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Use of the interactive whiteboardat physics lessons for students of non-physical specialties of pedagogical universities

Abstract. *The article deals with the techniques of using an interactive whiteboard at Physics lessons for students of nonphysical specialties at pedagogical Universities in Ukraine. The considerable attention is paid to the improvement of the educational process for students of nonphysical specialties by means of using an interactive whiteboard at physics lessons. The basic forms, methods and tools that lead to effective formation of students' new knowledge in physics are clearly highlighted.*

The modern approaches to lectures in physics using an interactive whiteboard are systematized and substantiated, which are used at lessons with the purpose of giving students new knowledge. It is shown that during such lessons, the teacher should make every effort to ensure that students do not remain passive listeners.

It is noted that one of the stages of the teacher's work with an interactive whiteboard at lectures is using presentations created in Microsoft Office. The attention is drawn to the fact that the use of an interactive whiteboard allows teachers to conduct dynamic classes in physics using author's materials and the materials created by other authors on appropriate data storage devices and on the Internet.

The article presents the basic tasks of teaching physics that motivate students' active work during classes and it leads to the development of their mental activity, in particular, to the formation of natural science and philosophy thinking and outlook. Some features of using an interactive whiteboard during lectures and practical classes in physics for future teachers of chemistry and biology are analyzed on the example of the topic "Physics of the atom".

It has been found out that interactive whiteboards are an important tool for conducting lessons of physics. One can show presentations, demonstrations, do simulation, make records and sketches with the help of an interactive whiteboard. In addition, the use of an interactive whiteboard in classroom enhances students' activity, increases the tempo of work of both a teacher and a student and increases the motivation of students to study.

It is established that the use of an interactive whiteboard in the educational process does not solve all pedagogical problems. At the same time, working with it not only facilitates the presentation of educational material, but requires the teachers and students to be more aware of the use of multimedia technologies.

Keywords: *interactive whiteboard, physics, classes, educational process, forms, methods, means, multimedia technologies, students of non-physical specialties.*

JEL Classification: I21, I23

Introduction.

The process of studying physics at the university should have a professional orientation aimed at training highly skilled specialists. It is difficult to predict what the graduates of a higher education institution will face in practice, with the practical use of whatpart of physics they will have to deal with. So it is necessary to providesuch a level of training in physics for students of non-physical specialties, which will allow to create a base for mastering disciplines of the subject block and will correspond to the tasks of the current stage of reforming of the secondary and higher professional education.

At present, there is a problem of scientific understanding: on the one hand, the understanding of the technological approach to teaching the course of physics for future teachers of chemistry and biology, on the other, the understanding of the content of the course in physics with the material of fundamental, applied, practical and professional orientation. The solution of the problem is to involve students in carrying out the research tasks that will enhance the quality of their professional training.

During the research on the problem of professionally oriented training of future teachers of chemistry and biology while teaching physics, the reasons that do not allow students to reach the proper level are found out. The essential reasons for the comparatively low quality of the training of future teachers of chemistry and biology in physics can be the following: the discrepancy of the content of the discipline “Physics” for students of non-physical specialties of pedagogical universities to the present state of natural sciences; insufficient training in physics for future students; lack of effective motivation to study physics; inconsistency of the existing forms of organization of educational and cognitive activity to the needs of professional training of students of non-physical specialties at the first (Bachelor) level of higher education; insufficient reflection of the professionally oriented material in the existing content of the subject“Physics”.

The solution of these problems requires enriching the content of students’ training in physics based on the study of the current level of development of science and technology; introduction of the fundamental, applied, interdisciplinary, practical component in combination with professional orientation; development of the methods for teaching physics in accordance with the traditional and innovative approaches for its mastering; use of the modern information technologiesof teaching. For the present, these approaches can be realized through the use of modern learning means.

An important step in the use of modern information technology is interactive whiteboards that ensure completeness of educational material presentation during the lessons. The effectiveness of their use in the classroom is no doubt, as while using them one can write, wipe, move objects, control software with the help of a marker or a finger; in other words, one can correct and reproduce educational material which together creates better opportunities for its learning by students.An interactive whiteboard is used together with a computer, a multimedia projector and multimedia products. Some more programs are also added to the interactive board to ensure its effective use. An interactive whiteboard simultaneously works as a computer monitor and a simple board. With the help of it one can not only display information from a computer, but also realize such relationships like“teacher-computer”,“teacher-student-computer”.

The works of V. Abramov[3], V. Antonenko[1], V. Armstrong [2],D. Averis [7], S. Barnes [2], G. Bonch-Bruevich [3],S. Brown [4], P. Clarkson[5],S. Curran [2], V. Door [7], J. Gee [6], D. Glover [7], F. Hardman [11], S. Higgins [11],V. Leonskiy [1], S. Lerman[12], C. Lewin [10],D. Miller [7],S. Mills [2],T. Nosenko[3], H. Smith [11], B. Somekh [10], S. Steadman [10], R. Sutherland [2], I. Thompson[2], R. Zevenbergen [12]and others are dedicated to the introduction of interactive boards in the educational process.The use of interactive boards in the classroom of secondary schools is elucidatedin the works of P. Byel’chev, T. Dovga, I. Kysla, S. Pasanova and others (for Physics lessons), E. Arshanskiy, O. Byelohvostov, L. Vorobieva, T. Derkach, L. Ignatieva, R. L’gova, E. Nechytaylova and others (for Chemistry lessons), E. Arbuzova, A. Braslavska, K. Galoyan, E. Dan’kova, T. Ivanova and others (for Biology lessons).

The aim of this article is to prove theoretically and to show in practical way the technique of using an interactive whiteboard at Physics lessons for students of non-physical specialization at pedagogical Universities.

