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Issues of natural and practical processes modeling to "algebra of vectors"

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Annotation

In this article, problems related to the concept of vector are presented in various sciences, and the importance of modeling these problems into vector algebra and different approaches are mentioned.

Keywords: Positive and negative numbers, scalar and Vector quantities, orientation, vector in mathematics and physics.

Let's give some information about vectors and their origin. First, we will present a problem that we are all familiar with from high school: The apple tree on the tree left its nest and moved 3 meters away (picture-1). The question "Where is it now?" was clarified about where it would be if it went up or down, and it was explained that along with positive numbers (above), negative numbers (below) should be studied.

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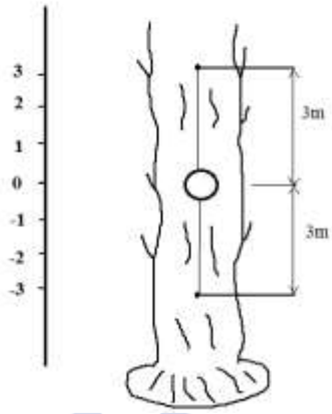
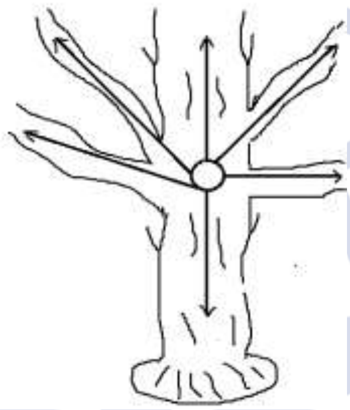


picture-1

Now let's study the issue in more detail. If the apple can move from its nest along thebranches in different directions (picture-2), naturally, we cannot determine where theapple is at the moment, which has moved 3 meters, only by +3 positive three or -3 negative three numbers.



picture-2

In the same way, if a car that left a certain city, for example, Samarkand, moved 100 km away, we cannot answer where it is now using only numbers. In order to answer such questions, we now need to know exactly which direction the moving apple or car is moving.

The above and many other motion related problems are quantities that are quantified not only by numerical value, but also by direction.

As we know, quantities defined only by numerical values are called scalar quantities, and quantities determined by numerical value and direction are called vector quantities. Examples of scalar quantities are distance, time, mass, and

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temperature, and examples of vector quantities are force, displacement, velocity, and acceleration.

It should be noted that as a result of adding, subtracting, multiplying, and dividing scalar quantities (numbers), more scalar quantities are formed. While addition, subtraction, and multiplication of vector quantities by scalar quantities again produce vector quantities, multiplication of vector quantities sometimes produces scalar quantities and sometimes vector quantities.

For example:

1. In rectilinear motion, the force vector multiplied by the displacement vector gives the scalar quantity work A done in the displacement. (Figure 1).

$A = F \cdot S \cdot \cos\alpha$

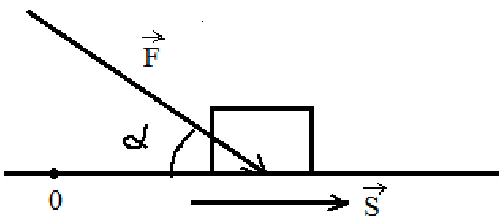
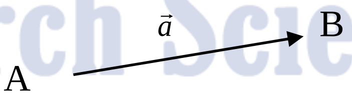


Figure 1

2. The velocity of an arbitrary point M determined by the $\vec{r}$ -radius vector of a rigid body rotating around a fixed axis with $\vec{\omega}$ -angular velocity is defined as the product of $\vec{\vartheta}$, $\vec{\omega}$ -angular velocity and $\vec{r}$ -radius vectors, and is a vector quantity.

Therefore, the need to study vector quantities (vectors) together with scalar quantities (numbers) has arisen in mathematics. As we know, mathematics is a science that studies physical and practical processes in terms of quantity (scalar and vector).

Some physical quantities, which are defined not only by their size, but also by their direction, such as force, speed and acceleration, are easy to learn to define (show) in mathematics by means of a directed cross-sectional vector.



$\vec{a} = \overline{AB} = \overrightarrow{AB}$

Here we present some information that is not usually found in higher mathematics textbooks.

One of the most basic concepts of modern mathematics is a vector, and its generalization is the concept of a tensor.

The concept of "vector" first appeared in the works of Irish mathematician and astronomer William Hamilton in 1845. In doing so, he used the vector concept to construct a number system summarizing complex numbers. U. Hamilton was one of the first to use the concepts of "scalar", "scalar product", "vector product".

