$

Answer to Question 1: iron(III) chloride ($FeCl_3$)

Answer to Question 2: iron (Fe) is reducing, Chlorine (Cl_2) is oxidizing.

Answer to Question 3: $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

Experiment 8. Interaction of iron with solid acids.

Pour a little iron shavings into each of the two test tubes. Add some solid sulfuric acid to one test tube and a 50-60% (ie solid) nitric acid solution to the other. Heat the test tube slightly to start the reaction.

Tasks: 1. What substances are formed from the reaction of iron with solid sulfuric acid? Write the equation of the reaction.

2. What substances are formed from the reaction of iron with solid nitric acid? Write the equation of the reaction.

3. Why should the test tube be heated during both reactions?

Answers: As in the previous experiment, groups of students come to a consensus based on their observations and answer questions. The group representative demonstrates the group's opinion with a worksheet.

Answer to Question 1:	$2\overset{0}{Fe} + 6H_2\overset{+6}{S}O_{4(solid)} \xrightarrow{t} \overset{+3}{Fe_2}(SO_4)_3 + 3\overset{+4}{S}O_2\uparrow + 6H_2O$
Answer to Question 2:	$\overset{0}{Fe} + 4H\overset{+5}{N}O_{3(solid)} \xrightarrow{t} \overset{+3}{Fe}(NO_3)_3 + \overset{+2}{N}O\uparrow + 2H_2O$

Answer to Question 3: Both acids passivate iron under normal conditions. Therefore, the test tubes must be heated to allow the reaction to proceed.

Ways of organizing and conducting experiments on halogens

Experiment 1. Chemical properties of chloride acid.

I. Pour the chloride acid obtained from the dissolution of hydrogen chloride in water into six test tubes. Put litmus paper in the 1st test tube. Place zinc pieces or magnesium tape on the 2nd test tube, and copper pieces on the 3rd test tube. Pour a little copper (II) oxide into test tube 4 and heat the solution. Add a little freshly prepared copper (II) hydroxide to the 5th and a little chalk or other carbonate salt to the 6th.

Tasks: 1. Write the equations of the reactions that take place between the indicated substances.

2. How to explain the formation of a blue solution in the 4th and 5th test tubes, and the release of gas in the 6th?

Answers: In the first test tube, the litmus is painted red. This indicates that it contains acid.

In the second test tube, the released H_2 gas $Zn+2HCl \rightarrow ZnCl_2+H_2 \uparrow$ burns.

The $Cu + HCl \rightarrow$ reaction does not proceed in test tube 3.

In the 4th test tube, black CuO dissolves, forming a blue solution.

$CuO + 2HCl \rightarrow CuCl_2 + H_2O$

It is the Cu^{2+} ions in the solution that give the solution a blue color.

In test tube 5, a blue $Cu(OH)_2$ sediment dissolves, forming a blue solution.

$Cu(OH)_2 + 2HCl \rightarrow CuCl_2 + 2H_2O$

In test tube 6, a colorless, odorless CO_2 gas that does not burn in oxygen is seperated, which makes the lime water nauseous.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2\uparrow + H_2O$

Experiment 2. Determination of chloride acid and its salts.

Pour 1-2 ml of dilute chloride acid into one test tube, the same amount of NaCl into the second and KCl into the third. Add a few drops of silver (I) nitrate or lead (II) nitrate solution to all test tubes.

Tasks: 1. Write the equation of the reaction that occurs in each test tube.

2. Check whether the sediment in the test tubes is soluble in nitric acid

Answers: Groups of students perform the tasks assigned to them separately under the guidance of a laboratory assistant and a teacher. Then, based on the general opinion of the group representatives, they write the answers to the given tasks in the workbooks.

Answer to Question 1: $HCl + AgNO_3 \rightarrow AgCl\downarrow + HNO_3$

$NaCl + AgNO_3 \rightarrow AgCl\downarrow + NaNO_3$

$KCl + AgNO_3 \rightarrow AgCl\downarrow + HNO_3$

Answer to Question 2: In all three test tubes, a white AgCl sediment insoluble in nitric acid is obtained.