1. Use ofthe interactive whiteboard during lectures

Physics is one of the most important subjects for understanding the essence of the world around us. In order to form the basic principles of physics in future teachers, as well as to reveal the most interesting and complex moments, various technologies and equipment are used. The modern classroom of physics is filled with such applied stuff, which in practice explains every law and its action. The use of interactive whiteboard can help to make the learning process and perception of information easier.

The term “an interactive whiteboard”stands for a touch screen, which can be controlled not only by a computer mouse, but one can make notes by the touch of a finger or special markers. In our teaching activities, we can use two types of the interactive whiteboard: SMART Board DViT (Digital Vision Touch) 480 [9] and Panasonic UB-T580 [8]. We have lectures with the interactive whiteboard SMART Board DViT 480 and practical classes with the interactive whiteboard Panasonic UB-T580, because in the classrooms wherethere are such interactive whiteboards are designed for lectures and practical classescorrespondingly. Let us give some examples of using an interactive whiteboard in practical classes ofPhysics for future teachers of Chemistry and Biology.

One of the stages for a teacher inlectures with the interactive whiteboard is to work with presentations created in Microsoft Office. The use of such presentations enables the teacher to use additionaltools, namely in the mode “Pointer” and “Magnifier”.

Equally important for the teacher is the interactive whiteboard with the opportunities to work in the mode of “white” board. Using this mode we can make all the necessary notes without chalk during the sessions. In addition this function makes it possible to save previously created notes and use them in thenext classes.

Finally you can use educational material created with the help of the programs in the interactive whiteboard. This may be material from own funds or from the Internet.

To successfully intensificatethe students’ learning activity in Physics lessons we use suchprogram to the interactive whiteboard SMART Board DViT 480:

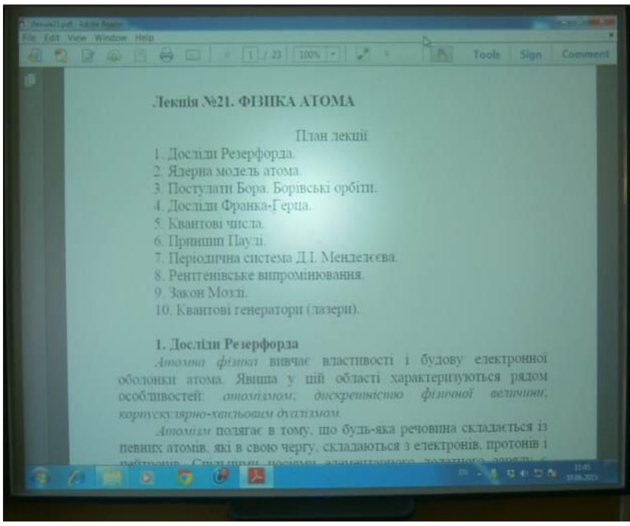
- notebook (SMART Notebook);
- virtual Keyboard (SMART Keyboard);
- additional (marker) tools (Floating Tools);
- video recorder (SMART Recorder);
- video player (SMART Video Player).

In addition to these programs, there are other software adapted to work together with SMART Board. The most popular are the three main applications of Microsoft Office: Word, Excel, Power Point.

It must be taken into account that the software was developed for the groupwork on the interactive whiteboard, which added some specificity to the work of the teacher during the lessons and provided an opportunity to create a huge number of various interactive tasks done in the classroom as well for students' independent work.

Using the interactive whiteboard we are able to carry out dynamic classes of Physicswith author's learning aids andthose created by other authors on the propercarriers and in the Internet. Let us give some examples using the interactive board during lectures and practical classes in Physics for the future teachers of Chemistry and Biology.

The students of these specializationsare limited with formal knowledge in Physics. As a rule they usually have some knowledge but it is limited with the educational material within school textbooks in Physics. They cannot use the knowledge received at schoolfor applied and practical purposes. Therefore the main task of the teacher is to find such forms, methods and tools that could lead to the effective masteringof new knowledge by students.



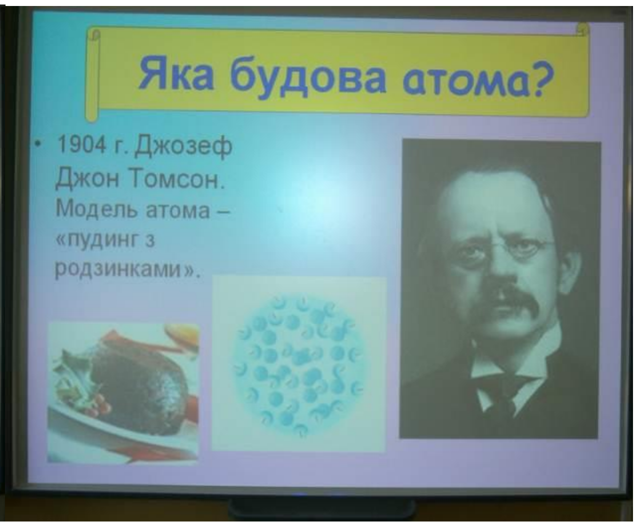


Fig. 1.Fig. 2.

All lectures in Physics stand for giving new knowledge to students. Therefore, during the lecture a lecturer must make every effort to ensure that students do not remain passive listeners. The main objective of the lectures for teachers is the creation of active work of students in class that will lead to the development of intellectual activity, including the formation of natural scientific thinking and outlook. As an example let us take the topic“Physics of Atoms”.The topic of the lesson is given on the interactive whiteboard and the students are introduced to the issues that will be considered in class and the issues for self-independent study (Fig. 1). We begin our lesson with the issue of “Rutherford’s Experiments”.We focuse the students’ attention on the first model of the atomic structure suggested by the English physicist J.J. Thomson in 1904 (Fig. 2).

