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IMPROVING THE METHODOLOGY OF ORGANIZING AND CONDUCTING LABORATORY TRAINING THROUGH DIGITAL TECHNOLOGIES

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Abstract: *In this study, the role of digital technologies in training future physics teachers in higher education institutions and the importance of virtual laboratories in performing laboratory work are described. Instructions on the virtual performance of laboratory work given in the subjects of molecular physics were analyzed using examples.*

Keywords: *Physics, real virtual laboratory, virtual laboratory, PhET, substance, student, digital technology.*

Аннотация: В данном исследовании описана роль цифровых технологий в подготовке будущих учителей физики в высших учебных заведениях и значение виртуальных лабораторий при выполнении лабораторных работ. На примерах проанализированы инструкции по виртуальному выполнению лабораторных работ, данные по предметам молекулярной физики.

Ключевые слова: Физика, реальная виртуальная лаборатория, виртуальная лаборатория PhET, вещество, студент, цифровые технологии.

INTRODUCTION

In the decision of the President of the Republic of Uzbekistan dated March 19, 2021, No. PQ-5032 "On measures to increase the quality of education in the field of physics and develop scientific research", "In general secondary schools, academic improving the quality of teaching physics in lyceums and higher educational institutions, improving textbooks and training manuals; such goals and objectives as "wide introduction of modern teaching methods, including information and communication technologies" into the educational process have been defined[1].

In higher educational institutions, the classrooms are equipped with modern equipment to organize laboratory exercises in physics classes by the requirements of the time, and these activities are currently being carried out on a large scale. Creating modern educational tools and visual developments and improving existing ones by researchers and pedagogues is one of the important tasks in organizing effective use of the provided equipment [2.3].

In studying physics, concepts such as theoretical knowledge, problem-solving skills, and

performing laboratory exercises are closely related and complement each other. Therefore, in addition to the formation of concepts such as the explanation of physics, the application of theory in each topic, and the use of virtual laboratories in practical training, the formation of concepts such as analysis, observation, concluding, and creativity, interests in inventions in science and technology are also formed. [4.5].

The modern content delivered to students does not include the development of science knowledge, such as the development of competencies corresponding to modern knowledge practice. This content should be presented in the form of well-structured and multimedia educational materials transmitted using modern digital technologies and communication tools. Modern methods of teaching are not only based on passive perception of the material but also active methods of formation of competencies based on mutual relations of students and their involvement in the educational process. It is an important task to form the skills of independent self-education in a modern student. By actively introducing various forms and devices of ICT-information and computer technology into the educational process of modern higher education, the independent activity of the student outside the audience has been fundamentally introduced as a new form of education. Currently, a new form of development of the mastery of a large number of topics without losing the volume and importance of independent work done by students at home is being implemented by increasing the role and role of digital technology devices [2.3].

LITERATURE ANALYSIS AND METHODOLOGY

Several works are being carried out to improve the efficiency of education using the development of 21st-century technology in conducting laboratory work in physics in a modern way. One of the important effects of digital technologies in science and education is virtual laboratories [4]. The use of modern information technologies in education is not an innovation for the civilized world but has become a reality. Currently, digital technologies have firmly entered the field of education. They make it possible to change the quality of the educational process and make the lesson modern, interesting, and effective. Virtual education also includes an ethical component - computer technology will never replace communication between students. It can only support the potential for collaborative discovery of new resources and is suitable for use in a variety of learning situations where students engage in dialogue with their peers and teachers about the material they are learning.

When conducting a lesson using virtual tools, the main principle of didactics is observed - a view that ensures optimal mastering of the material by students, increases emotional

perception, and develops all types of thinking in students.

The use of digital technologies in the process of teaching physics, the demonstration of physical phenomena and processes that are technically very difficult or completely impossible to fully demonstrate in laboratory conditions, expanding the possibilities of conducting high-quality laboratory training, and simulating various processes and phenomena allows to do [6,7].

ANALYSIS AND RESULTS

Interactive work in physics should be carried out in the form of a practical exercise to explain new knowledge or to complete the study of a specific topic. Another option is to do the work in independent, voluntary, individual lessons. Virtual physics is a new unique direction in the educational system. It's no secret that 90% of information comes to our brain through the eyes and nervous system, and until a person sees, he cannot clearly understand the essence of some events.

