INTRODUCTION

1. Subject of physics. Physical methods of research. Physics and technique. Computers in modern physics

1.1. Subject of physics; its relationship to philosophy and other sciences. We are going to study physics that is a science about nature. There are many sciences about nature, such as chemistry, biology, geology etc; physics is distinguished from them by studying the most common matter movement forms. So chemistry studies chemical reactions which consist in rearrangement of electron atom and molecule shells that is a physical process; biology studies the processes connected with the heat interchange, electric current flowing in living organism which are the physical processes also. There are the sciences border areas as physical chemistry and chemical physics, biological physics, biological chemistry, geophysics, geochemistry, astrophysics etc. Giving examples show that between difference branches of science the sharp bounds are absent but physics elements present always at all nature sciences.

As a science about the nature physics is closely coupled with other sciences, in particular with philosophy. For philosophy physics gives the real material used by philosophy for different generalization and conclusions. From other hand philosophic assertions often assist to physicists to give interpretation founded phenomena and regularities.

1.2. Physical methods of research: experiment, hypothesis, theory. The concept of physical models. An experiment is the main method by which physics researches visual environment. But theory also plays important role in our cognition of world. Its role is rising especially now in consequence of that by extend broaden one's knowledge about nature our conceptions become more and more abstract and therefore for explaining the modern experiment results the very abstract conceptions may be used. In physics history the cases are known when very improbable ideas firstly were expressed and appreciably later found experimental confirmation. As examples of this assertion we will give the electromagnetic waves and Maxwell's theory of the electromagnetic field, self energy of the bodies, dual character of the matter and existence at the particles the wave properties.

Physical theory operates with the objects which are named the physical models. The physical model is a concept that reflects the most essential features of the phenomenon or of object and allows their comparatively simple mathematical description. As examples of physical models we may denote so that material point, uniform motion, rigid body, continuous medium, ideal gas, point charge, homogeneous field, harmonic oscillation, monochromatic wave (in particular monochromatic light), absolute black body, infinite deep potential well, etc.

1.3. Physics role in the development of technology and the impact of technology on the development of physics. Physics as a fundamental science.

Physics history shows that significant physical discoveries lead to considerable progress in the humanity productive forces. So, after discovering Archimedes principle rapid growth of the navigation was observed; after discovering Newton laws Britain becomes a world smithy; discovering thermodynamics laws and gas laws led to the development of the steam engine and their mass application that allows to name 19 century as the vapor century; the electromagnetic induction phenomenon discovering by Faraday underlies of the work of energy induction generators and led to their intensive application that allows to name 20 century as the electricity century, and to intensive application of the electromagnetic waves in particular in the communication engineering; famous discoveries in the area of nuclear physics led to the nuclear arm creating and initiate to nuclear power engineering, technique of the radioactive radiations; finally outstanding achievements in area of quantum physics led to creation of contemporary spectroscopy, of solid-state electronics, of quantum electronics in particular of laser technique, computers technique, etc. Last circumstance gives the base to name physics *fundamental science*.

From stated above it is followed physics effect upon the technique is exceeding. So there is an inverse effect. The time when physicist can restrict oneself by the comparatively simple devices and attachments was over. Today's researcher is armed by the complicated and powerful attachments such as lasers, modern accelerators, radiotelescopes, electronic and ionic microscopes, different attachments for the ultralow and ultrahigh temperatures obtaining, different cosmic attachments and others. Besides a lot of materials and methods created for definite physical researches later found successful application at the different area of the science and technique.

Researches in physical area become so complicated and high-priced that from one hand state concentrated them in definite places which are named the *scientific cities.*

On the other hand the states combine their efforts for realization of the most ambitious projects that are essential important for the whole humanity so as Large Hadron Collider, (briefly, LHC), the works in the area of the controlled thermonuclear fusion.

Given examples show there is a close coupling between physics and technique, they mutually complement and enrich each other.

1.4. Computers and mathematical simulation in modern physics. With computers appearing in physics development new stage becomes. This stage is characterized first of all by appearing of possibility to solve new problems. We will name some of them. First of all the possibility of considering the more complicated physical models appeared. Computers applied as the elements of the experimental attachments or by other words they are used for automation of the experimental attachment. Besides in physical research computers are used when the mathematical simulation of the one or another phenomenon is realized.