Rutherford used for this purpose aflow of positively charged α-particles emitted by some radioactive substances (such as polonium) and have the charge $+2e$ and mass which is $6{,}64 \cdot 10^{-27}$ kg (Fig. 3-4). Passing a beam of α-particles through a thin gold foil, Rutherford found out that a quantity of particles deflectedto a very significant angle from the original direction, while the others even bounced off the foil.

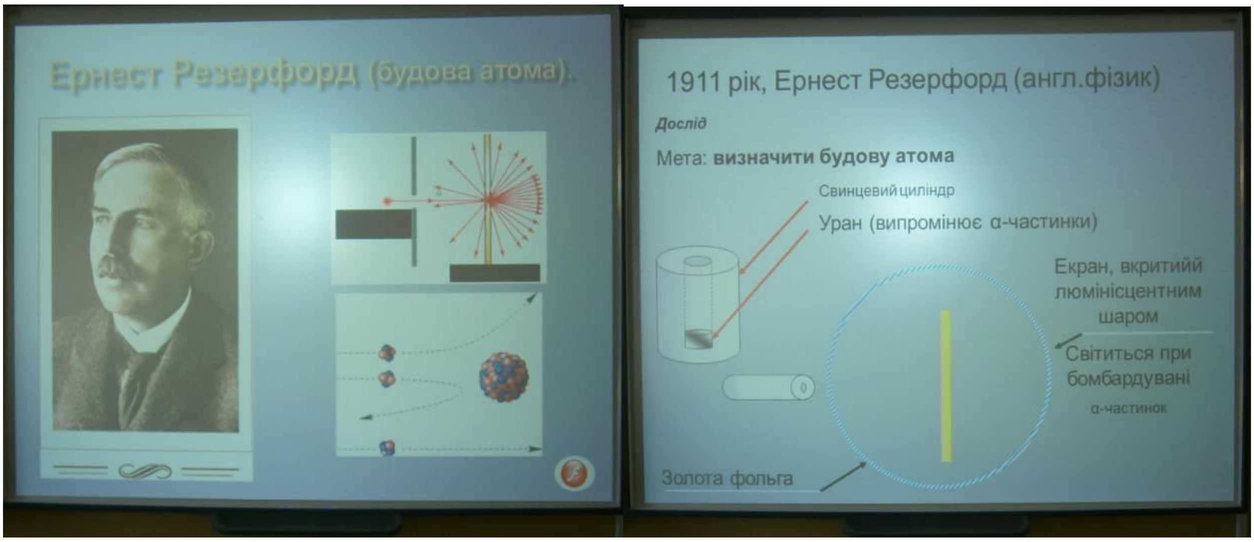
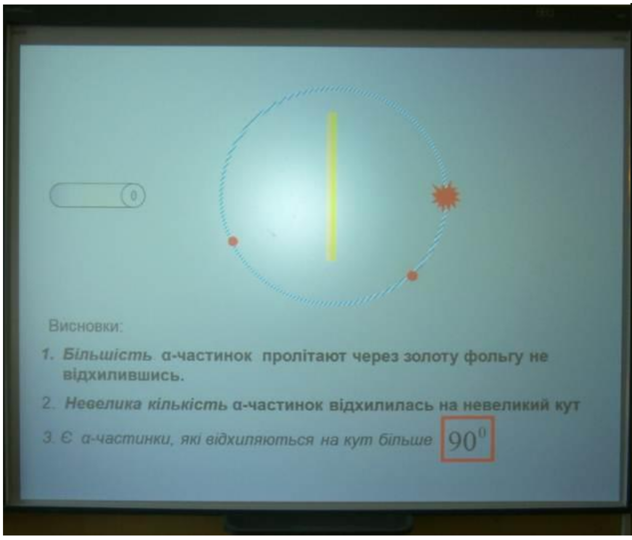


Fig. 3.Fig. 4.

The simplified diagram of Rutherford's experiments is shown in Figure 5. The source of α -particles was placed inside the lead block with a narrow channel. All α -particles except those which moved along the narrow channel, were absorbed by lead. A narrow beam of α - articles was falling on the gold foil perpendicular to its surface.

Behind the foil there was a movable screen covered with fluorescent substance; α-particles having passed through the foil caused flashes on the screen. This apparatusin the vacuum enabled to observe α- particle scattered by angle 150^0. It is important to emphasize that this result can not be explained within the model ofJ. Thomson because the positive charge of the atom distributed throughout its volume could not so much affect the massive and fast α- particles.



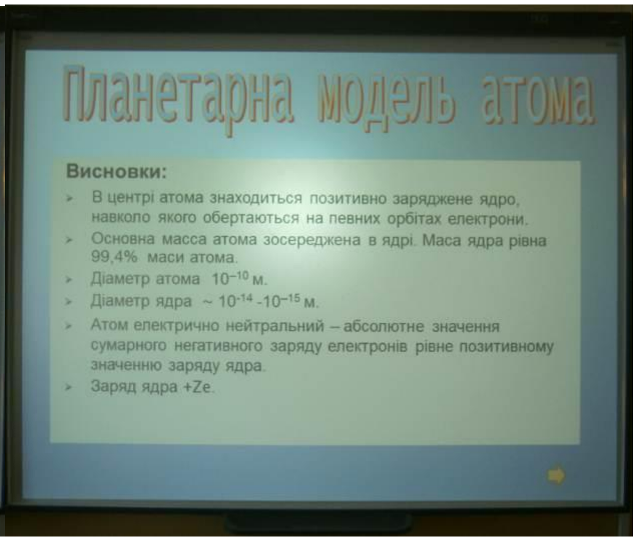


Fig. 5.Fig. 6.