Therefore, the educational process should be provided with visual materials, and it will be possible to see not only a static picture depicting a phenomenon but also to see this phenomenon in action [6.7]. Taking this into account, in this work we will use the existing virtual laboratory work on the PhET platform to organize laboratory work in molecular physics, the capabilities of this platform we have detailed in previous works[8.9.10].

Here is the process of conducting laboratory work "Study of Aggregate States of Matter" by students using the PhET program:

LABORATORY WORK. STUDY OF AGGREGATE STATES OF MATTER

The purpose of the work: is to study "States of Matter" in the PhET programming environment.

Virtual elements: Thermometer, gas tank, dynamometer, heat source.

Theoretical part: Aggregate states of matter On cold winter days, water freezes in ponds, lakes, and streams. In summer, on the other hand, if the water in the pool remains for a long time, it will dry up. In this case, water turns into steam. In nature, water is found in three different states. Solid - in the form of ice, liquid - in the form of water, and gaseous - in the form of steam.

So, steam, water, and ice are made of the same molecules. They differ only in the arrangement and movement of molecules. Steam is made up of individual molecules and moves continuously and irregularly. Therefore, the steam rising from the surface of the water easily mixes with the air. Air always contains water vapor. There are also other gases in the air, such as oxygen and carbon dioxide. Their molecules are also in constant and irregular motion.

If you look from the side at the light coming from the crack of the window, you can

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observe the non-stop and irregular movement of very small dust particles in the air. Their behavior is due to their constant collision with various gas molecules in the air. Let's slightly inflate the thin inflatable ball and close the mouth. If we pinch it with our hands, we will see that it is smaller.

So the gas can be compressed. Let's take two thin balloons and inflate one by blowing it through a tube. Then, fasten the mouth of the balloon with string and attach the other end of the tube to the mouth of another uninflated balloon. Then, if we release the thread tied in the mouth of the first balloon, the air passes through the tube to the second balloon and inflates it (Fig. 1).

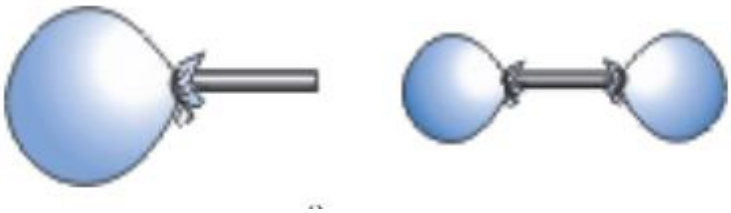

Figure 1.

So, the gas can pass from one container to another through a tube connected by itself. No matter what container we put the gas in, it will completely occupy the shape and volume of that container. The distance between molecules of gases is on average 100-1000 times greater than the size of molecules. At this distance, the mutual attraction of molecules is very small [11.12].

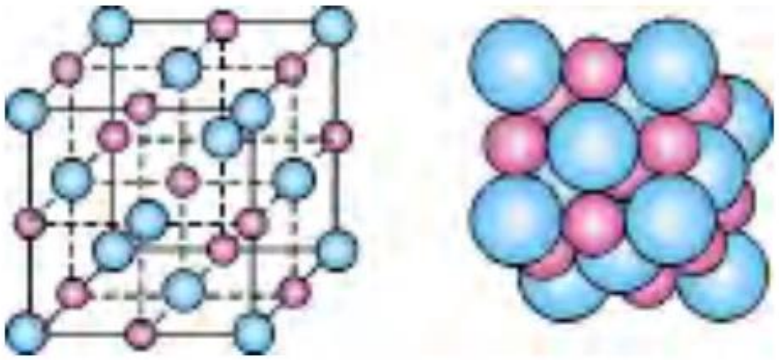

Figure 2.

Most of the things around us are solid. Pen, desk, house, car, etc. All of them have their form. It takes a lot of effort to change their shape. In solids, molecules (atoms) are closer than in liquids. In addition, they are arranged in order. It wobbles in place. For example, if we take table salt, its molecule NaCl is composed of Na - sodium and Cl - chlorine atoms. Figure 2 shows the arrangement of atoms. If you connect them with a straight line, it will look like a grid. The arrangement of atoms can change the hardness of the body. For example, the pencil you are

using, charcoal, and a very solid substance - a diamond, a diamond - is made of the same carbon (C) atoms. However, the placement structure is different. Solids have specific volume and shape [8.11].

