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THEORETICAL FOUNDATIONS OF TEACHING PHYSICS BASED ON THE LAW OF ENERGY CONSERVATION

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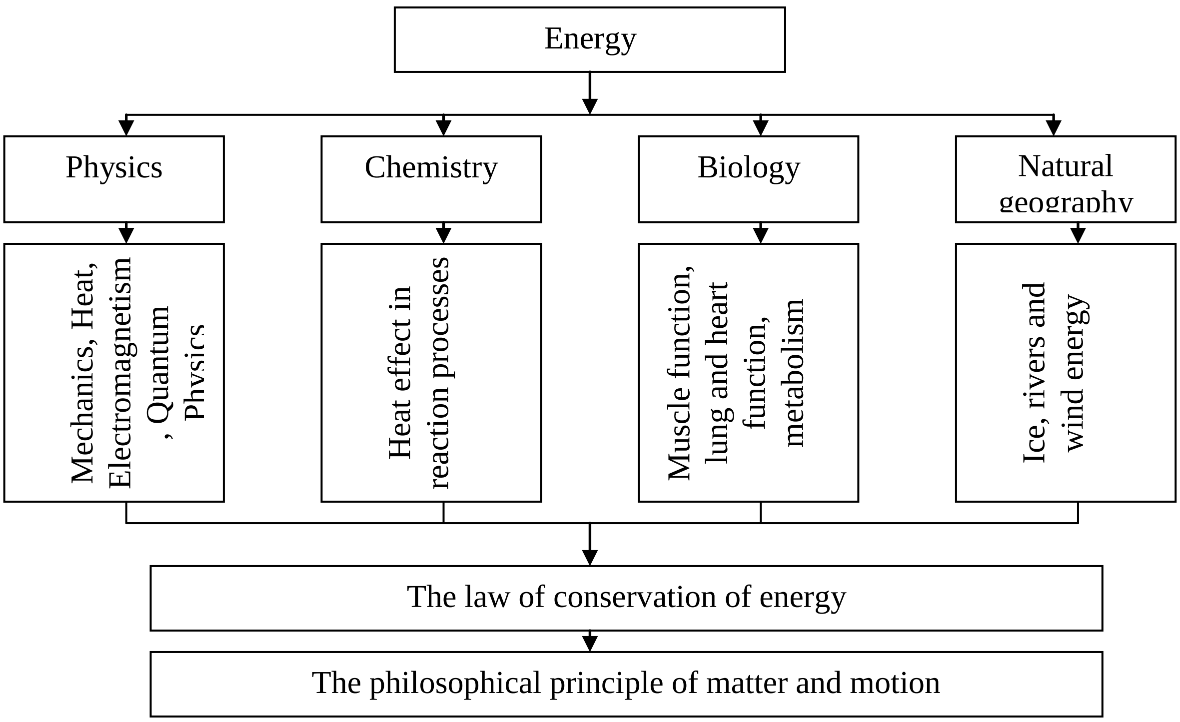
Abstract:
Scientific knowledge allows us to determine the interdisciplinary structural interdependence, based on the nature of the relationship of theoretical and empirical levels of knowledge. The terms "theoretical" and "empirical" are used to describe the methods of scientific knowledge, as well as to describe the various types of scientific activity at this stage in the development of science.

Keywords: Empirical, scientific knowledge, interdisciplinary structural

Scientific knowledge allows us to determine the interdisciplinary structural interdependence, based on the nature of the relationship of theoretical and empirical levels of knowledge. The terms "theoretical" and "empirical" are used to describe the methods of scientific knowledge, as well as to describe the various types of scientific activity at this stage in the development of science. Experimentation, as one of the means of research, forms the specific information base of knowledge. Logical, statistical, and mathematical processing of the "initial" information obtained from the experiment. This is also done so that within the framework of the theoretical model adopted for the purpose of explaining the pre–test situation, there is an opportunity to find new evidence arising from this test or model. Logical and mathematical tools include analysis, systematization, and grouping (logical tools, selected graphs, tables, graphs), identification of functional relationships (mathematical tools), and empirical generalizations. As a result, scientific laws are derived from empirical connections.

