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METHODOLOGY FOR ORGANIZING LABORATORY CLASSES IN ATOMIC PHYSICS BASED ON AN INTEGRATED APPROACH

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Abstract
At present, in order to address the problem of electricity shortages in our country, promising plans such as the use of nuclear power plants, wind energy, and solar energy are being developed. In these long-term plans and decisions, the use of nuclear energy is considered one of the key components, and priority tasks such as "Training personnel in the field of nuclear energy, developing educational institutions, and equipping educational-practical laboratories in nuclear physics with laboratory and instructional equipment, models, and analytical simulators" [1] have been defined. Ensuring the implementation of this resolution requires the preparation of highly qualified future physics teachers who possess modern knowledge of atomic physics and advanced teaching technologies. In the system of continuous education, along with theoretical knowledge, performing practical and laboratory work during the teaching of the physics course is essential, since students' theoretical knowledge is further strengthened through experiments and calculations during practical and laboratory activities [2].
Currently, there are many laboratory devices and laboratory complexes available for the Mechanics, Molecular Physics, Electromagnetism, and Optics sections of General Physics; however, laboratory work in the section of atomic physics is not in a satisfactory state, as it requires specially equipped rooms and specific

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devices. In particular, despite the presence of laboratory work in the curriculum for teaching atomic physics, many educational institutions lack the necessary conditions to conduct them. Taking this into account, laboratory work in this section can be performed virtually by using modern technological opportunities, computer equipment, and multimedia tools. To conduct virtual laboratory work with the help of a computer, it is sufficient for the student to have basic skills and competencies in using computer programs, even without deep knowledge of them. At the same time, when performing a laboratory task, students must follow methodological instructions, study the theoretical section of the work, understand the operating principles of measuring instruments, know the sequence of actions required to carry out the experiment, understand the meaning of physical quantities in the calculation formulas, answer control questions, and, in general, clearly understand the purpose of the experiment. Thus, the requirements set for students when performing virtual laboratory work on a computer are almost the same as those for performing real laboratory work in physics.

The advantage of performing virtual experiments is that students interested in the subject do not need to search for special instruments, equipment, or devices to independently conduct a particular experiment; they can perform the required laboratory work at any time and under any conditions. In this process, it is necessary for the student to read and understand the main information in the theoretical section, become familiar with the procedure for conducting the work, and carefully study the methods for calculating and analyzing the obtained results.

As an example, we present the purpose, operating principle, and brief description of the laboratory work titled “Study of the Laws of Laser Radiation Absorption in Liquids” from atomic physics, developed by the staff of the University of Colorado and available on the PhET.com platform (Fi 1).

