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DOI: <https://doi.org/10.24195/2617-6688-2022-1-4>**Methodology of using a computer in teaching in compliance with the learning outcomes on the topics “Light refraction. The law of refraction” in the IX grade****Shukur Alizade Hamid¹**

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The purpose of the research is to study the “Methodology of using a computer in teaching in compliance with the learning outcomes of the training on the topic “Light refraction. The law of refraction of light” in the IX grade. In the process of teaching, the learning outcomes on the content of experimental physics and modern life at the lesson involving computer technology, the students’ practical skills were formed, the interaction between the teacher and students was organized. The Crocodile Physics electronic laboratory program is used in the “research” phase of the course. The working principle of the program to conduct experiments before research was introduced to the students. They conducted an experiment to find out why light refracts at the boundary between two transparent media. Using Excel, they calculated the ratio of the angle of light incidence to the sine of refraction, and made a conclusion. Thus, after practicing virtual research, students applied what they had learned during the “creative application” phase of the lesson to the pictures.

Experience shows that the lesson built within this system arises students’ interest and enthusiasm. For example, “Light refraction”. In the law “The law of light refraction” we can show that all these factors are justified. In the process of teaching, the results of experimental physics and modern life content at a computer-based lesson, students’ practical skills and effective interaction between the teacher and students are organized.

Methods: The method of comparative analysis and surveys conducted among students were used during the research. The article contains the tasks, explanatory tables, pictures.

Application significance: teachers of Physics, those interested in the methodology, stakeholders can benefit from the article. Materials can be used in seminars, as well.

Keywords: computer, textbook, Crocodile Physics, methodology, the law of light refraction.

Introduction. Khaligov Akif Sahir oglu in his dissertation on “Ways to increase students’ interest in the process of teaching Physics in secondary schools” showed: The organization of teaching “Physics” with the help of computer technology should be divided into three main factors (Khaligov, 2004): 1) management of cognitive activity of individual students; 2) Management of training activities in the “Teacher-computer-student” system; 3) Management of teacher-student interaction and students themselves.

Experience shows that the lesson built within this system arises students’ interest and enthusiasm. For example, “Light refraction”. In the law “The law of light refraction” we can show that all these factors are justified. In the process of teaching, the results of experimental physics and modern life content at a computer-based lesson, students’ practical skills and effective interaction between the teacher and students are organized. At this time the student:

- Observes the law of light refraction by means of the computer.
- Measures physical quantities (beam angle, beam refractive index) using a virtual laboratory program, calculates and describes the results in a table in MS Excel.
- Determines the regularities between quantities (angle of incidence of the beam, angle of refraction of the beam, refractive index of the beam).

The purpose of the lesson: 1. To develop students’ thinking, practical and communicative skills by forming a scientific outlook on the “law of light refraction”. 2. To create and develop the ability to conduct experiments on “Light events” in virtual laboratory programs.

Learning outcomes (Murguzov M, 2020):

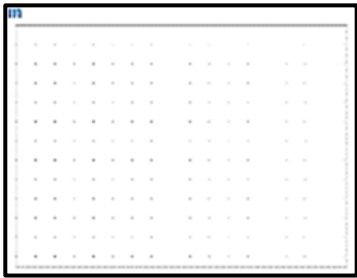
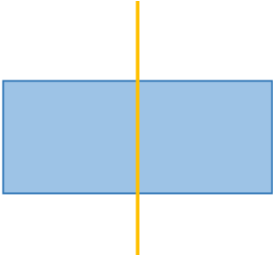
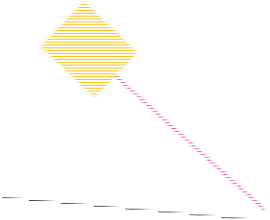
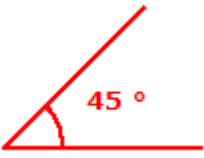
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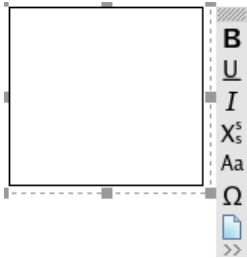
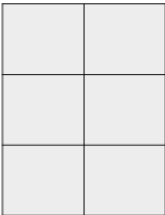
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- Substantiates the law of light refraction by simple experiments.
- Explains the physical nature of the concept "refractive index".
- Constructs and solves qualitative and quantitative issues related to the application of the law of refraction of light.