2. The common structure of physics course and objectives of physics studying in technical university.

2.1. The common structure of physics course in technical university. Course of physics in the in technical university consists of the next chapters:

- the physical fundamentals of mechanics.
- the fundamentals of molecular physics and thermodynamics.
- the electrodynamics;

- the oscillatory and wave processes.
- the wave optics.
- the elements of quantum physics, atoms and molecules physics.
- the elements of the condensed matter physics.
- the nuclear physics and elements of the elementary particles physics.

2.2. Objectives of physics studying in technical university. We will emphasize that physics is an integral science and therefore when one studies physics it is impossible to restrict oneself by some from giving above chapters only. Thereby in the physics studying one of the important tasks consists in acquirement of a scientific method of the world cognition by the students and training of the integral picture about surrounding world. On the base of these feature technician becomes more receptive to perception of new technical ideas, and his ability to advancement of new ideas arises also. So, good knowledge of physics makes the technician more competitive on the labour market and more advanced to acquirement by the allied speciality if the necessity arises therein.

The next task in the physics studying consists in support of general scientific and special courses needs such as theoretical mechanics, electrotechnics, electronics, different courses connected with technical thermodynamics and so on. Besides during the physics studying students must learn to estimate the errors of the measurement and learn to handling with the modern physical devices,

At last the students must receive the idea about physical phenomena and physical laws describing its which may be used in their future professional activity.

Control task

1. Which of physical phenomena are known to you? Please describe some of them.
2. By what methods physics learns world around? Please indicate the phenomena, which being at first discovered experimentally, have played a huge role in the mankind life.
3. Please indicate the phenomena, which being at first prognosticated theoretically, have played a huge role in the mankind life.
4. Please, give characteristic some of physical models.
5. What are the reasons which allow to consider physics as fundamental science?
6. Which of international projects in physical area are known to you?
7. Please, give examples of computers using in solving physical problems.
8. Please, give examples of physical phenomena and physical laws using in your future professional activity.

3. Physical fundamentals of mechanics

3.1. Introduction to Mechanics

3.1.1 Subject of mechanics. The concept of the mechanical movement. Body of reference. and frame of reference. Mechanics is the chapter of physics that studies the movement of the matter which consists in the simple displacement one of body relative another body (or system of them) accepted as unmoving in the problem that there is under consideration accepted as unmoving. The body which in the considered problem accepted as unmoving is called *the body of reference.* The body which in the considered problem is accepted as unmoving and the devices and attachments for time intervals and space distances measuring as well connected with the giving body form *the frame reference.*

3.1.2. Stages of mechanical development. Classical, relativistic, and quantum mechanics. In own development mechanics passed so stages:

- classical nonrelativistic mechanics (or Newtonian – Galilean mechanics);
- classical relativistic mechanics;
- quantum nonrelativistic mechanics;
- quantum relativistic mechanics.

Near we will give review of this stage. We will notice the first stage relates to description of body motion on the base of Newton laws. Later on it was found that these laws have the restricted domain of applicability. On one hand they turned inapplicable to description of bodies moving with a speed v close to the light speed $c = 3 \cdot 10^8 m/\sec$, that is

$$v \leq c \qquad (3.1)$$

On the other hand it was established that all material objects possess by mutual nature namely particle-wave one. More exactly some wave is connected with each material object. This wave is called de Broglie one with wavelength

$$\lambda = h/p, \qquad (3.2)$$

where $h = 6{,}62 \cdot 10^{-34} Joul \cdot sec$ is a Planck's constant, $p = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}}$ is object momentum, m is the object mass and v is its speed. The wave properties of somebody become essential if it locates in linear size area a which satisfies to the relation $a \sim \lambda$.

One may ignore bodies wave properties if the condition

$$a >> \lambda \qquad (3.3)$$

takes place for linear sizes of their localization area a. In this case mechanics is called *classical*. In the case when the inequality

$$v << c \qquad (3.4)$$

takes place mechanics is called *nonrelativistic*. When both of conditions (3.3) and (3.4) take place we have the *classical nonrelativistic* mechanics or *Newtonian – Galilean* mechanics (it is called shortly the *Newtonian* mechanics).

As it is seemed from the relations (3.2) – (3.4) Newtonian mechanics is used for slow motion macroscopic bodies describing.

If the conditions (3.1) and (3.3) take place mechanics is called *classical relativistic*. In this case the relativistic effects are taken into account but the wave properties occurrence of the somebody is ignored as before. Conceptions of this mechanics are used in the describing of the electromagnetic waves propagation, some radioactive radiations types propagation etc. In common case one may say using of the classical relativistic mechanics is acceptable when the body has motion velocity which satisfies the inequality (3.1) and when spatial area of its localization is large enough (the inequality (3.3) is satisfied as it was noticed above).