Based on the conclusion mentioned above we start the next issue“Nuclear Model of the Atom”. In this matter, the students pay attention to the fact that summarizing the results of the experiments, Rutherford proposed the nuclear (planetary) model of atomic structure in which an atom looks like a miniature solar system. According to this model, the whole positive charge and almost the entire mass of the atom (99.4%) are concentrated in the atomic nucleus. Thenucleus size $(\sim 10^{-15}\ \text{m})$is very small compared to the size of an atom$(\sim 10^{-10}\ \text{m})$. Around the nucleus in the closed elliptical orbits the electronsare movingand creatingthe electron shell of an atom. The nuclear charge is equal to the total charge of the electrons (Fig. 6). Then we offer the students to watch the video about the planetary model of an atom proposed by N. Bohr and E. Rezerford (Fig. 7).

After having watched the film we should make a generalization, namely we pay the students’ attention to the fact that the motion in its orbit, like any curvilinear motion, is a motion with acceleration. According to the laws of classical electrodynamics, the curvilinear motion must be accompanied by light emission of corresponding frequency. Therefore, in the motion of an electron around the nucleus, an atom must continuously radiate energy. But the reduction of energy leads to a reduction of the radius of the electron orbit, thus the electron must move in a spiral approaching the nucleus. And since the velocity of the electron does not change, the circular frequency of its rotation might be increasing and the frequency of radiation should be continuously increasing, it means that the radiation spectrum might be continuous. Continuously approaching the nucleus the electron should fall into the nucleus in a short perid of time, thus Rutherford’s model of the atom is an unstable system. As a conclusionwe should mention that atoms are really very stable systems and have linear but not continuous emission spectra. Having mentioned the two previous issues at,we demonstrated the use of the interactive board as a simulator of slides and video episodes. We’ll show the use the interactive board in the mode of “a white board” while explaining the next issue“Bohr's Postulates. The Orbitsof Bohr” to the students.

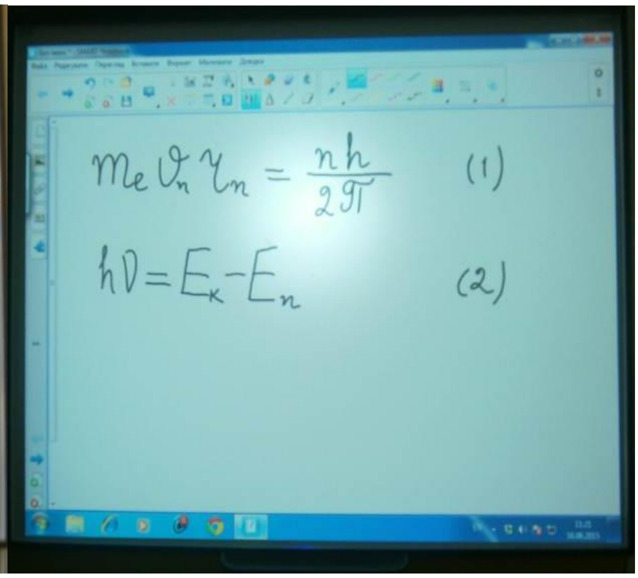


Fig. 7.Fig. 8.

We start this issue with the next atomic modelproposed in 1913 by N. Bohr, a physicist of the twentieth century. He introduced the idea of a quantum theory to the nuclear model of Rutherford and developed the theory of hydrogen atom which was fully confirmed experimentally.

Besides the presentations and video proposed above weexplain the educational material using the corresponding notes on the interactive whiteboard and student workbooks.It should be emphasized that on the basis of the Bohr theory of the atom there are two major rules called postulates. The lecturer gives the first postulate and writes the condition on the board which corresponds tothe orbits of the stationary statesof electrons in an atom (Fig. 8):

$$m_e \upsilon_n r_n = \frac{nh}{2\pi}, \qquad (1)$$

where r_n isthe radius of the n^{th}orbit, $N = \frac{1}{2} N_0$ isthe electron velocity in this orbit, m_e isthe mass of the electron, $m_e \upsilon_n r_n$ ismomentum on this orbit, n isan integer called principal quantum number of the electron $(n \neq 0)$.

Having given the definition of the second postulate, the lecturer writes the formula for the quantum of energy which equals to the energy difference between the stationary states of electronsbefore $(E_k)$and after $(E_n)$the motion (Fig. 8):