Provision: A laptop or a tablet, a textbook or an electronic textbook for each pair of students during the lesson. Electronic resource: "Crocodile Physics" Electronic laboratory program; (optical space, a transparent block, a beam box, a conveyor (2 pieces), a "text" section, an element container (Table 1). Formulation of the problem.

Note: You can change the color, size, and material of the resources in the "Properties" section. From the resources, the optical space (white board) – air, a transparent block – is a container or solid object containing liquid (liquids of different sections), and the beam box is a source of light.

<p><i>Schedule</i></p> <p>Optical space</p>	
<p>Transparent block</p>	
<p>Beam box</p>	
<p>Transportir</p>	

Text	
Elements container	

Course Outline: I organize the "motivation" phase of the lesson interactively and move on to the "research" phase.

Research Question: Why does an object appear to be broken at the boundary between two transparent media?

I listen to the students' assumptions concerning this question. I continue immediately after the answers.

We should review the process why the shape of an object changes at the boundary of two transparent media (air, water), we must consider the process that occurs when a ray of light passes from one medium to another. To do this, we will use the virtual laboratory program "Crocodile Physics".

Main part. Students conduct several surveys to conduct research. Before researching, I place the necessary resources from the "parts library" panel in the part tray. I bring to the stage "optical space" on which to experiment.

Note: Students are sent a link to the task to conduct the research, or the task is pre-loaded on the desktop of each student's computer. This saves time.

Research 1. What happens when light falls on the boundary of two transparent media? Justify.

Due to the difficulty of the work, the first part of the experiment is carried out by the teacher, the students (each student individually or in pairs) continue the experiment.

Procedure: 1. Place the transparent block and the ray box in the optical space. In the Properties section, select water as the material. To perform the operation, place the mouse on a small square figure on the block. When the hand gesture appears, click the mouse on the rectangle. In the window that opens, select "properties". This will bring up the "Properties" section on the right side, in the side panels. In the window that opens, select "Water" as the material. This means that a ray of light will pass from the air to the water. 2. Slide the beam box in an inclined position so that it breaks through the transparent block. 3. Bring the incident beam closer to the point of separation of the two boundaries of the transparent block normal (perpendicular to the center of the block). 4. Move the transporter and the text box from the toolbox to the optical space. 5. Using a conveyor, measure the angle of the beam incidence (α) and the angle degree between its path in the water and its perpendicular and record it in the text box. Repeat the experiment three times (Figure 1).

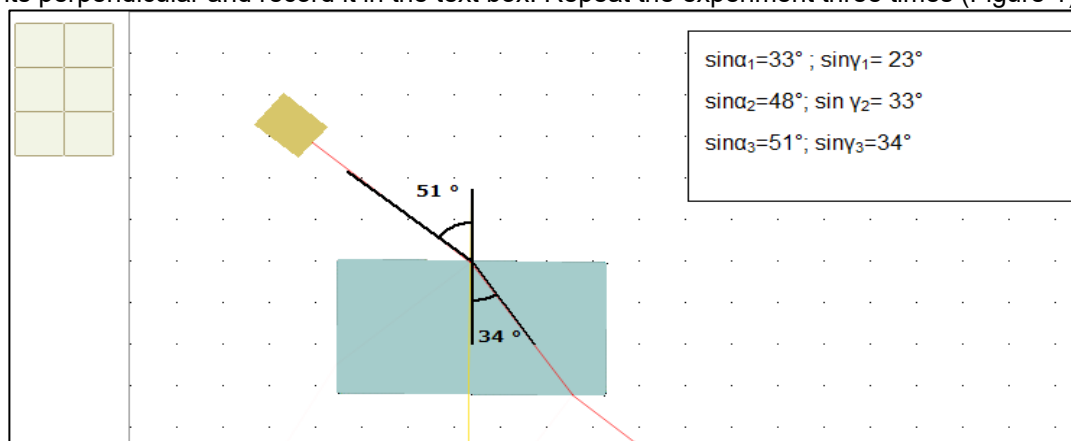


Figure 1.