The law of conservation of energy provides a commonality between all the phenomena and processes studied in the general secondary natural sciences, expressing the methodological significance of the law of conservation of energy and bringing alternative ideas into one system. Based on this, we can say that there is a generality that shows the importance of the law of conservation of energy not only in the teaching of physics, but also in various disciplines. (Figure 1). As can be seen from Figure 1, the law of conservation of energy provides interdisciplinary coherence and determines a single physical view of the universe, so to speak, the level of civilization.

Picture–1.



Figure–1. Interdisciplinary model of energy conservation law.

Replacing Galileo's principle of relativity with Einstein's principle of relativity also changed the theory of mechanical motion in bodies, the law of addition of velocities, a detailed interpretation of the law of dynamics, the concept of mass [1]. In our opinion, the following main components should be distinguished in the natural sciences, including physical theories. Because they are:

– The empirical foundations of the theory, the systems that realize reality with the help of abstract objects, the basic data that can be imagined in the form of models that describe some laws of nature in an idealized form, and their simple logical–mathematical results;

– Primary theoretical basis: a concept, hypothesis, pastulate, fundamental law or principle that mediates the expression of connections and relationships between the abstract objects of the idealized model;

– The logical apparatus of the theory;

– logical conclusions arising from the fundamental laws and principles of the theory.

The teaching of basic sections such as molecular physics, electrodynamics, and quantum physics is not sufficiently relied upon in the logical structure that characterizes theoretical generalization. Students are characterized by a low level of mastery of the basic rules, inability to distinguish the basic from the secondary, inability to explain the nature of events. In school practice, the theoretical approach is often understood as the verbal presentation of material, and in some cases, the analysis of learning experiences without demonstration, without the presentation of mathematical work without laboratory work. This situation is also observed during the teaching of the law of conservation of energy. Such an interpretation has nothing to do with the study of the content of scientific theories. To bring students into a system of theoretical generalizations, it is necessary to equip them with methods of intellectual experimentation, idealization, and the use of idealized objects (models).

The course of modern physics includes the basics of mechanics, molecular physics, the basics of electricity and magnetism, the physics of waves and vibrations, and the theory of the elements of quantum physics.

The generalization of knowledge involves the study of the laws expressed on the basis of the results of experiments, and is close to the theoretical generalization. Knowledge of the laws allows us to predict the results of many experiments, and even to predict the existence of some phenomena that are still unknown. Materials with educational experiments will be distributed around the law.

However, the opportunity to generalize knowledge is not always fully exploited. In the study of the phenomenon, the correctness of the law of conservation and circulation of energy is given in the form of a paste, which is then confirmed during the study of the materials. As a result, the training material on electromagnetic phenomena can be generalized as follows [2,3].

Introduction to the conversion of energy from one type to another in the electrification of bodies: introduction to the concept of electric field energy; study of energy cycles in an alternating current circuit; study of energy cycles in electromagnetic processes and electromagnetic induction; to explain in terms of energy the emission of free electromagnetic waves from ideal and real vibration systems. At the same time, in practice, both in the material of electromagnetic phenomena, and in other sections of the course, the physical experiment is not fully used in the study of the law of conservation of energy, and it is not necessary and sufficiently consistent with theoretical explanations.

The theoretical level of knowledge not only lays the groundwork for a deeper study of physical concepts and laws, but also has a great influence on the embodiment of the natural scientific landscape of the universe in the minds of students. Because the law of conservation of energy forms the basis of the laws of nature, it is both theoretically and practically interconnected. In the rapid development of physics, the question of the interrelationship between theory and experiment has always been and will remain a major issue. More or less knowledge based on experiments cannot be achieved without the help of theory.

The conservation laws that make up the class of general laws express the principle of the integrity of physical theories. The scope constitutes a class of laws indicating the existence of limited preservation.

The scope of application of conservation laws is the universal law underlying modern physics. Conservation laws have a special place in physics because of their absolute generality. The application of these laws from space to the molecular world, from macro–bodies to elementary particles, is confirmed by the fact that events and processes are related by their properties of space and time symmetry. For example, the fact that time is homogeneous leads to the law of conservation of energy. The homogeneity of space leads to the law of conservation of momentum, the isotropy of space leads to the law of conservation of momentum, and so on. Each view of symmetry has its own law of conservation. The universality of conservation laws makes them extremely heuristic. In particular, conservation laws, while performing their methodological function, serve as criteria for testing physical hypotheses.