Order of work

1. In the Phet window, select the "Heat&Thermo" section [9].

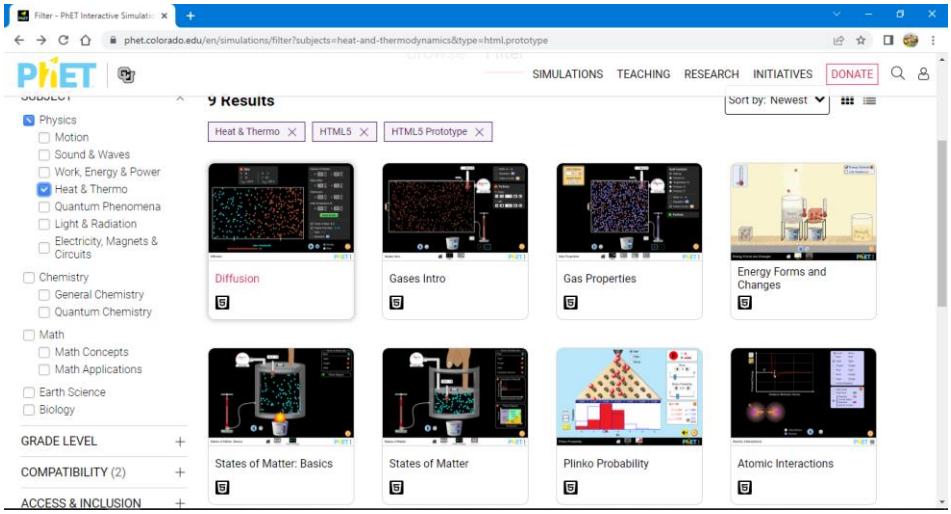

Figure 3.

2. Run the States of Matter simulation from the opened simulations.

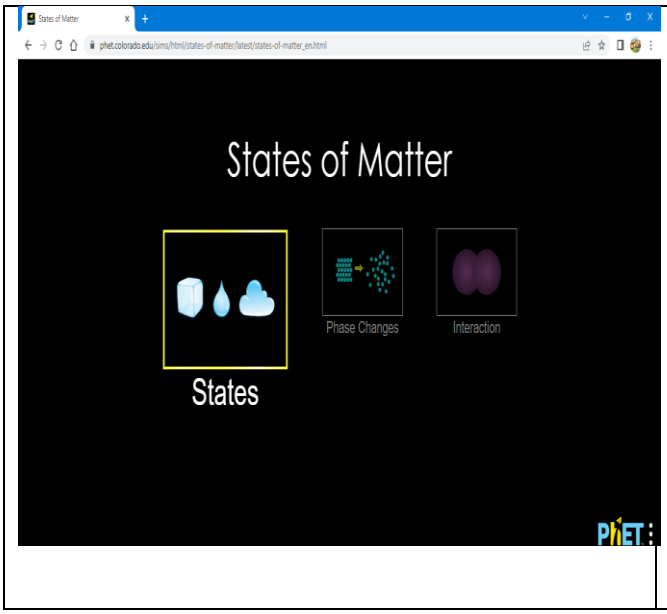

Figure 4.

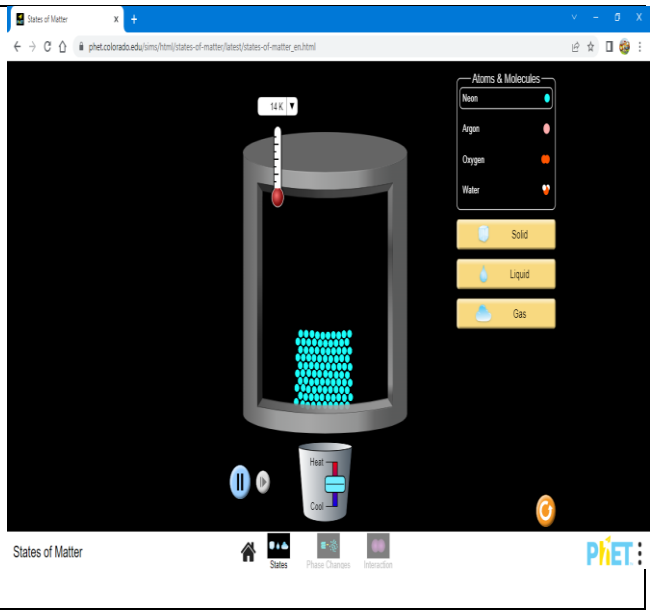

Figure 5.

