

Generalized Law of Mechanics

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Abstract

In the article is examined the united law of mechanics, which generalizes three Newton's law. In whatever state the material point was: rest, the uniform or increasing motion, the vector sum of the forces, which act on the point also of the forces, which oppose to such forces, is equal to zero.

It is known three Newton's law, which are formulated as follows:

1. Exist such the frame reference, called of inertial of, relative to which the material points, when on them do not act any the force (or they act force mutually balanced), are found in the state of rest or of the uniform the rectilinear of motion.

2. In the inertial reference system the acceleration, which obtains the material point with a constant mass, directly proportionally resulting all applied to it forces and is inversely proportional to its mass.

3. Material points interact with each other by the forces, which have identical nature, directed along the straight line, which connects these points, equal on the module and opposite in the direction:

We know that the forces by their nature can be potential and kinetic. Potential forces are determined by the gradient of the scalar potential, in field of which is located the body. The gravitational forces, which follow from the law of universal gravitation are an example of such forces

$$F_g = G \frac{mM}{r^2}.$$

To the material point m from the side of the material point M acts the potential force

$$\vec{F}_g = mG \operatorname{grad} \frac{M}{r}.$$

This force is directed to the side of the material point M .

Besides potential forces there are kinetic (inertial) forces, which are connected with the fact that body they have a mass, also, in order to accelerate such bodies to them necessary to exert force

$$\vec{F}_a = m\vec{a}.$$

The force of inertia \vec{F}_m is opposite to the force \vec{F}_a therefore

$$\vec{F}_m = -F_a.$$

The force, which acts on the material point, can be contact, when another material point acts on it.

Let us examine the possible interaction types and motion of material points.

1. If no forces act on the body, then it rests or it moves in the assigned inertial system with the constant velocity and the summary vector of the forces, which act on this body is equal to zero.

2. If potential forces act on the material point, and it rests in the assigned inertial system, then this point is had mechanical connections with the inertial system, and in accordance with third Newton's law the summary vector of the forces, which act on it, is equal to zero.

3. If contact force acts on the material point, and the material point does not have mechanical or other connections with the inertial reference system, then material point accomplishes increasing motion. In this case contact force is also balanced by the inertial force and the summary force vector is equal to zero.

4. Gravity forces are an example of the potential forces, which act on the material point. For such forces of is satisfied the condition

$$\vec{F}_g = F_m,$$

Therefore

$$-m\vec{a} + mG \operatorname{grad} \frac{M}{r} = 0$$

And the again vector sum of forces is equal to zero. And this case to be reduced to third Newton's law.

5. If body moves along the curvilinear trajectory, then third Newton's law is carried out, since the centrifugal and centripetal force are equal, but they are opposite in the direction of

Thus, all three Newton's law can be combined into one generalized law with the following formulation:

In whatever state the material point was: rest, the uniform or increasing motion, the vector sum of the forces, which act on the point also of the forces, which oppose to such forces, is equal to zero.