$$h\nu = E_k - E_n. \qquad (2)$$

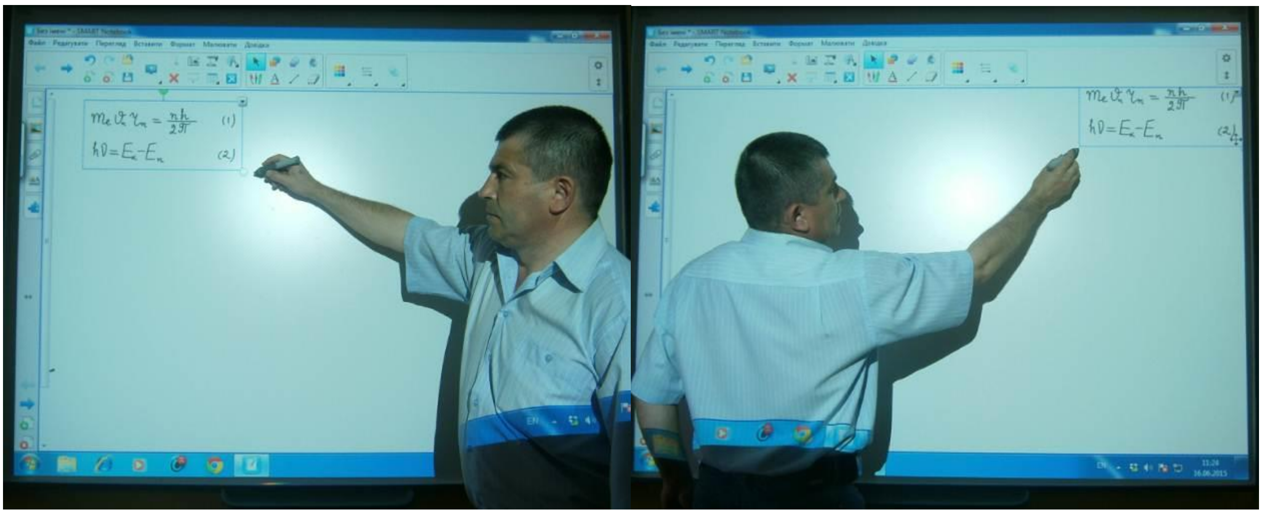
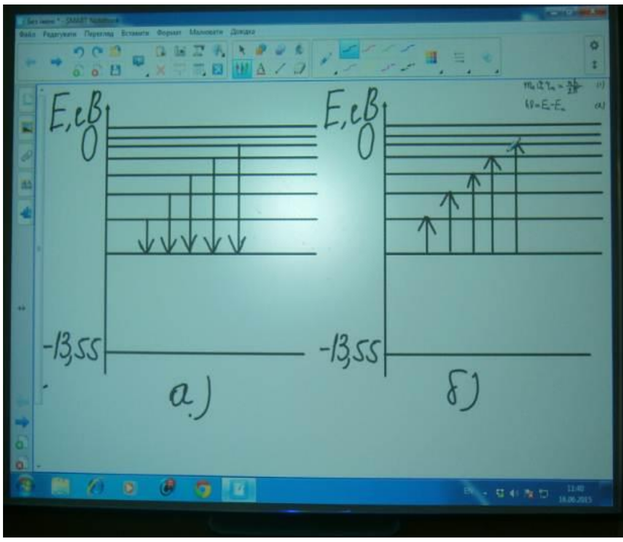


Fig. 9.Fig. 10.

These conclusions should be well kept in mind while solving problems.

As we can see in Figure 8, in the mode of “a whiteboard” we have the opportunity to write with a marker or a finger. In addition we can reduce thesenotes (Fig. 9), we are able to fold, to move them in a comfortable side of the board (Fig. 10), to save and to restore the notes at any time.



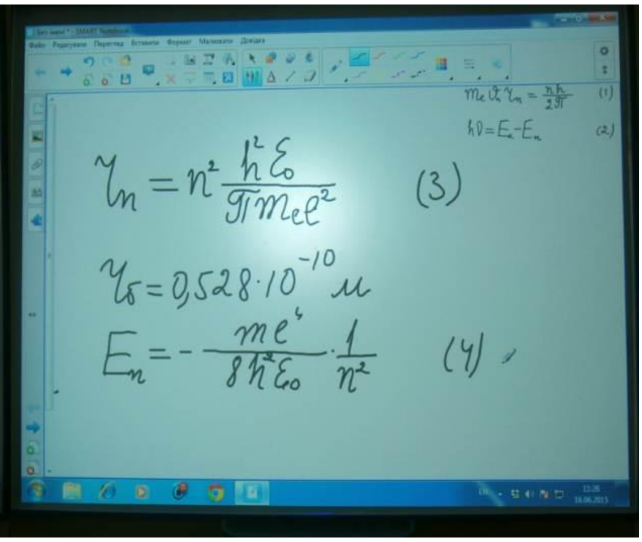


Fig. 11.Fig. 12.

Combining traditional teaching with the mode of “a white board”we draw students' attention to the fact that the emission occurs when the atom moves from the state with higher energy to the state with lower energy (Fig. 11a). Atom energy absorption is accompanied with its motion from the state with less energy to the state with more energy (Fig. 11b). Since these atom motions from one state to another in a schematic plan does not cause any difficulty, we do their sketches in the mode of “a white board”.

Continuing the explanation of the educational material we draw students’ attention to the use of the Bohr postulates. We emphasize that due to their use we can make possible to calculate the circular electron orbits of hydrogen atom and successfully explain some patterns in the spectrum of its emission. On the board we write the expression of the Bohr radius (Fig. 12):

$$r_n = n^2 \frac{h^2 \varepsilon_0}{\pi m_e e^2}, \tag{3}$$

where e is the charge of electron and proton, ε_0 is the electric constant.

We do not insist on obligatory derivation of this formula (3) and the following formula (4), and we write them in the final form.

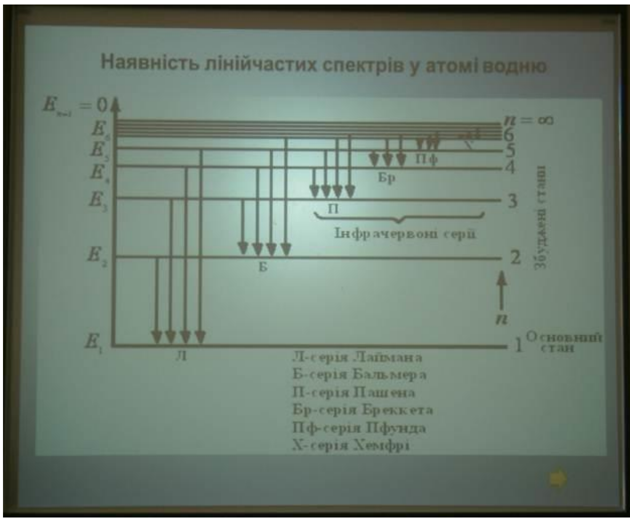
We say that, if we assume $n = 1$,then we getthe value of the first Bohr radius, which is a unit of length in atomic physics: $r_Б = 0{,}528 \cdot 10^{-10}$ m (Fig. 12).