3. Select solid, liquid, and gas states and observe the process.

a) by raising the temperature of the gas.

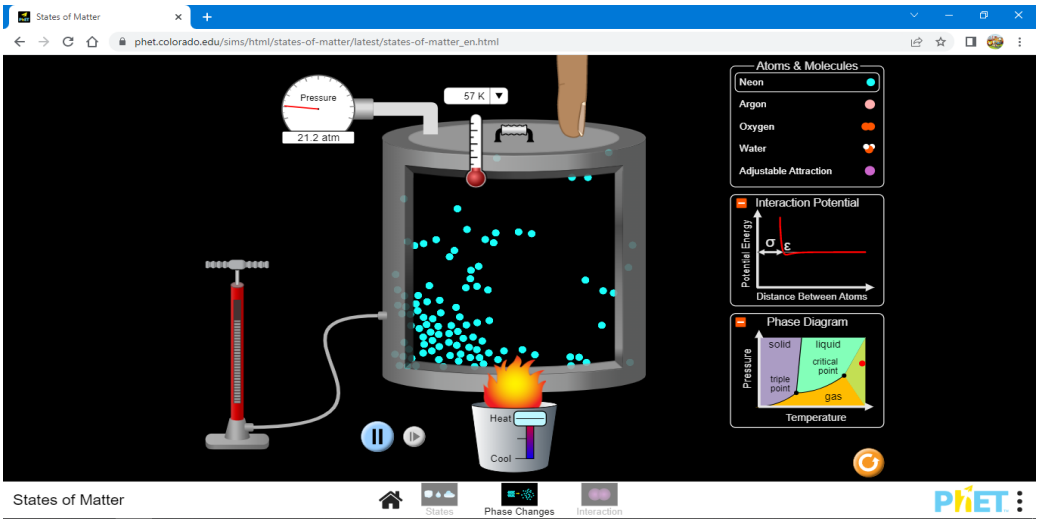

Figure 6.

b) Increasing the gas pressure by pushing down the lid of the container.

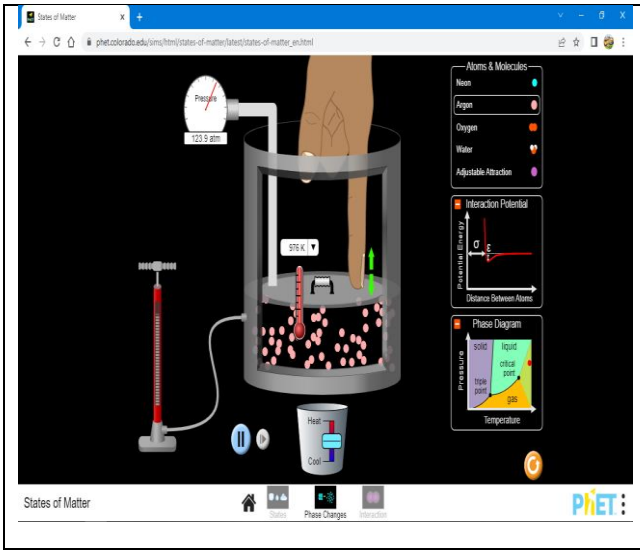

Figure 7.