There is no phenomenon in nature today that does not obey these laws. The law of conservation plays a major role in mechanics, molecular physics, electrodynamics, atomic physics, elementary particle physics, and astrophysics. This is due to the following reasons.

1. In the application of this law, the description of the moving forces and the shape of the trajectory of the motion of the objects have no value, so these laws allow us to solve the problem without considering them perfectly in terms of the laws of dynamics. Any violation of the laws of conservation indicates that this process cannot take place under these conditions.

2. The fact that the laws of conservation do not depend on the description of the driving forces allows them to be applied even when the forces are not known at all.

3. The application of the laws of conservation in a number of cases helps to solve the problem in a simple way.

The study of the law of conservation of energy requires the widest possible use of its heuristic significance in the teaching of physics. For example, Om's law for a closed chain is derived from the law of conservation and circulation of energy. The relationship between current and voltage in transformer windings, the dependence of surface illumination on the distance to the light source, the Einstein equation for the photoelectric effect, and so on are determined. Students will encounter the law of conservation and circulation of energy when considering the energy aspects of galvanic elements, Om's law. The law of conservation of energy is a classical and modern theory of the conductivity of metals; the zonal theory of solids is the basis of the theory of specific and mixed conductivity of a semiconductor. The basic law of electromagnetic induction is the law of conservation of energy. Energy is the law of conservation of momentum, the experimental confirmation of the relationship between mass and energy remains the mainstay of nuclear physics.

The role of conservation laws in the teaching of physics shows that they are of great scientific and methodological importance. The didactic tasks of studying the laws of conservation are as follows: 1)can be one of the means of shaping the natural–scientific landscape of the universe. The reason is that they express the unity of the material world, the non–existence and non–existence of matter and motion, which lie at the heart of this landscape; 2)becomes a means of acquiring new knowledge in the process of teaching on the basis of a combination of theory and experiment; 3) is a means of making connections between the natural sciences; 4) serves as a means of generalizing and systematizing knowledge.

The law of conservation and circulation of energy is valid for all forms of motion of matter, so on the basis of this law it is possible to cover many sections of educational material from a single scientific point of view, which is of great importance in shaping the knowledge system. In addition, the explanation of facts, events and processes on the basis of the law of conservation of energy is important for students to form a natural–scientific view of the universe.

For the laws of physics, the law of conservation of energy is conceived in empirical knowledge as a deductive result. Newton's laws and formulas have the same properties for different forces (Guk's law – for elastic force, Amonton's law – for friction, the laws of universal gravitation – for gravity and repulsive force).

Figure–2.