We write the energy in any energy level as a formula (Fig. 12):

$$E_n = -\frac{me^4}{8h^2 \cdot \varepsilon_0} \frac{1}{n^2}. \tag{4}$$

After having written the formula (4) we conclude: the total energy of an electron in a stationary orbit is inversely proportional to the square of its number.

It is important to emphasize that the Bohr theory can explain the presence of linear spectra generated in the hydrogen atom in the motion from one stable state to another (Fig. 13). If the drawings are simple, we make their sketches in the mode of "a white board" and complicatedones are made in the mode of "Slide" (see. Fig. 13).



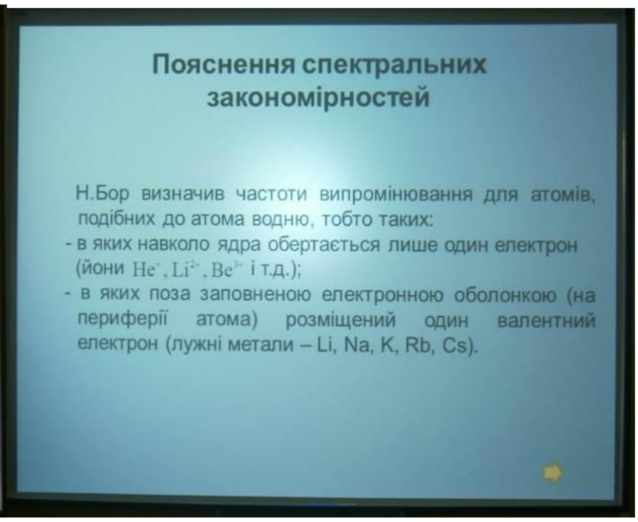


Fig. 13.Fig. 14.

Finally we draw students' attention to the fact that similarly Bohr defined the frequency of theradiationfor atoms like hydrogen atoms: ions - He^+, Li^{2+}, Be^{3+} etc.; alkali metal - Li, Na, K, Rb, Cs(Fig. 14).Thus, while learning this topic by the students we briefly showed the use of the interactive board in lectures. The next stage of our article is to demonstrate the use of the interactive board inpractical classes.

2. Use of the interactive whiteboard during practical classes

Together with the lectures in physics, where the main aspect is the use of multimedia, it is also important to consolidate and use the theoretical knowledge, in particular, in practical lessons whiledoing tasks, where there is a reproduction of real phenomena and processes observed in nature. These features of natural patterns, we can demonstrate with the help of an interactive whiteboard in the form of slides, video clips, etc.

While doing tasks with the help of the multimedia whiteboard, we can show pictures in both static and dynamic mode, to view video clips of various physical, chemical and biological phenomena and processes occurring in nature. The pictures, which in the process of solving tasks need to be completed, play an important role. This can easily be done using an interactive whiteboard.

The formation of physical notions, learning physical laws and theories is a long process that requires not only the initial perception of knowledge, but their systematic assimilation during practical classes. The use of the interactive whiteboard in practical sessionsallows to make them more modern and visual. The practical sessions of this type can develop cognitive capabilities of students and encourage them to the active participation. Using interactive forms of learning inpractical classes a teacher has the opportunity to give visual examples of applied and practical use of physical phenomena and laws. These visual, dynamic and interactive approaches allow students to think independently, analyze physical processes, show resourcefulness and ingenuity.

It is known that the physical notions are formed as a result of solving tasks. Therefore, while solving tasks with the help of the interactive whiteboard in practical classes, we shouldform interest in the student, as well as during the lectures. It is necessary to disclose specific approaches to solving tasks. It is especially important that this approach (use of an interactive whiteboard) should take a limited place and does not replace the other approaches. Teaching experience shows that solving tasks not only with the traditional approach, but also with the use of multimedia provides an effective study of the teaching material, itsmastering, training, control and directs each student to do a differentiated choice of tasks in accordance with student's level of training.

Each practical class in physics for future teachers of chemistry and biology should meet the following requirements:

- a clear statement of the didactic and educational goal, establishing a logical connection between the objectives of each lesson, the general tasks of teaching and education in training of a specialist;
- scientific choice of teaching material for the lesson corresponding to the level of students' development;
- the focus of the class on the formation of natural science thinking;
- optimal combination of methods and means of teaching;
- organization of individual and group work of students.

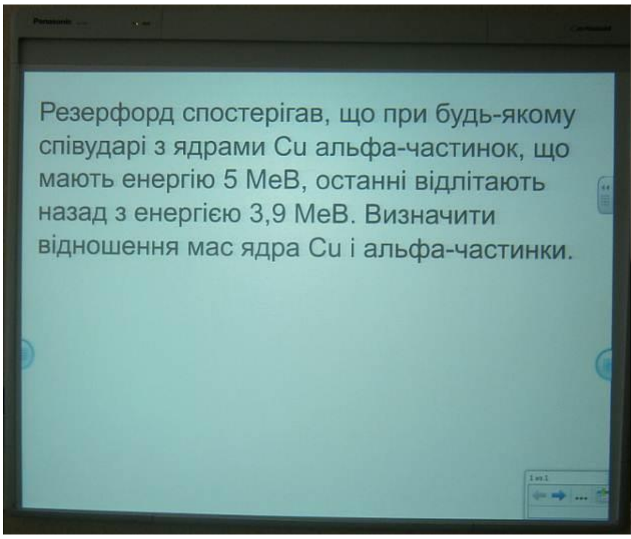
In the process of solving tasks the students master the methods of researching various natural phenomena, get acquainted with new progressive ideas and views, discoveries of domestic and foreign scientists, the achievements of science and technology.