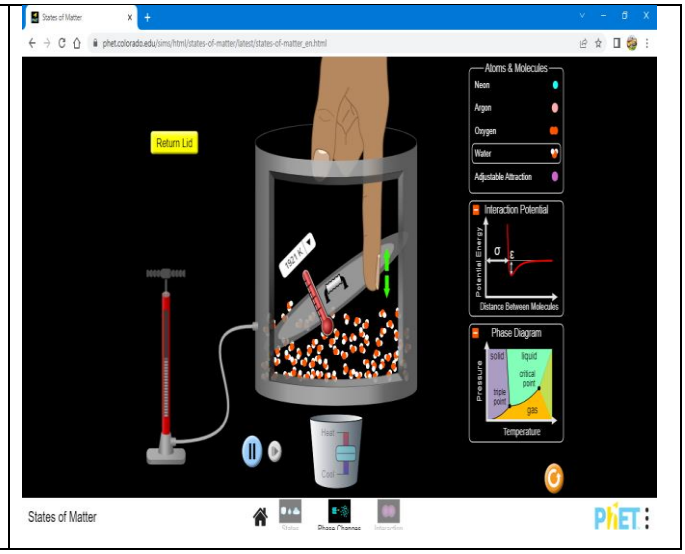

Figure 8.

c) study the impact forces by making the spheres collide with each other.

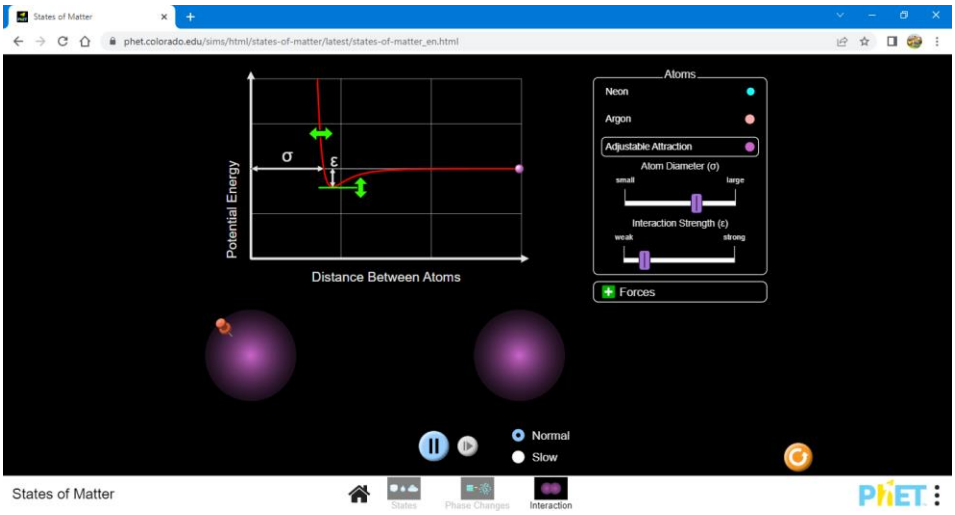

Figure 9.

4. Explain the observed phenomena

Control questions

1. What is the cause of the diffusion phenomenon? 2. Why does diffusion speed up with an increase in temperature? 3. Give examples of diffusion phenomena observed in gases, liquids, and solids. 4. Do you know immiscible liquids? 5. Is it possible to convert solids into gaseous state? 6. Have you seen air that has been converted to a solid state? If you haven't seen it, maybe you've heard it. 7. Even though chewing gum is solid, it easily changes shape. What do you think is the reason for this? 8. Give examples of the use of the properties of solid bodies, liquids, and gases in life and technology.

According to the results of the experiment, students have:

- draws conclusions based on accurate scientific data and strengthens self-confidence. - obtaining results with the help of a practice device allows students to discover new knowledge, and develop skills on the subject. - using an experimental device, students strengthen new knowledge and develop an interest in innovation and invention. - students form and develop the concepts of drawing conclusions and analysis based on the results of experience [12].

CONCLUSIONS AND SUGGESTIONS

Organization of the educational process with the help of digital technologies and a complex of virtual laboratories in the teaching of physics has several advantages. - students' interest and motivation in physics appear and increase. - students strengthen and develop theoretical knowledge. In this work, the scientific and pedagogical literature on the use of virtual tools in the modern education system was analyzed, based on this, the special importance of using the virtual laboratory in the educational process was revealed.

The article considers the use of digital technologies in the educational process, the issue of virtualization of education, and the possibilities and advantages of virtual laboratory work in the study of processes and phenomena that are difficult to study in real conditions. By independently performing the laboratory work presented in the work, the students' ideas and knowledge about the aggregate states of matter were strengthened. The conducted experiments showed that organizing the lesson in this way led to an increase in the quality and efficiency of the lesson.

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