In general, the vector concept is studied in two ways.

1. A vector representing physical processes occurring in real life.
2. A vector studied in mathematics.

Vector in physics: magnitude; is characterized by its direction and placement point. For example, the force vector is characterized by its magnitude, direction, and point of inflection. When we move it to another point in space, its effect on movement can change.

A vector in mathematics is a directed cross section, characterized only by its magnitude and direction. In mathematics, a free vector is considered and it can be moved parallel to any point in space. Vector comes from the Latin vector meaning "carrier".

Moreover, since it is fully characterized from mathematics by vector coordinates, it can be generalized not only in three-dimensional Euclidean space, but also in any n-dimensional space. In other words, a vector can be studied in mathematics as any set of ordered numbers. In this case, the ordered set of numbers can also be considered as a vector row, vector column.

Below we give a brief overview of the fields in which the vector concept is used, in other words, problems from modeling to vector algebra in mathematics.

Vector pointer. The concept of a vector is a quantity that we encounter in our everyday life. We use it every day to help us quickly find an object or to use it as a "traffic sign".

Vector in physics. All physical quantities that move with magnitude, direction, and reference point. For example force, speed, acceleration and other real vectors.

Vector in literature. For example: in Ivan Andreevich Krylov's fable about "The Swan, the Herring and the Crab", the cart stays in place due to the fact that these creatures move in different directions (equal effects of the forces applied to the cart are zero) (picture-3). It also has a metaphorical meaning that if everyone pulls the cart to their side, the work will not be done.

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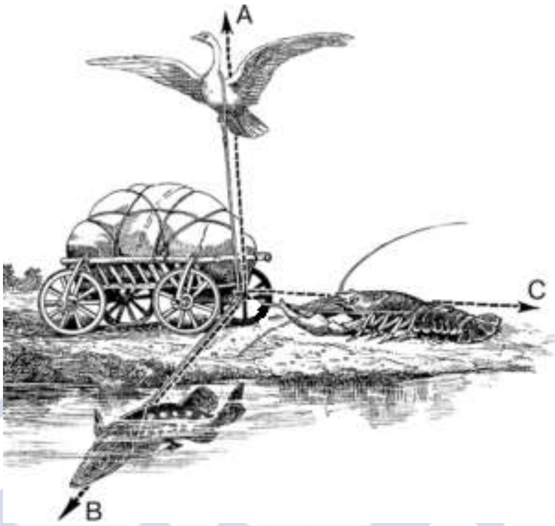

picture-3

Vector in chemistry. All reactions in chemistry is carried out according to the direction.

Vector in biology. Organisms that transfer parasites from one organism to another are called vectors. For example, lice transmit the causative agents of typhus, and rats are vectors that transmit plague from one organism to another.

Vector in economics. Since a vector can be considered as a sequence of ordered numbers, the sequence of products produced by an enterprise in the economy can be considered as the constituents of a vector. For example, if a textile factory produces 500 towels, 450 gowns, and 450 shirts in one shift, its production schedule for a month or a year can be represented by a three-dimensional vector.

Based on the above, we can conclude as follows. If we learn linear operations on vectors and their multiplication well in mathematics, it will be easier for us to master not only the vector quantities encountered in life, but also the problems of other natural and practical processes.

We present problems that lead to the concept of vector multiplication of vectors.

Below we consider the problem of finding the velocity of an arbitrary point of a rigid body moving with angular velocity around a fixed vertical axis (Figure 2).

It is known from the physics course that the velocity of an arbitrary point of a rigid body moving with a constant angular velocity around a fixed axis $\vec{\omega}$:

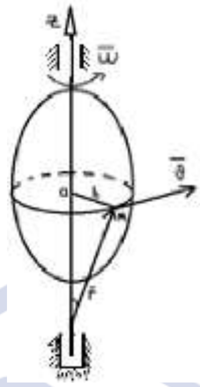

Figure 2.

1) $\vec{\vartheta}_m$ the numerical value of the speed is equal to the distance from the point M to the axis of rotation multiplied by the numerical value of the rotational angular velocity: $\vartheta_m = h \cdot \omega$ or $\vartheta_m = \omega \cdot |\vec{r}| \cdot \sin\varphi$ as shown.

2) $\vec{\vartheta}_m$ velocity is perpendicular to the cross section from point MO-M to the axis of rotation.

3) From the end of the $\vec{\vartheta}_m$ velocity vector, the short path of the descent of the $\vec{r}$ vector to the $\vec{\omega}$ vector must be counter-clockwise.

It will be shown later that these three conditions can be written in the form of vector multiplication.

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