Using an interactive whitebooth on practical physics classes helps students develop new skells and abilities, including the ability to design, make decisions and do creative work, and maintain a high level of innovation.

The correct choice of educational tasks is very important; they determine the rationality and compactness of the use of the interactive whiteboard. Successfully selected tasks promote the development of interest in self-acquisition of knowledge, develop critical thinking, and help master complex phenomena in society and nature for future teachers of chemistry and biology.

Of course, it is worth remembering that doing tasks and exercises for these specialization serves as preparation for students' future practice, use of the acquired knowledge and skills for the study of professional subjects.

For example, let's take the task of the chapter "Atomic Physics". Solving the problem of Physics is made in the traditional sequence. Besides reading the conditions of problem for the entire audience, we show its condition on the interactive board: "Rutherford observed that in any coordinated attack with nuclears Cu of α-particles with energyof $5\,\text{MeV}$, the last ones fly back with energy of $3{,}9\,\text{MeV}$. Identify the mass ratio of core Cu and α-particles" (Fig. 15).



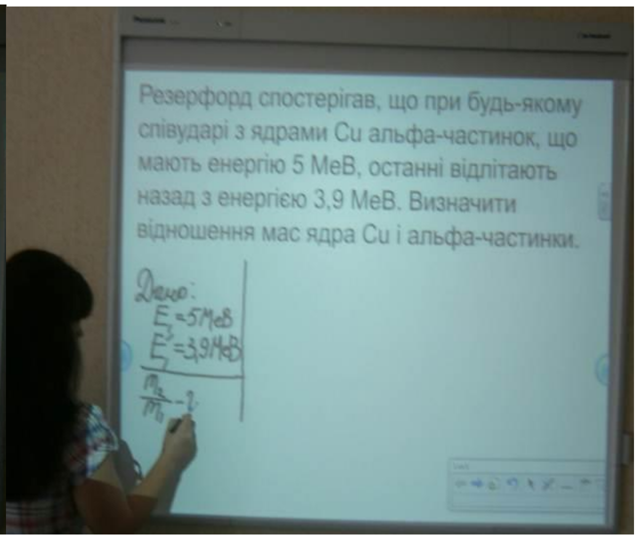
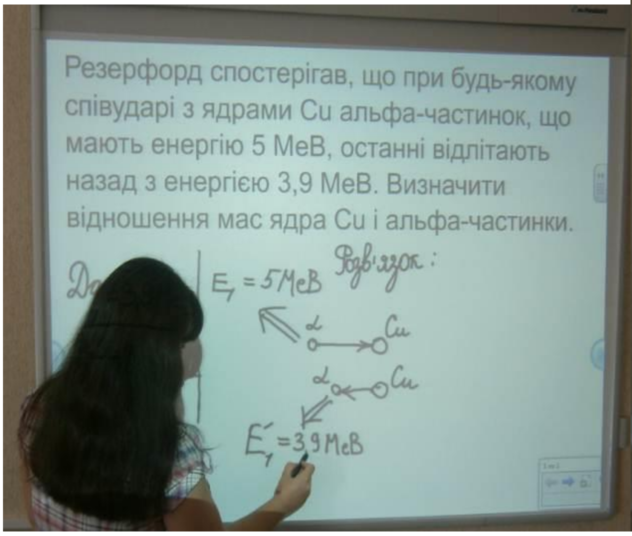


Fig. 15.Fig. 16

After reviewing the condition of the problem,we make a preliminary analysis of the problem: we get to know the unknown terminology, revise if necessary the appropriate material and so on. After that a teacher calls one of the students to analyze the conditions of the problem, find out its physical content, the way of finding the solution. The student writes briefly the condition of the problem, if necessary he reduces these conditions to the system of CI units (Fig. 16).

For a better understanding of the problem it is advisable to do a schematic drawing, to demonstrate an experiment, watchvideo with such a phenomenon, process, law and so on. All these elements are very easy to observe while using the interactive board (Fig. 17).



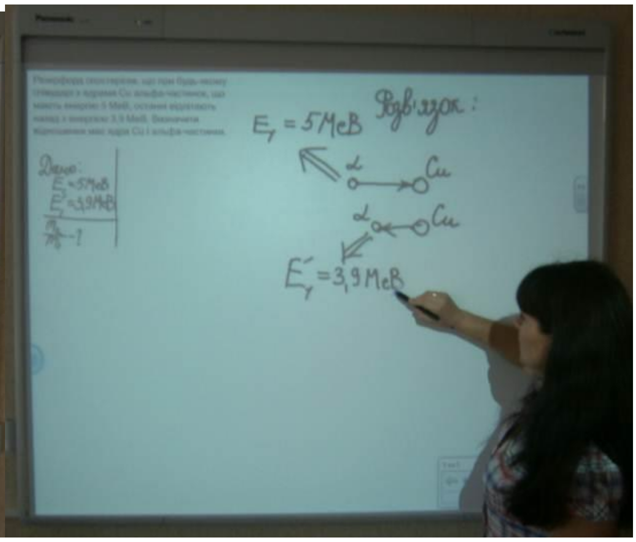


Fig. 17.Fig. 18.

The proposed problem has a large solution so a part of the material written on the whiteboard can be saved, reduced (Fig. 18) and transferedto a comfortable place for us on the board (Fig. 19), or we can go to a new page.