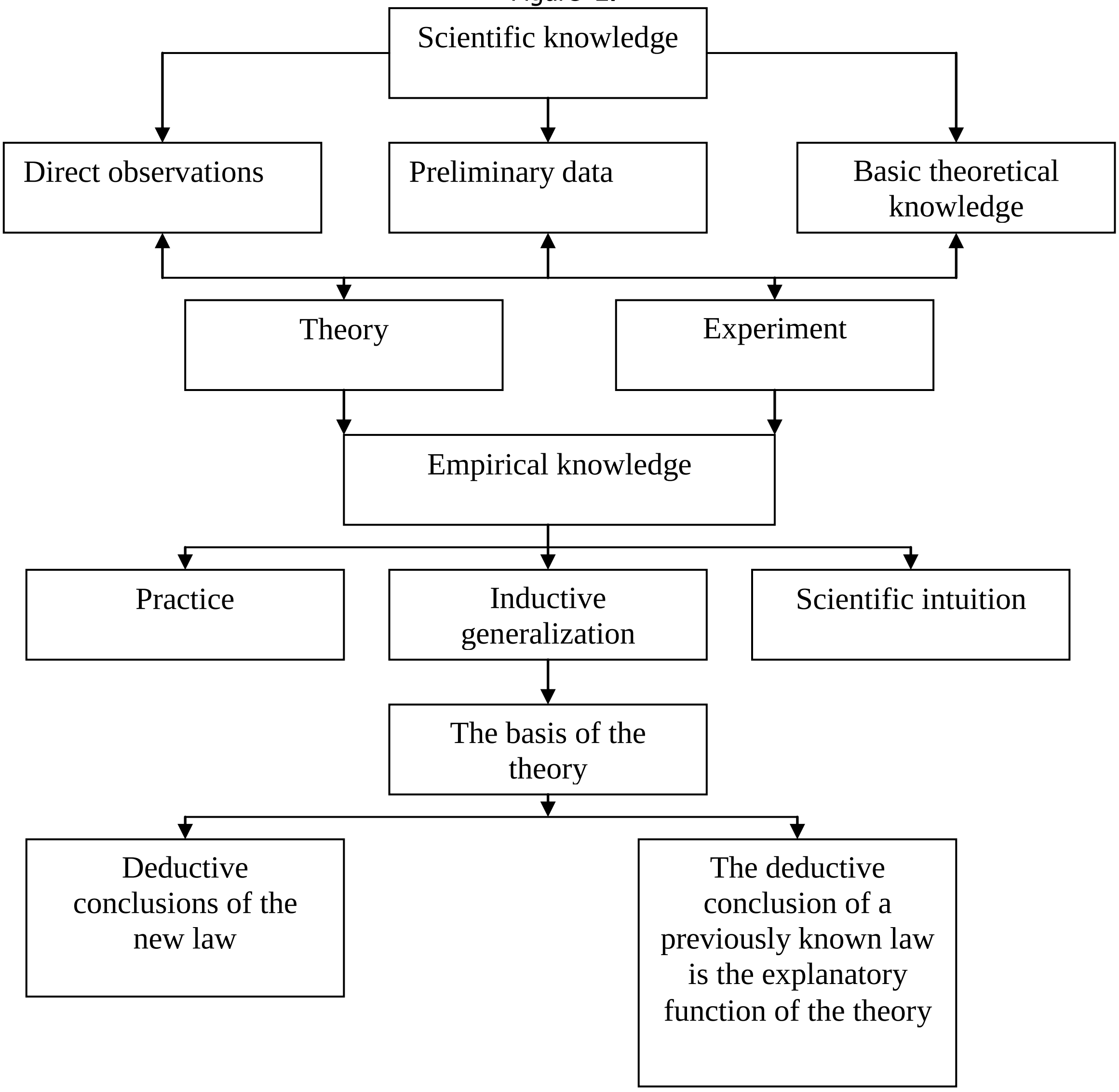


Figure 2. The interrelationship of the scientific cognitive process.

In the process of studying the law of conservation of energy, a typical structure of the theory of knowledge specific to the natural scientific periodicity is discovered (Figure 2). The diagram describes the connections between experience, empirical knowledge, theory and practice.

If we observe the growth and development of a single plant from the processes that take place in nature, it involves several processes. It involves biological, chemical, physical, geo–territorial processes and events. If we study a tree from a seedling or seed through a multimedia tool that accelerates its development, it is possible to observe that the processes take place according to the laws of the natural sciences.

Energy has been the main determining factor in all the processes that take place in the universe since its inception. While energy transfer, circulation, storage, exothermic, endothermic reactions are chemical and physical processes, the georegional environment affects the speed and state of the processes. Using the analogy method of scientific knowledge, how many potential energy reserves does a walnut tree have when it reaches a size proportional to its height, width, mass, and other parameters? Where is this energy source and from what energy cycle does it occur? The unity of the natural sciences is the product of the law of circulation and conservation of energy.

To sum up, we have scientifically and methodologically analyzed the need to teach the law of conservation of energy in the teaching of physics based on the interdependence and continuity of theory and experiment. It is known that until now, the law of conservation of energy in general secondary education and textbooks was revealed only on the basis of the laws of mechanics. But the law of conservation of energy is subject to general fundamental principles. In this sense, given that the continuity of theory and experiment is one of the most important methods of cognition, it is necessary to study the laws of mechanics, molecular physics, electricity, quantum physics on the basis of the law of conservation of energy.

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