6. Calculate the values of the angles using Excel and determine the ratio of the values of the sines of the angles of the refraction incidence for each experiment.

$$\left(\frac{\sin \alpha}{\sin \gamma} \right).$$

Figure 2

	A	B	C	D	E	F
1			Дарәсә			Hesablama
2	1-ci təcrübə	$\sin \alpha_1$	33	0,54464	$\sin \alpha_1 / \sin \gamma_1$	1,393897
3		$\sin \gamma_1$	23	0,39073		
4						
5	2-ci təcrübə	$\sin \alpha_2$	48	0,74314	$\sin \alpha_2 / \sin \gamma_2$	1,364472
6		$\sin \gamma_2$	33	0,54464		
7						
8	3-cü təcrübə	$\sin \alpha_3$	51	0,77715	$\sin \alpha_3 / \sin \gamma_3$	1,389764
9		$\sin \gamma_3$	34	0,55919		

Note: You do not need to use a four-digit math table to know what values the angles will take. Excel is more suitable for these calculations. To do this, select the cell (D2) where the calculation will be performed. 2. In the selected cell, type the formula “= SIN (RADIANS (C2))” or “= SIN (RADIANS (C2))”. 4. Press the Enter key. For further calculations, swipe over the lower right corner of cell D2.

In this case, all prices will be calculated automatically (Table 2).

7. Compare the angles of incidence and refraction according to the density of the medium and the refractive index when the light beam passes from one medium to another by changing the material of the transparent block. Repeat the experiment three times. Discuss the result (the textbook presents research questions) (Murguzov M., Abdurazagov R., Aliyev R., Aliyeva D., 2016):

Figure 3 shows the densities of different media and the values of the absolute refractive index. In addition, the values of the refractive index of different environments are listed in the properties section of the program's "transparent block" resource.

Figure 3

Matter	Density (ρ)	Refractive index (n)	Matter	Density (ρ)	Refractive index (n)
	kq / m^3			kq / m^3	
Air	1,29	1	Diamond	3500	2,42
Ethanol	789	1,36	Quartz Glass	2200	1,46
Water	1000 (t=20°C)	1,33	Quartz	2600	1,54
Ice	900	1,31	Rock salt	2100	1,54
Vegetable oil	930 (t=20°C)	1,52	Glass	2500 (t=20° C)	1,57

Approbation of research results: The main provisions of the article are reflected in the author's theses

submitted to scientific conferences in Azerbaijan and abroad, as well as in scientific articles published in various journals in Azerbaijan and abroad.

Conclusions. 1. The beam/ray falling on the air-water boundary is on a plane perpendicular to the surface from the point where the beam falls and the beam falls. 2. As a ray of light passes from one medium to another, it changes its direction at the boundary of both media. This phenomenon is called refraction of light (Murguzov M., Abdurazagov R., Aliyev R., Aliyeva D., 2016). 3. When increasing the angle of incidence, the angle of refraction increases (Murguzov M., Abdurazagov R., Allahverdiyev A., Aliyeva D., Nuriyeva K., Samadov A., 2011). 4. The ratio of the sines of the angle of incidence and refraction remains constant; n is a constant quantity and is called the relative refractive index. 5. The value of the refractive index does not depend on the angle of incidence or refraction of the beam, it depends on the properties of the two given media: where n_1 and n_2 are the refractive indices of the first and second media, respectively. 6. The light beam is refracted when it passes from a low-density transparent medium to a high-density transparent medium. In this case, the angle of refraction is smaller than the angle of incidence, and the refracted beam approaches the perpendicular drawn to the point of incidence at the boundary of the two media (Murguzov M., Abdurazagov R., Aliyev R., Aliyeva D., 2016). 7. A ray of light falling perpendicular to the boundary separating two transparent media of different densities passes through the second medium without refraction. 8. The reason why an object appears to be broken at the boundary between two transparent media is that light travels at different speeds within different environments.

Thus, the law of light refraction is expressed by two provisions:

- The incident beam is located on a plane perpendicular to the boundary of the two media from the point of incidence of the refracted beam and the incident beam.
- The ratio of the sine of the incidence angle to the sine of the refraction angle is a constant quantity for the two given media.

The refractive index of a medium relative to a vacuum is called the absolute refractive index of that medium. The absolute refractive index indicates how many times the speed of light in a given medium is smaller than the speed in vacuum (Murguzov M., Abdurazagov R., Aliyev R., Aliyeva D., 2016):

$$n = \frac{c}{v}$$

The law of light refraction at the boundary between two environments can be written in general terms:

