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Interdisciplinary Connections: Mathematics and Physics

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Annotatsiya. Umuman olganda har bir fanning o'ziga yarasha qonuni, masalaga yondashish prinspi va tamoyillari bor. Ammo hozirgi dunyoning maqsadi har bir fanni alohida emas, birgalikda, jamlab o'rganishdan iborat. Masalan, hozirda rivojlanib kelayotgan STEM, STEAM xalqaro o'qitish metodikalari hamda turkiy xalqlar uchun so'nggi yillarda dunyo yuzini ko'rayotgan Al-Xorazmiy o'qitish metodikalari shunday fanlararo aloqadorlikga asoslanadi. Ya'ni unda o'quvchilar hayotdagi bir muammoni tanlashadi va bu muammoni hal qilish uchun bir nechta fanlardan bir vaqtning o'zida foydalanishadi. Ushbu maqolada ham xuddi shunday matematika va fizika fanlarining o'zaro aloqasida haqida so'z yuritamiz.

Kalit so'zlar. STEM, STEAM, AL-Xorazmiy o'qitish metodikasi, matematika, fizika, nisbiylik nazariyasi, og'irlik markazi, Menelay teoremasi.

Annotation. In general, each science has its own laws, principles and principles of approach to the problem. But the goal of today's world is not to learn each subject separately, but together. For example, STEM and STEAM international teaching methods, which are currently developing, and Al-Khorazmi teaching methods, which have appeared in recent years for the Turkish people, are based on such interdisciplinarity. That is, students choose a problem in life and use several subjects at the same time to solve this problem. In this article, we will talk about the relationship between mathematics and physics.

Keywords. STEM, STEAM, AL-Khorazmi teaching methodology, mathematics, physics, theory of relativity, center of gravity, Menelaus theorem.

Аннотация. Каждая наука имеет свои законы, принципы и принципы подхода к проблеме. Но цель сегодняшнего мира – не изучать каждый предмет отдельно, а вместе. Например, на такой междисциплинарности основаны международные методы обучения STEM и STEAM, которые сейчас развиваются, и методы обучения Аль-Хорезми, появившиеся в последние годы для тюркских народов. То есть учащиеся выбирают задачу

из жизни и используют несколько предметов одновременно для решения этой задачи. В этой статье мы поговорим о взаимосвязи математики и физики.

Ключевые слова. STEM, STEAM, методика преподавания АЛЬ-Хорезми, математика, физика, теория относительности, центр тяжести, теорема Менелая.

In applying mathematics to physics, the prevailing view is that the equations expressing the laws of motion should be in simple form. The entire success of the scheme seems to be related to the use of simple equations. Thus, it is provided with the principle of simplicity, which can be used as a tool for physical investigation. If it obtains data that corresponds to certain simple equations from some rough experiments, it concludes that by performing the experiments more precisely, it will obtain data that corresponds more accurately to the equations. However, the method is very limited because the principle of simplicity applies not to all natural phenomena but only to the fundamental laws of motion. The discovery of the theory of relativity necessitated altering the principle of simplicity. One of the fundamental laws of motion, according to Newton, is the law of gravitation, expressed by a very simple equation. However, according to Einstein, a complex technique must be developed before his equation can be written. It is true that from the standpoint of higher mathematics, it is possible to justify the view that Einstein's law of gravitation is simpler than Newton's, but this involves giving a very subtle meaning to simplicity, which significantly undermines the practical importance of the principle of simplicity as a tool for investigating the foundations of physics. Despite being contrary to the principle of simplicity, what makes the theory of relativity so acceptable to physicists is its remarkable mathematical beauty. Unlike beauty in art, this is an indefinable quality, but those who study mathematics usually have no difficulty appreciating it. We now see that we need to replace the principle of simplicity with the principle of mathematical beauty. In striving to express the fundamental laws of nature in mathematical form, the researcher must primarily strive for mathematical beauty. He still needs to take simplicity into account in a way that obeys beauty (for example, Einstein succeeded by choosing the simplest form of the gravitational law that corresponded to his spacetime continuum). Often, the demands of simplicity and beauty coincide, but where they conflict, the latter should take precedence.