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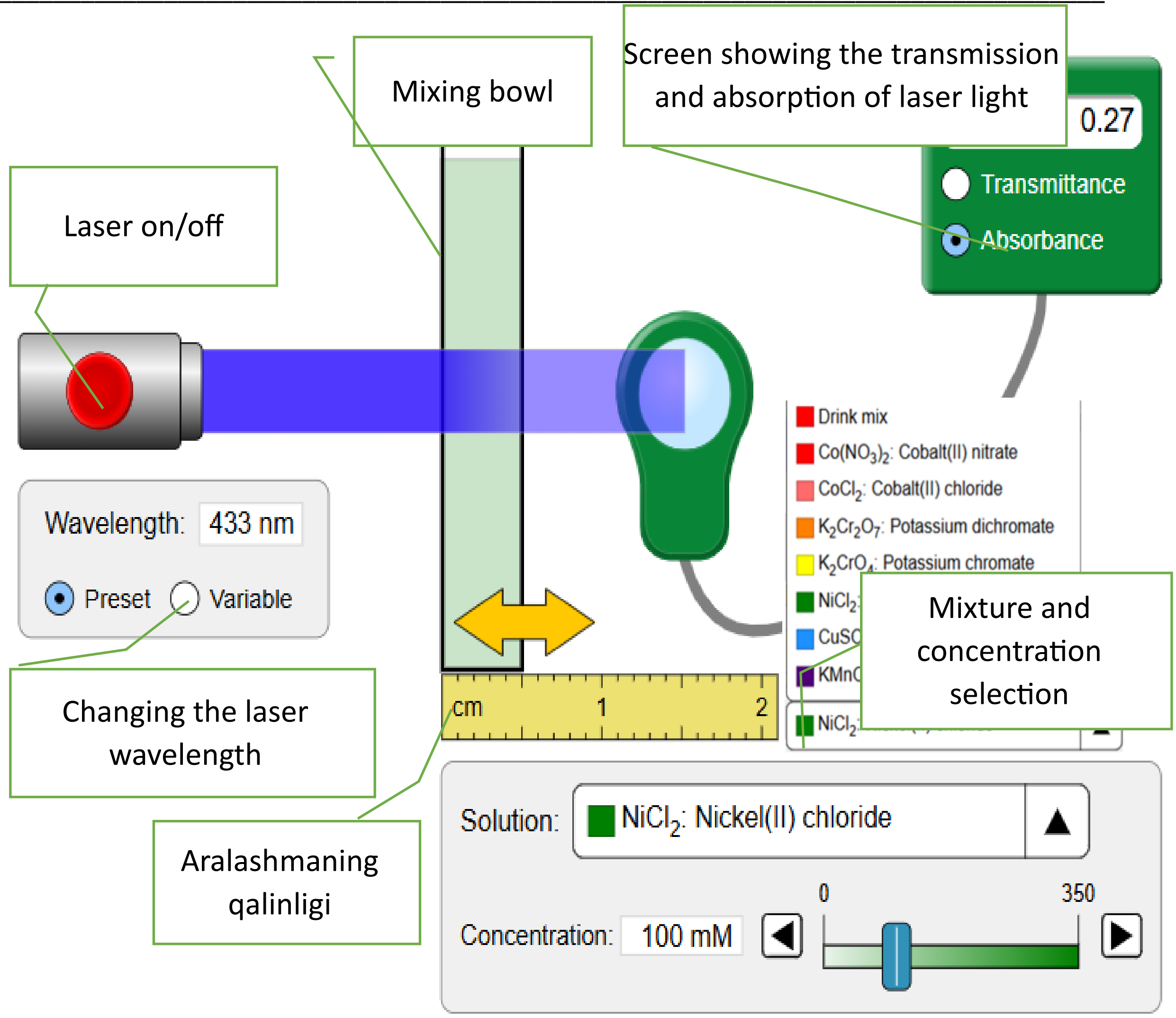

1 – figure. Lab training interface

During the implementation of this laboratory work, it is necessary to emphasize interdisciplinary and internal integration on the topic under study. In the laboratory work under study, internal connections exist between the departments of nuclear physics and molecular physics, electromagnetism, and optics, and before performing the work, it is necessary to have a clear idea of these connections. Table 1 below shows the mechanism for implementing internal and interdisciplinary integration in the laboratory work under study.

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1 – table Intra- and interdisciplinary integration in laboratory training

Internal connection		Interdisciplinary connection		
Electromagnetism	**Optics**	**Mathematics**	**Chemistry**	**ICT**
Structure and principle of operation of a light laser; Absorption of electromagnetic radiation when it passes into a medium; Change in wavelength of electromagnetic radiation when it passes into a medium; When light passes through a substance, its intensity decreases - the light is absorbed in the substance. The change in light intensity is proportional to the distance dl and the magnitude of the incident light intensity I dJ=-kJdl (1)- Bougeries law.	The laws of refraction and reflection of light at the boundary of two media; Study of laws such as the dependence of the absorption coefficient of laser light in liquids on the thickness and concentration of the medium absorbing coherent light waves, the frequency (wavelength) of the radiation in the liquid; The Bouguer-Lambert law. $I = I_0 \cdot e^{-\varepsilon lC}$ (2)	Through integration $lnI - lnI_0 = -\varepsilon lC$ (3) we get the result; If we define the result based on the division rule of the logarithmic function as follows $A = -\log(I_0/I)$; We derive the Bouguer-Lambert law for the absorption coefficient as follows: $A = \varepsilon lC$ (4) where A is the absorption, l is the liquid thickness, C is the mixture concentration, ε is the absorption coefficient; $\varepsilon = \frac{A}{lC}$ (5) we have a working formula.	• What is the ratio of water and substance to prepare a mixture of a certain concentration? • Preparing mixtures of different concentrations? • How does the concentration change by reducing a substance? • How does the concentration of a substance change by evaporating a substance?	• Web dasturlash (Html, css, JavaScrip, PhP); • Adobe Flash Player animatsiyasi; • Crocodile chemistry simulyatori; • PhET Simulations simulyatori; • Vectorian Giotto; • InteractivePhysics ; • Microsoft Excel dasturi.

