

# THE LAWS OF MOLECULAR PHYSICS AND THERMODYNAMICS IN HIGH SCHOOLS TEACHING METHODS

Ergashev Jamshid

Jizzakh State Pedagogical University

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**Abstract.** *Today, the use of modern information technologies, which differs from the traditional way of teaching, provides an opportunity to achieve high efficiency. This article analyzes the effective methods and problems of forming the imagination of the model of theories in the minds of students, introducing them to phenomena and processes in the teaching of physics. The principles of applying computer technologies and using multimedia tools based on them to the process of teaching the laws of molecular physics and thermodynamics of the physics course are described:*

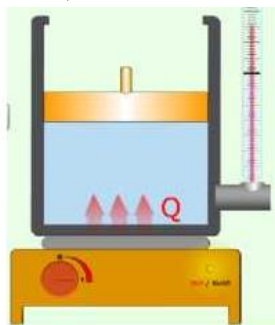
**Keywords:** *brownian movement, modern information technologies, physical phenomena.*

## INTRODUCTION

Ensuring the interrelationship of education, science and production, reflecting it in the content of education, is a unique and important direction of modern teaching methods. In fact, today the fact - proofs are increasing extremely, the emergence of new methods and ways of research leads to a continuous increase in the amount of knowledge. From this comes the necessity of solving the question of how and by what methods the students can be activated in the process of learning. This requires new methodological approaches in the educational system. Therefore, today various modern educational technologies are widely used in the educational process, which activate the educational activities of students while preserving the traditional form of lessons. On the basis of such modern educational technologies, if physical phenomena are explained to the students in a visual way, the sum of knowledge, skills and qualifications acquired by them will be embodied. For this purpose, in this article, using the convenience and possibilities of modern educational technologies, the methodical lesson development of the logical and interdependence of theoretical and practical knowledge in teaching the subject of the laws of thermodynamics was described. It repeats the information about the mutual exchange of different types of energy known to the students, and analyzes the complex processes in which the internal energy of the body changes both due to heat transfer and due to work, with concrete examples. Research shows that students absorb 43% of the material in the first 15 minutes of the lesson, and 24% in the next 30 minutes. Therefore, it is appropriate to pass the lecture in the modern active method. For this, the teacher explains the information in the lecture during the first 10-12 minutes, which is the student's activity period.

As noted, the logical and interdependence of theoretical and practical knowledge of teaching thermodynamics and laws of molecular physics is an example of methodical lesson development based on modern educational technologies. "Many things are being done in order to ensure the implementation of the decision No. 997. For example, the third law of thermodynamics: when reaching absolute zero, processes in physical systems stop. Absolute zero is the lowest temperature we can experience. In this case, we measure the temperature in degrees Kelvin. In this

way, the temperature and cooling are caused to bring the entropy of the system to absolute zero. In such cases, it is more accurately treated as a constant. Therefore, entropy will have a minimal but constant value. The value of absolute zero in Kelvin is zero, but if we use it in the Celsius temperature scale, it is -273.15 degrees. Many methods are now used in schools and higher education to teach the laws of thermodynamics. Let's take a look at some. Suppose a group is studying the first law of thermodynamics for an isobaric process. In this, the teacher explains the formulas and physical meaning of the first law of thermodynamics for the isobaric process, using the material on the table. Task: the gas is compressed, that is, external forces do positive work, and the gas itself does negative work; then the 1st law of thermodynamics takes the following form:  $Q = -A$ ,  $\Rightarrow$ ,  $Q = A$ .  $A = -800$  (J);  $A^* = 800$ (J). When work is done by external forces, the gas gives off heat to the surroundings (Figure 1)



**Picture 1. When work is done by external forces, the gas gives off heat to the surroundings**

At the conclusion, each group talks about the results, the rest of the students fill in the table. A student from each group is called to check the table, he fills in the table: writes the law, formulas and physical meaning of the first law of thermodynamics for isochoric, isothermal, isobaric process.

*Cluster.* This method helps to create conditions for students to think freely and openly about optional problems (topics) and freely express their personal opinions. The "cluster" method requires identifying a structure that allows thinking about the relationships between different ideas. This method is a form of non-objective thinking. Its use is carried out in connection with the principle of human brain activity. "Cluster" method serves to ensure that the thinking activity is in harmony until a specific topic is mastered by the students in depth and thoroughly. "Cluster" method can be used in the process of training organized with students individually or in groups. In group-based training, this method is manifested in the form of a set of ideas expressed by group members. This creates an opportunity to harmonize the ideas put forward by each member of the group and to find connections between them.

this method, the following conditions must be met:

1. Write down what you think. Instead of thinking about specific problems, just write them down.
2. Don't stop writing until the allotted time is up. If you can't think of an idea for a certain period of time, then start drawing a picture of something on paper. Continue this process until a new idea is born.
3. Do not focus on spelling or other aspects of your writing.
4. Try to introduce as many new ideas as possible within a given concept and show the interrelationships and connections between these ideas. Do not limit the quality of the set of ideas and show the connections between them. It is recommended to use the "Cluster" method in some physics classes to control the knowledge and skills acquired by the students on the topic

taught in the previous lesson. In this, the students are asked to write down whatever they want about the given topic.

