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Study of Physics Using Mental Experiments

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Annotation. The article discusses the forms of development of students' thinking skills, types of intellectual experimental-theoretical thinking, external illustrative mental experiments, the ability to more visually describe the conclusions of physical theory, the degree of study of the studied process or physical phenomenon in a mental experiment.

Keywords: experiment, thinking ability, experience, material technical problem, real experiment, analysis and synthesis, object, process, event, researcher, logical thinking.

One of the forms of developing the thinking ability of pupils and students is to engage in an intellectual experiment. An intellectual experiment is different from a traditional practical-empirical experiment in that it is a stage in the level of theoretical knowledge of a science. In other words, an intellectual experiment is a special type of theoretical thinking.

For example, what results are obtained when a student measures the weight of an object on a spring scale at the poles of the Earth and at the equator? When asked, he can immediately imagine the experience and find a clear answer. So, in an intellectual experiment, he develops his skills and abilities in the "virtual world" without doing a real experiment. This method allows not only to increase the student's theoretical thinking ability, but also to solve the material and technical problems required for a real experiment.

Analysis and synthesis are among the most important aspects of thinking in theoretical thinking, and they are closely interrelated. Together, they allow us to fully imagine reality.

Analysis (analysis) is the division of an object, process or event into separate parts or the separation of its individual properties, characteristics and attributes.

Synthesis is the mental connection of parts of the object under consideration or the combination of their properties and properties. With these methods, for example, the thermal expansion of a solid is explained on the basis of the motion and interaction of its constituent particles.

In an intellectual experiment, based on the researcher’s logical thinking and creative imagination, only experimental and theoretical materials can move forward in the research together and solve unresolved scientific problems. Therefore, every researcher first applies a mental experiment.

Thought experiments are not a creed. It is an intellectual "operation" developed on the basis of requirements and principles tested in scientific theory. Each of these "operations" is subject to rules arising from the objective laws of science. This ensures that the results of the intellectual experiment are at a high scientific level.

Intellectual experimentation plays a major role in physics education. This is because it is a process of knowing an object or event based on an ideal physical model, having the structure of a real physical experiment, and their operation subject to the laws of physics and logic.

As noted above, mental experiments are used in practice to study physical processes that are problematic to learn in practice. From the "famous" intellectual experiments in the history of physics, we can cite the following:

1)Archimedes' experiments - the discovery of the swimming condition of an object;
2)Model of ideal heat engine (Carnot cycle);
3)Maxwell's "Demon" - the idea of creating the second type of perpetual motion;
4)Boltsman's "Demon" - as opposed to Maxwell's demon, proving that the second law of thermodynamics is random in nature;
5)"Paradox of twins" - the difference in time intervals in different number systems;

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6)Einstein's elevator is an intellectual experiment of Einstein's free-falling elevator, which describes the equivalence of gravitational and inert masses and establishes the theory of relativity;

7)Schrödinger's "cat" - an intellectual experiment that shows that quantum mechanics is not a pamphlet;

8)Heisenberg's gamma microscope is an intellectual experiment that confirms the uncertainty principle.

There are also illustrative mental experiments. Their purpose is to provide a more visual illustration of the conclusions of physical theory. In the early stages of the study of physics, such is the case - illustrative mental experiments play a major role. Because physics studies nature, natural phenomena and processes on the basis of abstract ideal models, and mathematical apparatus is used to characterize it. Students receive information mainly in the form of emotions.

Therefore, in physics education, information should be presented in the form of symbols, symbols, models, schematics that affect the feelings of students. This is why an intellectual experiment is useful here in bringing abstract physical reality to a view that can be demonstrated in the eyes of the reader. In the process of studying physics, in an intellectual experiment, a visual connection is formed between images conducted with ideal physical models and real processes based on images and symbolism. The intellectual experiment allows the passage of the abstract ideal in the real case, but the real case is explained on the basis of the result obtained.

- In the process of intellectual experimentation, in our opinion, the following cognitive problems are solved:

- create ideal models that describe the process, event or object, its real state;

- on the basis of the developed, simulated model the separate aspects of a physical phenomenon or process are studied, its physical meaning is explained and conditions of application of the model are defined;

- formation of simple, vital concepts and ideas on the basis of information collected about real physical objects, processes, their properties and characteristics;

- to describe and express the first physical laws and principles based on the results of observations, the results of real experiments;

- deeper understanding of the physical meaning of the fundamental conclusions of important physical theories;

- to give instructions on the preparation and conduct of a real experiment and to develop the skills and abilities to theoretically substantiate it;

- research on methods of studying this or that physical phenomenon, process.