Pure mathematics and physics are becoming increasingly intertwined, but their methods remain different. The situation can be described as such: the mathematician plays a game in which he invents the rules, while the physicist plays a game applied by nature. However, over time, it becomes apparent that the rules the mathematician finds interesting are the same as the rules

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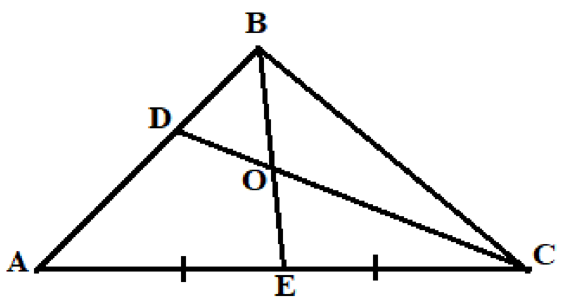
chosen by nature. It is difficult to predict what consequences all this will lead to. It is possible that the two sciences will eventually merge, with each branch of pure mathematics having its own physical application, and the importance in physics will be proportional to its interest in mathematics. Currently, we are, of course, very far from this stage, even on the simplest questions. For example, in physics, only four-dimensional space is of significant importance, whereas spaces of other dimensions arouse approximately the same interest in mathematics. However, this discrepancy may be due to the incompleteness of current knowledge, and future changes may make four-dimensional space more mathematically interesting than others. The tendency of mathematics and physics to merge provides the physicist with a powerful new method of investigating the foundations of his science, a method that has not yet been successfully applied but which I believe will prove its value in the future. The method starts by choosing that branch of mathematics which is thought to form the basis of the new theory. This choice should be strongly influenced by the viewpoint of mathematical beauty.

Thus, the age-old dream of philosophers to connect the entire nature with the properties of whole numbers may one day come true. To achieve this, physics will have to develop a long way to determine the details of how the correspondences are carried out. A very clear indication for this development is that in modern mathematics, the study of whole numbers is closely related to the theory of functions of a complex variable, a theory which, as we have already seen, has a good chance of forming the basis of physics. Now, as they say, let's provide proof by example and present you with a wonderful example of the connection between mathematics and physics.

Problem. Given a triangle ABC. Segment CD divides side AB in the ratio $3:2$ starting from point A. If a median is drawn from point B, in what ratio does this median divide the segment CD?

At first glance, the problem does not seem very difficult. However, to solve this problem, the student needs to know how to apply either Menelaus' theorem or the correct use of similarity. Let's assume they know one of these methods, for example, applying Menelaus' theorem. In that case, the solution to the problem is as follows:



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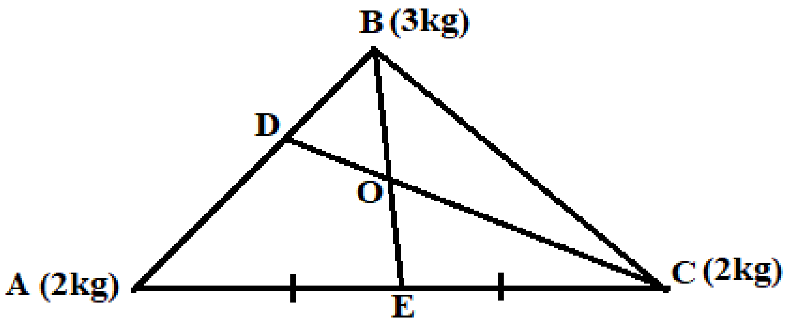
So, according to the problem statement, $AD:DB = 3:2$ and $AE = EC$. According to Menelaus' theorem: $\frac{AE}{EC} \cdot \frac{CO}{OD} \cdot \frac{DB}{AB} = 1 \Rightarrow \frac{CO}{OD} = \frac{AB}{DB} \cdot \frac{EC}{AE} = \frac{5}{2}$. Thus, the median from B divides segment CD in a $5:2$ ratio. It was solved quite easily, right? But what happens if the student does not know Menelaus' theorem? This is where the concept of the center of mass in physics helps the student. How, you ask? It's quite simple...

The idea is to use the concept of the center of mass or centroid in a triangle, which can be an intuitive way to solve the problem without directly invoking Menelaus' theorem. The centroid of a triangle divides each median in a $2:1$ ratio, and understanding this can provide an alternative approach to solve the problem.

Let's imagine that there are some objects at the vertices of triangle ABC, and together they form a single composite object, which naturally has a center of mass (the lines connecting the vertices do not have weight). Let's denote this center of mass as point O. To illustrate this, let's assume there are objects with masses of 2 kg at vertex A, 3 kg at vertex B, and 2 kg at vertex C.



In that case, the point D will have a mass of 5 kg. Now, let's recall the principle of moments (or the law of the lever) in physics. According to this principle:

$$OD \cdot 5 = CO \cdot 2$$

$$\frac{CO}{OD} = \frac{5}{2}$$

Thus, we have solved what appears to be a simple mathematical problem using principles from physics. This is indeed a marvel of the interconnectedness of these sciences. There are many such instances of the relationship between mathematics and physics, and these cases further

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encourage students to study both subjects. We will conclude with a proverb: "United we stand, divided we fall!"

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