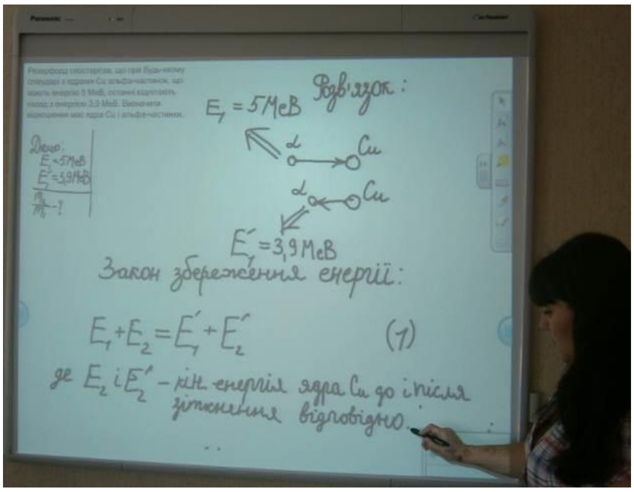


Fig. 19.

In a common blackboard we wipe the notesand in order to return to them we need to write these notes again on the blackboard. In the case of using the interactive board, we can use the notes once written at any time.

This approach can be used in any part of the course in physics. The calculated tasks of such content should also be offered to master the material while testing students' knowledge and skills. We also realize: there is a specific problem that students, while conducting numerical calculations using the innovative approach, do not always overlook the essence of the physical problem.

In spite of the foregoing, within this innovative approach, not every student can understand the general physical situation, which is in the condition of the task, clearly imagine the physical process or phenomenon, formulate a sequential solution of the task and only then receive an answer to the task. Before solving tasks using the interactive whiteboard, we recommend discussing the issues related to solving this task. Whilesearching the answers to the tasks, the students develop a general vision for solving and analyzing the physical laws and phenomena that underlie them.

It should be noted that the use of the interactive whiteboard when solving physical tasks leads to saving teaching time at lesson, allows the teacher to automatically compute the data presented in tables, graphically to represent physical processes and phenomena, and to analyze and compare the results obtained by using the graphs, diagrams.

While solving the problem at the interactive whiteboard, a student starts to face some difficulties that he cannot figure out or imaginary restorea phenomenon, process, law, etc., he can use the appropriate software or the Internet, which can show it in the form of slides or video. Having received the appropriate information the student continues to solve the problem. The combination of such possibilities of the interactive whiteboard is important for the development of students' cognitive abilities. With the appropriate software for interactive boards we can also conduct laboratory sessions.

It can be stated that when using the multimedia approach in solving tasks, students' knowledge is specified, the conditions are created for understanding the essence of phenomena and processes of nature. The physical theories, concepts and quantities reachthe realisticmeaning;the students develop the ability to think, establish causal relationships, find out the main thing and reject non-existent. Solving tasks with the help of the interactive whiteboard allows students to be aware of the knowledge, deprive them of formalism.

The topical issue in studying the course of physics by future teachers of chemistry and biology is its relationship with other sciences: it is important not only the knowledge but also its summary in the general picture of the world. This is of great importance for students' formation of the scientific worldview and for understanding the complex problems of the present: social, environmental, economic.

While studying the course of physics by the students of non-physical specialties of pedagogical universities, in our opinion, it is necessary to consider also the following circumstances: the increasing role of physics in scientific and technological progress; the interdisciplinary connections and their obligatoriness for obtaining professional basic education.

Conclusions.

We investigated the educational and cognitive activity of the future specialists in chemistry and biology in terms of the computer-based approach based on the use of the interactive whiteboard. It was clarified that teaching the special subjects, the use of teaching methods and the methods of mastering the educational material can be supplemented and improved by the appropriate use of the information technologies. This is often achieved by means of usingthe interactive whiteboard and the corresponding software package that is consistent with the general teaching methodology. This package of applied computer programs gives the teacher and students a guided set of training exercises and tasks.

It is found out that existing multimedia boards are convenient not only for students in studing, but also help teachers in multimedia education, as they improve the organization of the educational process and directly help to provide educational material of reference, applied, practical and professional content.

The use of the interactive whiteboard while training future teachers of chemistry and biology as a basis for optimization of the educational process during the study of physics is considered. In particular, considerable attention is paid to the use of the interactive whiteboard during lectures and practical classes.

The organization of the educational and cognitive activity of the future teachers of chemistry and biology with the help of an interactive board during the study of physics was studied and the following tasks were solved: the methodical features of the motivation development in educational activity of students of natural sciences in pedagogical universities; the methodological approaches to the formation of natural sciences competence in physics; systematic improvement of the methodology of the organization of the educational and cognitive activity with the use of multimedia, which leads to productive mental and practical activities of students in the process of mastering the educational material.

Thus, an interactive whiteboardis an important tool for carrying out lessons. With the help of an interactive whiteboard we we can give presentations, demonstrations, simulations, make notes, sketches,etc. In addition, using interactive whiteboards in the classroom helps students to improve their activity, to increasethe teacher'space of work as well as students' and to form motivation of students to learn. But the use of an interactive whiteboard in the educational process does not solve all educational problems. Interactive whiteboards do not only help to presenteducational material, but they requirea high awareness of multimedia technology fromteachers and students.

The conducted research on the problem of using an interactive whiteboard during lectures and practical classes in physics for future teachers of chemistry and biology does not reveal all aspects of the organization of the educational process and the qualitative training of specialists-naturalists. In the future, the reseachon this issue can be carried out in order to improve the content and system of teaching physics, taking into account the use of the interactive whiteboard during laboratory work, individual tasks and independent work.

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