*Brainstorming.* The "Thinking attack" method of education serves to ensure students' activity during the lesson, free them from thinking in the same standard way, encourage them to think freely, collect different ideas on a specific topic, and teach them to be creative.

The main principle and condition of the "thought attack" method is to absolutely prohibit criticism of the opinion expressed by each student, and to encourage all kinds of jokes. The aim is to ensure the free participation of students in the learning process. The effective and successful use of this method in the educational process depends on the teacher's pedagogical skills and breadth of thinking. When using the "brainstorming" method, the number of students should not exceed 12. This method can be effectively used in lessons of repeating a certain chapter of physics, at the end of laboratory work, in excursion lessons.

*Crocodile Technology software*

The Crocodile Technology program allows high school students and teachers, lyceum, college students to use the possibilities of modern information technologies for deeper mastery of the "electrical" part of physics. In addition, Crocodile Technology software can be used in electrical engineering and circuit theory courses. Figure 8. The program is an electronic designer that allows you to simulate the process of assembling electrical circuits on the monitor screen, as in real experience, and measure electrical quantities with a multimeter (3-dimensional), ammeter and voltmeter.

*Crocodile Physics software.*

Crocodile Physics is a powerful simulator that allows you to model physical processes and create and observe experiments related to mechanics, electrical circuits, optics, and wave phenomena. This program can be used in classes through an interactive board, and can also be used as an independent work on a personal computer. This powerful program allows you to observe physical phenomena, conduct experiments and model processes of various levels of complexity. For example, in the program, you can program microprocessors and simulate 3D models of robotics.

This program, regardless of the profession, teaches the user to be curious, think creatively, and analyze the results of work. The possibilities of the program are very wide, and it can be widely used in practical training (that is, in solving problems), especially in performing virtual laboratory work.

*Blitz questions.* In this type of supervision, it is necessary to have a clear objective, to think and plan why the blitz questions are being asked. Questions according to the purpose of application:

to identify the shortcomings of acquired knowledge, to achieve deeper mastering;

it is necessary to give the acquired knowledge, skills and qualifications on a certain subject in the form of tests.

Questions should be reliable and practical. The level of simplicity or complexity of the questions asked to each student and the scope of the topic should be the same.

*Debate.* Debate classes are distinguished by clarifying issues that have not been resolved in the competition classes, and making correct, clear judgments and concise conclusions. Debate requires alertness on the part of readers. It teaches to think independently and quickly, to be responsive, to think about the rightness or wrongness of the given opinion, and to prove one's

opinion independently and consistently. As a result of mutual argument and debate, the most correct and favorable solution is reached. The student listens to the convincing arguments of the opposing side through the debate, realizes his "I", makes an independent conclusion about the scope of his worldview, scientific creativity, whether it is right or wrong. Teaches how to use various methods and tools, creative thinking, and effective use of opportunities to protect one's opinion. In order to conduct an effective discussion lesson, students need to have a broad understanding of the text or topic being discussed and have studied it well. Currently, in connection with the development of computer technologies, new forms of organizing lessons are being formed. Among them, one of the widely used practical works is the visual explanation of physical processes that are difficult to observe with the help of special programs on a computer by means of electronic textbooks, animations, virtual experiences and presentations. There are many e-tools related to physics course designed in this way, and they are shown to be used mainly for schools, academic high schools and colleges. Because these electronic tools are used to show physical processes, electronic textbooks, animations, virtual labs and experiments to the students of the course in the teaching of physics in the general high school in the training institutes. These virtual laboratory works have the purpose of the work, the necessary tools and equipment, the procedure for performing the work, control questions, like the usual laboratory works. It is known that the application of computer technologies and the use of multimedia tools based on them in the process of teaching a physics course is of great importance from the pedagogical and psychological point of view, and leads to the following important results:

The educational process is activated, the efficiency of the lesson increases;

The transmission of educational materials in various forms (with the help of voice, text, video, graphics, animation) attracts the attention of students;

A high level of visuality arouses a great interest in the studied subject in the student and listener;

Ensures long-term retention of learned educational material;

The opportunities for independent education of students and listeners will increase and the problem of time shortage will decrease.

There must be certain conditions and technical means for organizing lessons using modern information technologies in the educational process.