The level and depth of the study of a process or physical phenomenon under study in a mental experiment may vary, but a positive result in its study will come first.

The method of intellectual experiment is a method of theoretical study of the physical problem under consideration. This method was founded during the formation of physics (Archimedes, G. Galileo, I. Newton) and has not lost its relevance today!

In the process of development of physics education, the following technologies of intellectual experiment were formed:

a) replacement of a real physical process, event or object with a model that has its basic and necessary physical properties;

b) the use of "idealized" tools and equipment in the ideal model according to the rules of idealization;

c) study of one or more objects in the model of a physical object without taking into account other properties;

g) variational change of the quantitative and qualitative characteristics of the physical object in the model, taking into account the environment in which it is located, its impact on it;

d) predict how the physical object under consideration will change under the new conditions of the model, taking into account its properties and characteristics;

e) the application of the results and new knowledge obtained in the ideal model as a result of an intellectual experiment to the real object in analog form or to a similar object, process

Hence, intellectual experimentation is the most powerful tool of the cognitive process. It allows you to gain new knowledge in the study of physical phenomena and processes in the ideal model instead of the

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real model, as well as to study the most important properties of the real object. The intellectual experiment, its structure, application and "abandonment" (when not justified) operate in the ideal model in ideal conditions, and this characterizes the life and creative activity of the learner.

An intellectual experiment is an operation of studying its properties and properties by placing this ideal model in real different experimental situations. The behavior of a model under given physical conditions is predicted based on the laws and rules that were previously imposed on its properties.

Possible methods of intellectual experimentation are as follows:

• body or system, the process is divided into individual parts, and then they are combined into a whole system (body). For example, the process of thermal expansion of solids is explained by imaginary dividing the body into individual particles and increasing the distances between them;

• Create an imaginary model of the universe and explain the events in it.

The laws of motion of the planets, their properties, the magnitudes of the acceleration of free fall in them, the oscillating motion of the mathematical pendulum and the laws of gravitation of the whole universe are explained;

• changes in the properties of the system as a result of changes in the state of aggregation of one of the objects in the system under study. For example, when a certain part of water freezes, Pascal's law changes in it, the motion of the liquid changes;

• Conduct a mental experiment under boundary conditions. The suitability of a model for real conditions or events is checked by gradually increasing one of the characteristics (parameters) of its mathematical model for the considered physical system, event or process to the maximum threshold value or decreasing it to the minimum threshold values.

The examination of mathematical models developed in intellectual experiments on the basis of computer technology, that is, on the basis of computer modeling, remains of great importance. Taking into account the unique capabilities of computer technology, in a short time the model is determined as "Suitable" or "Unsuitable".

1. At the current stage of development of physics education, modeling is approached in two ways:
2. Create models that consist of material elements and work on the basis of real natural laws. They are used to describe the nature and occurrence of physical processes in the restoration of the structure of an object (system) (for example, the operating model of an electric motor, the model of an aircraft wing, the spatial structure of crystals, the formation of fluctuations in water and gas flow, etc.): An ideally ideal model is created. It can be "Fixed" based on pictures, schematic view, animation, selected characters and symbols.

Computer modeling allows you to observe the recommended model on a monitor screen. We can see on the screen what happens to the ideal object in almost real conditions. Interactive computer models are part of the electronic textbook, which differs in its unparalleled level of knowledge and scientific concentration and effectiveness. Therefore, they are widely used in the teaching of physics to implement short-term processes and events, as well as the teaching of laboratory work in virtual form.

In physics classes, students are given physical problems that can be solved through a variety of interesting intellectual experiments, such as the speed of a mosquito in a room floating in the sea, the movement of water in particles, the diameter of a thin wire using a ruler, the reflection of light from a dim surface, the color of its appearance, the color image of objects taken in infrared light at night, etc., develop students' theoretical thinking skills.

Thus, the role of intellectual experiments, intellectual and virtual models in the independent study of physics is great. It provided an opportunity for a deeper and faster study of the physical nature of physical phenomena and processes.

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