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ФИЗИКО-МАТЕМАТИЧЕСКИЕ НАУКИ И ИНФОРМАТИКА, МЕТОДИКА ПРЕПОДАВАНИЯ

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В сборник включены материалы по актуальным проблемам физики, математики
и информатики, проблемам обучения физике, математике и информатике в школе и вузе. Рас-
сматриваются вопросы содержания, качества знаний, организации исследовательской и само-
стоятельной работы, использования информационных технологий в преподавании физики,
математики, методики математики и методики физики.

Адресуется преподавателям, аспирантам, магистрантам и слушателям учреждений,
обеспечивающих повышение квалификации и переподготовку педагогических кадров.

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Секция I
ФИЗИКА
И МЕТОДИКА ПРЕПОДАВАНИЯ
ФИЗИКИ

**THE ACCELERATED MOVEMENT PRESENTATION
BY MEANS OF ELECTRONIC DIGITAL MODEL
“ATVUD MASHINE” IN VIRTUAL INTERACTIVE
DEMONSTRATION EXPERIMENT**

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Interactive digital models, which are used at present time, are designed to display physical processes in dynamic under the possibilities of changing some parameters of the task. Usually such presentation of physical phenomena show the peculiarities of physical motion only qualitatively. That is there is no any possibility to calculate definite data and to determine the parameters of real task. Students during studying in the laboratory measure and determine physical parameters for verification and confirmation of physical laws. This helps to assimilate the material through its visual perception. However, achieved skills for presenting dynamic pictures on the computer screen using animation tools including for example the Shockwave flash format also may be used to present the visual tasks of the next quantitative level. It means that the modern level of informatics allows to reproduce in digital form not only qualitative but also quantitative schemes of the motion of physical systems. That is instead of laboratory device «Atvud mashine» it is really to use a virtual physical motion via digital model capable to imitate the accelerated motion of an object at an action of uncompensated gravity force.

Such approach corresponds to the real substituted action of educational laboratory complexes. That is, on the digital model it is benefit to simulate physical movement by means of an electronic demonstration experiment with the possibility of varying the input parameters of the task and recording the output parameters, which are usually fixed in the performance of the tasks during study on the laboratory physical practicum. In this case, the real movement and its characteristics recorded on a laboratory installation should be quantitatively reproducible on digital analogs.

The report presents the main points of organizing and conducting a laboratory demonstration session on the dynamics of translational and rotational motion using a well-known educational laboratory installation – the so-called «Atvud mashine». This equipment allows us to consider a wide range of kinematics and dynamics problems, namely, after virtual measuring the time, mass, distance covered by the element, it is possible to calculate the acceleration of gravity, the moments of inertia of the blocks, moments of frictional force, block masses, etc. An electronic version of such a work can, in addition to existing laboratory equipment, expand the understanding of the processes due to the flexibility and speed of sampling the parameters of the experiment. The instant electronic measurement and fixing of the database, which is formed in the course of acquaintance with the processes under consideration is benefit to study of physical phenomena. In the electronic version of

the work, it is fairly easy to foresee a variation in the experimental and quantitative conditions of given physical motion.

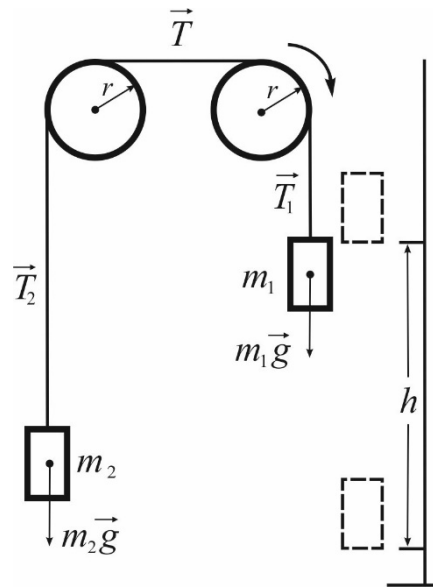


Figure 1

The traditional Atvud machine has two elements connected by a weightless thread through two blocks being rotated with friction for general case. Also there presences electronic time measurement system, that gives kinetic characteristic “time”, required for movement of right element having a mass m_1 at distance of h under the action of gravity force and others forces (Figure 1). The basic system of equations which connects the parameters of rotational and line movement for elements in approximation of an action of friction forces in rotation axes of blocks is the next. Following Figure it is clear the means of all used here denominations.

$$\begin{aligned} m_1 g - T_1 &= m_1 a ; \\ m_2 g - T_2 &= -m_2 a ; \\ (T_1 - T) r - M &= I \frac{a}{r} ; \\ (T - T_2) r - M &= I \frac{a}{r} ; \\ h &= \frac{1}{2} a t^2 ; \\ I &= \frac{1}{2} m r^2 . \end{aligned}$$

The solution of these equations as known depends on the all parameters. So it is possible to connect the measured acceleration of gravity g , the moment of the frictional force M , the radii of the blocks r , their masses m_1 and m_2 , the moments of inertia being the same I , and the tension forces of the filaments T_1 , T_2 and T . It is possible to use the data of several independent electronic measurements of the passage time t of element of height h with the subsequent application of the listed working expression. Also, based on electronic measurements, it is advisable to plot the

dependence of the angular acceleration on the resultant moment. Some steps of getting of analytical expressions for parameters of task to be determined via digital experiment as a real demonstration physical process are demonstrated here

$$\begin{aligned} (m_1 - m_2) g - 2I \frac{a}{r^2} - 2M \frac{1}{r} &= (m_1 + m_2) a ; \\ a &= \frac{(m_1 - m_2) g - 2M \frac{1}{r}}{m_1 + m_2 + 2I \frac{1}{r^2}} ; \\ g &= \frac{m_1 + m_2 + 2I \frac{1}{r^2}}{m_1 - m_2} a + \frac{2M \frac{1}{r}}{m_1 - m_2} ; \\ M &= \frac{(m_1 - m_2)}{2} g - \frac{1}{2} \left(2I \frac{1}{r^2} + m_1 + m_2 \right) a . \end{aligned}$$

Digital model presents the movement of elements in device in accordance with one of real structure of a system. Thus, the electronic experiment on the laboratory device «Atvud mashine» allows to simulate the motion with and without friction and restore the parameters of the circuit with collective discussion of the features of the process.