First, to information resources:

Personal computer;

Projector;

Multimedia tools;

Scanner (for transferring complex schemes and drawings, images to a computer);

Video camera (for video conferencing and other purposes);

Printer, photocopier (printing and duplicating handouts, and for other purposes) and other resources.

Second, special software must be available.

In the educational system, multimedia electronic textbooks, lectures, virtual laboratory works, various animation programs and electronic version, special programs are necessary for creating slides.

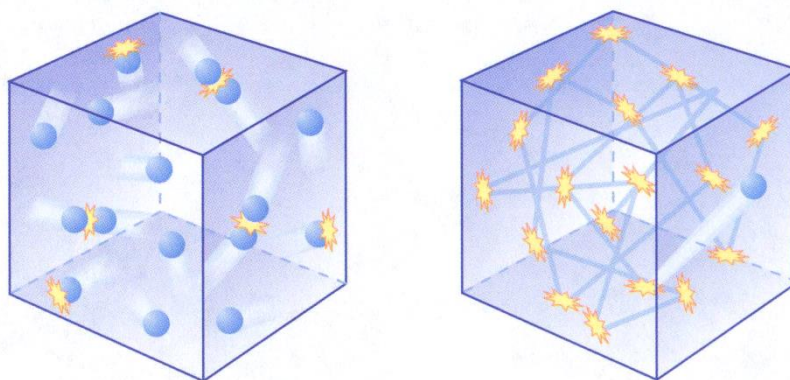
The use of computer models in educational processes, taking advantage of information technologies, gives its results. The principles of using computer models in educational processes are as follows:

- ❖ the computer program should be used when it is impossible to conduct the experiment or the experiment is moved to an unobservable level;
- ❖ the computer program helps in identifying the studied detail or in illustrating the problem being solved;
- ❖ as a result of the work, students should know both qualitative and quantitative connections of quantities characterizing events with the help of a model;
- ❖ while working with the program, the students' task is to work on tasks of different difficulty, as this allows them to work independently.

### **ANALYSIS AND RESULTS**

Today, the use of modern information technologies, which differs from the traditional way of teaching, provides an opportunity to achieve high efficiency. In terms of teaching physics, it is important to develop effective methods of forming the imagination of the model of theories in the minds of students, introducing them to phenomena and processes. We will now look at Brownian motion, a branch of molecular physics. In 1827, the English naturalist Brown showed in an experiment that due to the constant movement of pollen particles suspended in liquid, their positions during a certain period of time are in the form of complex sinuous lines. Figure 2 shows the states of the Brownian particle during 30 seconds. Particles in the liquid move in this way due to the impact of liquid molecules on them from different sides.

Several liquid molecules can hit a particle at a time. But if more molecules hit it from one side, the particle moves in the direction of those molecules, then as a result of more molecules hitting it from the other side, the direction of movement changes again, and this process continues continuously. Such a complex motion of a particle in a liquid is called Brownian motion. We can describe the motion of a computer model of particles in plane or three-dimensional coordinates. For this purpose, in the given time interval, the particle moves in a random direction, invisible to the indicator, so that its displacements along the coordinate axes obey the normal distribution with the dispersion identified in the formulas (Fig. 2).



***Fig. 2. The random motion of particles***

The random motion of particles can be done using Macromedia Flash, one of the multimedia programs that can be used in an understandable way for students. Using the active elements of this program, we can see the random movement of molecules as a diffusion phenomenon and Brownian motion as an electronic animation. For this purpose, we will get



acquainted with the process of building a model showing the movement of molecules in Brownian motion in the Macromedia Flash program. Let's start the Macromedia Flash program. Create a new document using the program's file menu. We make a "particle" image in the upper left part of the new document window (Fig. 3). Using the "Add Motion Guide" command from the "Timeline" section of the program, we create a motion layer that guides the object. On the resulting layer, we can draw the direction of movement with the help of the pen tool, that is, the direction of voluntary movement. Activate the "Create Motion Tween" command from the context menu of the selected object. As a result, the object on the screen will automatically move to the starting point of the guide, that is, it will move animatedly along the direction of movement predetermined by the user. We select the last frame of the animation scene and burn the keyframe from the context menu. In the last frame, we remove the object from the selected part and push it to the end of the guide, that is, to the end of the drawn trajectory. This process is repeated several times and prepared in separate layers. As a result, we can describe the random movement of particles, Brownian motion, in the Macromedia Flash environment.

### **CONCLUSION**

It should be noted that in some cases, shooters have encountered cases of describing and demonstrating physical phenomena to students on a blackboard or verbally without the necessary equipment. But the development of modern information technologies has changed this situation. The fact that teachers can independently create educational resources in physics and that it is not too difficult to demonstrate to students, as well as presented many options for preparing high-quality educational resources.

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