$$\frac{\sin \alpha}{\sin \gamma} = \frac{n_2}{n_1} = \frac{v_1}{v_2}$$

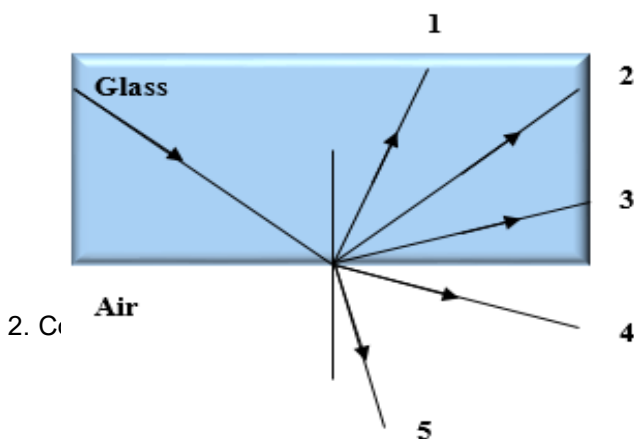
Therefore, the absolute refractive index at the boundary between two media is equal to the inverse ratio of the speed of light propagation in these media. This means that the light refraction at the boundary of a transparent medium is the result of its propagation at different speeds. An environment with a low speed of light is called a medium with a high refractive index or optical density, and an environment with a high speed of light is called a medium with a low refractive index or a low optical density.

When a beam of light passes from a low-density medium to a high-density medium, it approaches the perpendicular drawn to the point of incidence at the boundary between the two media.

An optical disc is used in the school laboratory to check the law of light refraction (Figure 2).

Creative application:

1. The light beam falls on the glass-air boundary (Figure 3). What number is indicated by the tested and returning rays [4, p. 240]? Justify.



Picture 3

M., Abdurazagov R., Aliyev R., Aliyeva D., 2016).

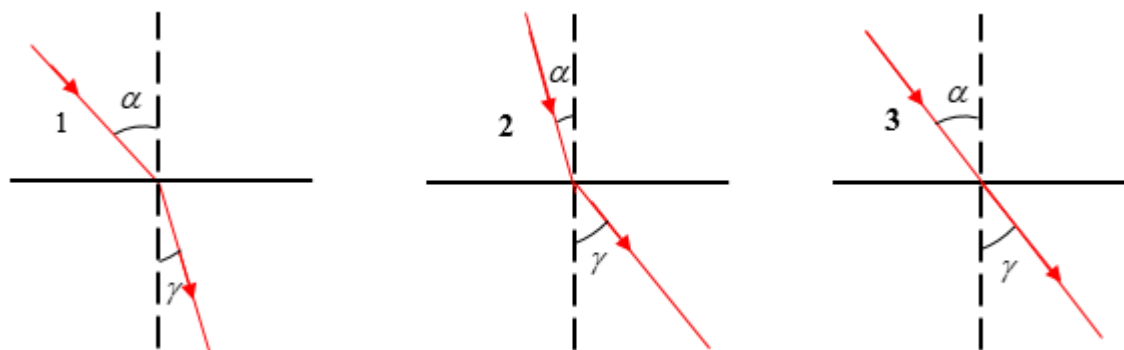


Figure 4.

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Методика використання комп'ютера у навчанні відповідно до результатів навчання за темою «Заломлення світла. Закон заломлення» в IX класі

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Основною метою дослідження є вивчення методики використання комп'ютера в навчанні за результатами заняття з теми «Заломлення світла. Закон заломлення світла» в IX класі. У процесі викладання результатів навчання за змістом експериментальної фізики і сучасного життя на уроці, побудованому з використанням комп'ютерних технологій, формувалися практичні навички учнів, організовувалася взаємодія учителя та учня. Електронна лабораторна програма Crocodile Physics використовується на "дослідницькому" етапі курсу. Студенти ознайомлюються із принципом роботи програми для проведення експериментів перед дослідженнями. Потім експериментують з тим, чому світло заломлюється на межі двох прозорих середовищ. За допомогою Excel обчислюють відношення кута падіння світла до синуса заломлення і доходять висновків. Таким чином, після практики віртуального дослідження учні застосовують те, що вони дізналися на етапі "творчого застосування" уроку, до картинок.

Досвід показує, що урок, побудований у рамках цієї системи, викликає у учнів інтерес і ентузіазм. Наприклад, «Заломлення світла. У законі «Закон заломлення світла» можемо показати, що усі ці чинники виправдані. У процесі викладання результатів експериментальної фізики і змісту сучасного життя на комп'ютерному уроці організовуються практичні навички учнів і ефективна взаємодія учителя і учня.

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Методи: використовувався метод порівняльного аналізу. Стаття містить завдання, пояснювальні таблиці, картинки. Важливість застосування : стаття може бути корисна учителям фізики, що цікавляться методикою.

Ключові слова: комп'ютер, підручник, *Crocodile Physics*, методологія, закон легкого заломлення.

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