The table above shows internal integration in laboratory work based on a comparative analysis of knowledge obtained in the departments of molecular physics and electromagnetism of general physics. Interdisciplinary integration is achieved through connections between disciplines such as mathematics, chemistry, and information and communication technologies (ICT).

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In order to fully study the subject under study in laboratory exercises, it is necessary to implement not only internal and interdisciplinary integration, but also integration between types of exercises. In fact, although integration between types of exercises has existed for a long time and is observed to occur spontaneously, paying special attention to this integration is one of the main factors of educational effectiveness. In the laboratory work under study, when implementing integration between lecture, practical and independent training exercises, theoretical information related to the subject, issues on the subject, and specific tasks for independent training should be indicated [4]. Table 2 shows an example of tasks necessary for integration between types of exercises related to the subject.

2 – table **Integration between training types in laboratory training**

Integration between types of training		
Lecture session	**Practical training**	**Independent learning**
Explain the Bouguer-Lambert law? How does the concentration of a solution change if the volume of a solution decreases? How does the absorption of light change as the concentration of a solution increases? What is the relationship between light absorption and the thickness of a liquid? Show the difference and relationship between the absorption and transmission coefficients of radiation? Show the relationship between the absorption coefficient in a liquid and the color of the radiation and the color of the solution? How does the absorption of light in a solid depend on the thickness and concentration of the absorbing medium?	If the wavelength of the laser light is 549 nm, $Co(No_3)_2$ Calculate the absorption coefficient of a mixture with a cobalt II nitrate concentration of 100 mM/L and a mixture thickness of 0.5 cm, and an absorption of 0.24, and compare the result with the results in the literature.	- Create animations using tools such as Vectorian Giotto, Interactive Physics. - Create animations of laboratory work using web programming (Html, css, JavaScript, PhP). - Create a simulation of the preparation of a mixture concentration using Crocodile chemistry. - Design a simulation similar to this work using the PhET simulations simulator. - Create data in the form of spreadsheets in Microsoft Excel from the results obtained.

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The above-mentioned virtual laboratory work is currently being performed by students. Initially, the laboratory work is explained by the teacher, and then the following additional tasks are assigned to the laboratory work for students to complete independently. During the performance of these tasks, students receive laboratory results via mobile phones and analyze the results.

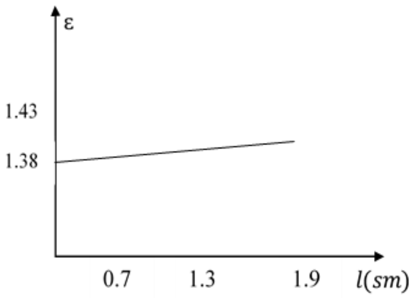
During the performance of laboratory work, the following laws observed in the absorption of laser radiation in liquids are studied.

Task 1. Study the dependence of the absorption coefficient on the liquid thickness at a constant concentration of the selected solution. In this case, the liquid thickness is changed without changing the concentration of the selected solution and the absorption coefficient for each thickness is recorded in Table 3.