Experiment 3. Obtaining chloride acid and experiments with it.

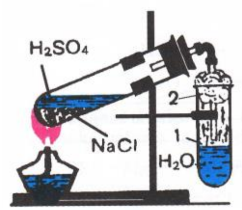


Figure 5. Obtaining chloride acid in the laboratory

Install the device as shown in Figure 5. Pour 2-3 g of table salt into the test tube and add solid sulfuric acid until all the salt is wet. Close the mouth of the test tube with a stopper through which the gas pipe passes. Place the end of the tube in another test tube so that it is about 0.5-1 cm below the surface of the water. Then carefully heat the mixture in the 1st test tube for 5-6 minutes. Make sure that the sulfuric acid does not splash on the test tube, which contains water.

Tasks: 1. Write the equations of the chemical reactions between solid H_2SO_4 and NaCl under normal conditions and under intense heating.

2. What is the reason for the appearance of a thin stream drop in the second test tube?

3. Why should the end of the gas pipe be 0.5-1.0 cm deeper than the bottom of the water?

Experiments 1, 2, and 3 are a bit risky, that’s why it is not possible for several groups to conduct them simultaneously. Such experiments should be conducted with the participation of a laboratory assistant and under the guidance of a teacher. Simply divide the students into groups after the demonstration and ask them to write the answers on the worksheet. This means that as soon as the practice is over, students are divided into groups and answer the questions with a general discussion based on their observations and theoretical knowledge.

Answer to Question 1: $NaCl_{(b)} + H_2SO_{4(solid)} \rightarrow NaHSO_4 + HCl$ (under normal condition)

$$2NaCl_{(b)} + H_2SO_{4(qatı)} \xrightarrow{t} Na_2SO_4 + 2HCl$$ (when heated)

Answer to Question 2: The seperated HCl gas dissolves in the water vapor on the surface of the water and forms a thin stream on the wall of the test tube.

Answer to Question 3: The end of the gas pipe should be placed close to the bottom of the test tube so that the HCl gas is more soluble in water and gas escapes.

Thus, by conducting the above experiments and solving experimental problems, students' practical skills and creativity are better formed.

The following results were obtained from the study.

Our systematic research in the field of studying the need for practical work in the teaching of chemistry in general education schools, modern problems of chemistry and their impact on the quality of students' knowledge allows us to draw the following general conclusions.

1. For the first time, we have created a system for organizing and conducting experiments in chemistry in order to increase the efficiency of teaching chemistry and to build it in accordance with the requirements of the time [1, 3].

2. By organizing and conducting experiments in chemistry, the content of the school chemistry course was improved in accordance with the development requirements of the time and the level of development of science. Ways of organizing and conducting experiments in chemistry

related to students' independent work methods and methods of solving experimental problems have been identified [4-6,9,14].
3. In the process of teaching chemistry, the essence of the problems of education was determined, it was determined that there are wide opportunities for labor education, the means and methods of realization of those opportunities were researched.
4. Ways have been identified to organize and conduct chemistry experiments to test students' ability to understand, coordinate, compare, organize, think, and apply chemistry. [2, 11, 20].
5. A new educational infrastructure has been formed with the application of methods of organizing and conducting experiments in chemistry.
6. In the teaching process, using the methods of organizing and conducting experiments in chemistry in extracurricular activities, it was found that the subjects with increased interest in chemistry were better mastered by students with poor reading.
7. When the resources developed for the organization and conduct of experiments in chemistry are used effectively to strengthen students 'knowledge, they affect the development of students' attention, logic, memory and speed of information reception.
8. Laboratory experiments in chemistry, practical work, experimental problem solving create a favorable system between the theoretical foundations of chemistry and the practical part.

The main results of the dissertation are reflected in the following articles.

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