FORMING STUDENTS' UNDERSTANDING ON THE BASICS OF MATTER IN THE 11TH GRADE PHYSICS LESSON

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Abstract*. In this article the method to teach physics will be provided and expanded with the procedure that should be followed in the lesson. The article will illustrate the lesson process from its intention to the way it should be conducted.*
Keywords*: leptons, hadrons, quarks, gluons, elementary particles*

Questions that are intended to be discussed during the lesson:

1) Elementary particles and their classification;

2) leptons, hadrons, quarks, gluons.

Glossaries on the topic:

Elementary particles-the smallest particles of matter. Elementary particles are the initial indivisible elements of the matter structure. A lepton is an elementary particle with a half-spin that does not participate in the strong interaction. Leptons belong to the family of fermions. There are three types of leptons: the electron, the muon, and the tau lepton. Hadrons are composite subatomic particles consisting of two or more quarks bound together by the strong interaction. A quark is a fundamental particle in the Standard Model, with a half-integer electric charge of e/3 (+2/3 e and -1/3 e) and has not been found free.

The main content of the lesson

Elementary particles are the first indivisible particles that make up all matter. Elementary particles remain unchanged. All elementary particles mix with each other and turn into each other, which indicates their existence. All particles have a progenitor, i.e., an opposite particle. For example, the opposite particle of an electron is a positron. A particle and an antiparticle have a common mass, and its charge will be opposite to each other. When a particle collides with an opposite particle, the charge disappears, (annihilates) and turns into other particles. Quarks are a number of fundamental particles that are created inside protons and neutrons, which means they are created by high-energy scattering of electrons and neutrons. The strong interaction of quarks is caused by the exchange of gluons.

Particle and anti-particles. At the time when the positron particle was first discovered, predictions were made about the properties of the antiproton by theoreticians. However, to obtain this particle, a 6 GeV proton accelerator was needed. Such a (uskoritel) was built in a special type, and the experiment on obtaining antiprotons and antineutrons began. In 1955, O. Chemberlen, E. Segre, K.Biganda and T. Ipsilantis obtained the antiproton through the following reaction. $\mathrm{p} + \mathrm{p} \rightarrow \mathrm{p} + \mathrm{p} + \bar{\mathrm{p}} + \mathrm{p}$ In the 50s, it ended with the hanging of the antihyperon. Several forms of antimatter have been obtained in the laboratory, and they are tritium and helium antinuclears. These experiments were carried out in 1970-74 at the Serfuxov accelerator and achieved great results. In 1998, the first antihydrogen atom was obtained.

Surprising Particles. In 1947, 10 years after having created the pion, cosmic rays and the newly built high-energy accelerators began to fill the table of elementary particles with new particles. More than 30 particles have been opened at this time. From the active particles K-mesons, or kaons, with a particle mass of about 500 MeV, and then the heavy particles Λ and Σ were discovered. The newly discovered particles have a surprising difference: they were born in pairs, but particles and antiparticles stopped forming. Another legality appeared here. For example, this reaction appeared from the collision of two protons. $p+p \rightarrow p+\Lambda+K^+$ means two-particles and K+-criterion surprising two-particles have appeared. The resulting surprising particles then decayed into leptons, nucleons and peons. The second difference between them is the long lifetime of the surprised particles. In the decay of Λ hyperon, the particles involved in the collision are broken into p or n. In this case, the lifetime of the surprising particles should be $\sim 10^{-22}$-10^{-23} seconds. Their lifetime is $\sim 10^{-10}$ seconds, which corresponds to weak exposure. Therefore, to explain the nature of such surprising particles, M. Gell-Mann and K. Nishidjamy, these surprising particles can carry another new quantum number, which they named surprising quantum number. The surprising quantum number is preserved in the strong effect and is not fulfilled in the weak effect. This explained the sudden appearance of surprising pairs of particles. Therefore, surprising particles appear in the strong impact reaction, the long life of which is explained as the cause of the decay process due to the weak impact. Among the discovered surprising particles, the presence of particles with a rest mass greater than the rest mass of nucleons was found. These particles were called hyperons. They include Λ, Σ^0, Σ^+, Σ^-, Ξ^0, Ξ^-, Ω^-.

Gluons. After it was determined that elementary particles, considered the smallest building blocks of matter, have complex particles, the problem of searching for the smallest bricks of matter has arisen. If there are such particles, all particles with a complex structure known to us so far must be composed of them. The American physicists M. Gell-Man and D. J. Tsveyg created the hypothesis that mesons and baryons are composed of simple particles called quarks in 1964. According to this hypothesis, baryons are composed of three: u, d, s quarks and antibaryons are composed of antiquarks. In Quark theory, the color charge built up around a quark can either remain the same or increase as it moves away from the quark. As a result, as the distance between quarks increases, their interaction energy increases. Because the quarks are very close to each other inside the hadron, there is little interaction between them, and the quarks behave like free particles inside the particle. As the distance between quarks increases, the color charge of the system increases, and the energy of interaction between them increases. Therefore, quarks can be called “on slavery” if they are outside the center. Maybe that’s why quarks can’t be observed in their free state. In 1964, M. Gell-Mann and J. Zweig proposed the hypothesis that neutrons and protons are composed of ordinary particles called quarks. Quarks have no internal structure and in this sense are considered to be true elementary particles. There are four fundamental interactions between elementary particles: gravity; electromagnetism; strong (nuclear) and weak interactions. Mainly, the strong interaction occurs due to the exchange of gluons. The concept of gluon is derived from the English word glue. As a result of the introduction of the concept of color, quarks began to be called beautiful, attractive. That is, quarks like u, d, s are called beautiful. Quarks of different beauty differ in mass, but quarks of the same beauty in color differ in color. The concept of color was introduced into quark theory to solve the quark statistics problem. It is believed that the force that binds and holds quarks together in hadrons is due to that color. Quarks interact with gluons, which are massless and have spin equal to 1. In the exchange of quarks with gluons, the quarks color changes, but the type does not change, and the remaining quantum numbers are preserved. We present the quarks description that have been discovered so far in the table.

Table.

Quark descriptions						
Descriptions	Types of quarks					
	D	U	s	c	b	t
Electric charge Q	-1/3	+2/3	-1/3	+2/3	-1/3	+2/3
Number of baryons B	1/3	1/3	1/3	1/3	1/3	1/3
Spin J	½	½	1/2	1/2	1/2	1/2
Pairs P	+1	+1	+1	+1	+1	+1
Isospin I	½	½	0	0	0	0
Isospin projection I_3	-1/2	+1/2	0	0	0	0
Surprising s	0	0	-1	0	0	0
Charm c	0	0	0	+1	0	0
Bottomness b	0	0	0	0	-1	0
Topness t	0	0	0	0	0	+1
The mass contained in a hadron, GeV.	0.31	0.31	0.51	1.8	5	180
Free quark mass, GeV	~0.006	~0.003	0.08-0.15	1.1-1.4	4.1-4.9	174 ± 5

School teachers face difficulties a lot when teaching elementary particle physics in the 11th grade. The reason is that they do not know the interaction of fundamental particles and what bodies are made of when studying the structure of the universe. Today, we know more than 400 elementary particles. Few study hours in school physics do not give them the opportunity to study them deeply. However, school physics teachers and pupils need to know the elementary particles we mentioned in order to have elementary concepts. For this reason, this article will be a methodical guide for school teachers and students. We recommend the inclusion of such concepts in school physics and more in-depth teaching.

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