In nature may be realized the case when inequality

$$a \ll \lambda \tag{3.5}$$

takes place and the inequality (3.4) is valid also. Then we say about *nonrelativistic quantum mechanics*, which is used for describing the objects behaviour when one may ignore its relativistic properties (slow motion when the inequality (3.4) satisfies) but it is necessary to take into account their wave properties. The application objects of this mechanics are electrons of light atoms, electrons from the outer atomic shells in heavy atoms, electrons in the crystal lattice, etc. Domain of applicability of this mechanics is wide enough; particularly on its base heat, electrical and magnetic properties of solid are explained.

If the inequalities (3.1), (3.5) we have the *relativistic quantum mechanics*. In this case at describing the objects behaviour one has to take into account as their relativistic properties connected with large motion velocity so their wave ones. As examples of the objects which for their describing require the relativistic quantum mechanics we will point out the electrons from the interior atomic shells in heavy atoms, atomic nuclei, microparticles in the accelerators etc. Besides consequent theory describing the objects behaviour with taking into account both their relativistic properties and the quantum ones simultaneously does not originated up to date.

3.1.3. Newtonian and relativistic conceptions of space and time. Mechanical motion consists in simple displacement somebody in the space in the course of time. The question arises about nature space and time, and about their properties.

By space we will mean the philosophical category which is the form of the matter existence and which is connected with establishing sizes of the real subjects and their mutual displacement. By time we will mean the philosophical category also establishing the order of events in space and their duration. It is necessary to distinguish in the approach to solving of the problem in Newtonian and relativistic mechanics. In Newtonian mechanics space and time have the absolute character: space-time relations between objects and events do not depend on the viewer point of view. Besides relations mention above are independent ones from others. Finally in Newtonian mechanics space and time possess by properties of uniformity and in additional to this space possesses by the property of isotropy. Space uniformity means that in it there are no the pointed out points. In another words if one wants to select the origin of coordinate system there are no points which would be the most acceptable for this purpose. One may say the same in relative to time: on the time axis there are no the acceptable points for the origin of time reference selection.

By passing to the relativistic conceptions of space and time it should kept in mind that these conceptions have some differences in special relativity and in general one. Let us consider the space and time properties which are common in both cases. First of all in this case space as well as time lose its absolute character and become relative concepts. Here the sizes of the objects and duration of the events and even their order depend on the viewer point of view. In this case instead of individual matter existence forms, space and time there is a single form of space – time. Whereas in Newtonian mechanics the event is characterized by space coordinates and by moment of time separately in relativistic mechanics it is characterized by the point in 4-dimensional space-time. In special relativity unified space-time possesses properties of uniformity and isotropy.

Situation in relativistic mechanics is manifestly described by the great A. Einstein's teacher G. Minkovsky: «***The views of space-time, which I'm going to develop in front of you, have grown on the basis of experimental physics. That is their strength. They will lead to drastic consequences. Now the space itself, as well as time itself fully go into the realm of shadows, and only a union of both of these concepts retains an independent existence».***

Concerning general relativity we note in this case in comparison with the special one the 4-dimensional space-time properties of uniformity and isotropy are lost. Its properties occur closely connected with mass distribution in this space. This circumstance is good illustrated by Einstein's words: «***Substance indicates the space how to curve and space indicates matter how to move».***

3.1.4. Structure of mechanics as chapter of physics course. As chapter of physics course mechanic in one's turn consists of the following chapters:

- kinematics;
- dynamics;
- statics.

We will characterize these chapters. Kinematics is a chapter of mechanics which studies bodies motion without taking into account factors effecting on the motion character. Because on the motion character of the body its interaction with others bodies effects one may say that kinematics studies bodies motion without taking into account their interaction with others bodies. This chapter has the descriptive character.

Dynamics is a chapter of mechanics which studies bodies motion with taking into account factors effecting on the motion character. Dynamics is the «heart» of mechanics. It describes bodies motion with taking into account interaction between bodies and therefore describing of the mechanical processes on the base of dynamics is more complete than on the kinematics base.

Statics is a chapter of mechanics which studies the conditions of bodies equilibrium being under the forces acting. This chapter often is considered as a particular case of dynamics.

In this part of book we pass to learn of kinematics.