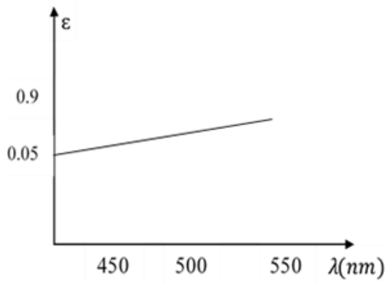
3-Table

№	λ (nm)	l (sm)	Solution	C (mM/L)	A	ε	ε (%)
1	403	0.7	$Co(No_3)_2$- cobalt II nitrate	200	0.2	1.43	1.2
2		1.3			0.36	1.38	
3		1.9			0.53	1.4	

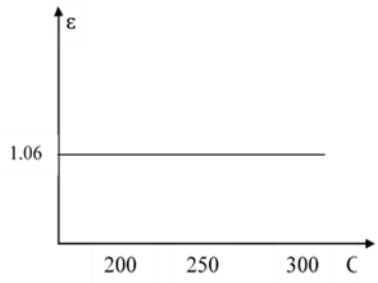
Based on the results obtained, draw a graph of the relationship ε=f(l) (Figure. 1).



1- Figure.



2- Figure.



3- Figure.

Task 2. At a constant concentration of the selected solution, the wavelength of radiation is changed without changing the thickness of the liquid and the results are recorded in Table 4.

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4- Table

№	λ(nm)	l(sm)	Solution	C(mM/L)	A	ε	ε(%)
1	450	1.5	$CuSO_4$- copper II sulfate	150	0.02	0.08	2.6
2	500				0.01	0.05	
3	550				0.02	0.09	

Based on the results obtained, draw a graph of the relationship ε=f(λ) (Fig. 2).
Task 3. The concentration of the solution is changed without changing the type and thickness of the selected liquid solution, the wavelength of the radiation, and the results are recorded in Table 5.

5- Table

№	λ(nm)	l(sm)	Solution	C(mM/L)	A	ε	ε(%)
1	658	1	$NiCl_2$- Nickel I chloride	200	0.21	1.05	0.9
2				250	0.27	1.08	
3				300	0.32	1.06	

Based on the results obtained, draw a graph of the connection ε=f(C) (Fig. 3). Based on the results obtained and their graphs, a conclusion and report are written on the laboratory work and 10 test tasks related to the work are completed [5]. Thus, instead of performing laboratory work in the Nuclear Physics department in real conditions, students should perform the virtual version of this work. Therefore, after performing virtual laboratory work, performing real laboratory work will be understandable for students and the topic will be further consolidated. In addition, simulation programs such as Yenka, Phet simulation, Vectorian Giotto, Interactive Physics, Crocodile physics, Crocodile chemistry can be used effectively. Simulation programs, on the one hand, simultaneously form students' skills and competence in using ICT, and on the other hand, they allow them to master the topics more deeply and understand their content and essence through practical application of theoretical knowledge. This, in turn, will develop the skills and abilities of future physics teachers to use simulation programs to teach topics that are difficult for students to master in class.

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References

1. O'zbekiston Respublikasi Prezidentining 2019-yil 16-oktyabrdagi "O'zbekiston Respublikasining yadro-energetika dasturi uchun kadrlar salohiyatini rivojlantirish strategiyasini tasdiqlash to'g'risida" PQ-4492-son qarori qarori. – Qonun hujjatlari ma'lumotlari milliy bazasi, 09.11.2021-y., 06/21/3/1037-son, 09.11.2021 y.
2. Nasriddinov K.R., Xudayberdiyev E.N., Samandarov L.Q., Azzamova N.B. Umumiy fizika kursining elektromagnetizm bo'limidan laboratoriya ishlari. — Toshkent.: Malik print co, 2022. –201 b.
3. Рожков М.М. Методика изучения строение атома в курсе физики средней школы. Дис... канд. пед. наук. – Москва: 1964. – 243 б.
4. Nasriddinov K.R., Xudayberdiyev E.N., Samandarov L.Q., Qosimov R. Umumiy fizika (Atom va yadro fizikasi) dan masalalar to'plami. — Toshkent.: Malik print co, 2022. -240 b.
5. Samandarov.L.Q. Integrativ yondashuv asosida yadro fizikasi bo'limini o'qitish metodikasini takomillashtirish. p.f.f.d dis. avto. – Q., 2023. – 48 b.
6. https://phet.colorado.edu/sims/html/beers-law-lab/latest/beers-law-lab_all.html