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Using A Mini-Installations To Explain The Stern Experiment On "The Speed Of Motion Of Gas Molecules" To 9th Graders.

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Abstract: *When I was working at the school, I had difficulty explaining the topic due to the lack of laboratory equipment, sometimes these phenomena and processes are so unusual that even hardworking students find it difficult introduce them to your mind. Many objects and phenomena considered in courses of electricity, magnetism, molecular and nuclear physics with virtually no than are not associated in ordinary life. so I decided to use this device to explain the lessons. This helped me a lot to achieve a high score. Using this article, I will explain the principle of construction and operation of a mini- Installations.*

Keywords: Mini- Installations, ideal gas, Stern's model, molecular velocities, particle trajectory, phenomena visually, physical phenomena, computer modeling, demo model.

INTRODUCTION

To help students understand the basic principles of phenomena, their schematize, linking with previously studied models. For example, talking about the thermal motion of molecules of an ideal gas, consider their collision as absolutely elastic collision of hard balls, and the movement between collisions as the uniform motion of a material point. These models and phenomena have already been studied. in the course of mechanics, therefore, must be mastered by students and understandable to them.

To improve the visibility of this method of explaining complex physical of phenomena it is proposed to use mini-installations simulating these phenomena
visually. When using these settings, this phenomenon may actually not take place. It is like a computer simulation when all events unfold on the monitor screen. The difference is that they manage the process themselves students, not a computer. An example is a mini-installation, Stern's modeling experience in measuring molecular velocities.

Materials and methods

It is difficult to study the motion of an individual molecule in a gas, since as a result of collisions, its speed often changes. At the same time her mean square speed should be equal to v_{sq}. In such In this case, the question arises: what is the proportion of molecules having in a given moment speed v_{sq}?
In 1859, the English physicist J. Maksvell theoretically found that gas molecules move at different speeds at the same temperature. According to his theory, the distribution of molecules over speeds has the form of a curve depicted in fig. 10. More molecules are moving. with a speed of v_m, which, however, is somewhat less speed v_{sq} [1].

The velocity of the gas molecules was first experimentally determined in 1920 by the German physicist O. Stern (1888–1969). In experience, it was found that the speed of silver atoms in vacuum is v_m = 440 m / s.

Now, theoretically, using formula $V_{sq} = \sqrt{\frac{3RT}{M}}$, we determine the root-mean-square velocity of silver atoms. Knowing that temperature evaporated silver atoms T = 1233 K (melting point silver), a molar mass M = 0.108 kg / mol, it is possible to theoretically calculate the mass of a silver atom and the root mean square velocity v_{sq}: $v_{sq} = \sqrt{\frac{3 \cdot 8{,}31 \cdot 1233}{0{,}108}}\, {}^{m}/_{s} \approx 5{,}33\, {}^{m}/_{s}$

This value is slightly higher than the velocity v_m found in the experiment. According to the Maksvell distribution, the speed v_{kv} also a bit more speed v_m[2]. Stern's experience confirmed the correctness of molecular no-kinetic theory, as well as correct theory Maksvell on the distribution of molecules according to their speeds.

RESULT AND DISCUSSION

On a paper disk attached with a button to a cardboard base, there are two concentric circles depicting cylinders A and B of the Stern installation. From
vectors of different lengths in different directions are plotted from their common center. These vectors depict flying silver atoms. On the circumference of a smaller
the radius is marked with the point S - slit, and through it, with a dashed line, drawn trajectory (relative to the Earth) of silver atoms falling on the outer cylinder [3].

The work is carried out in pairs. One student aligning the dotted line with the edge transparent ruler, pencil begins to lead along the ruler. Another at this time holding behind the plastic holder-tongue, rotates the paper disk clockwise. With a fairly uniform rotation, following the trace left by a pencil on paper can qualitatively judge the trajectory of silver atoms relative to cylinders. Before starting the experiment, it is necessary to draw the attention of students to
inadmissibility of sudden movements.

The resulting curves, of course, only qualitatively demonstrate particle trajectories. However, they allow for a short time (5-10 minutes) almost all students themselves “feel”
which way the silver atoms deviate
how the displacement of the projection of the slit on the external cylinder depends on the speed atoms
how the displacement of the projection of the slit on the external cylinder depends on the speed cylinders
why the projection with moving cylinders is wider than with motionless ones.

If we compare the method of simulating mini-installations with computer
models, then he undoubtedly wins in visibility. Firstly, such the installation is simple, and therefore understandable to everyone. Secondly, the generation that grew up on computer games, understands that "you can draw anything on a computer" and computer models use weak trust to illustrate phenomena
students. Thirdly, when the student is forced to be the driving force of the installation, this maximizes his attention, which sharply increases the pace of development material.
In addition, the methodology of simulating mini-installations wins by factor time. In order to figure out which buttons to press and in what format enter the initial data when modeling on a computer is also necessary time (sometimes exceeding simulation time), which is unfavorable for operation in the classroom.

If you compare this technique with classic classroom demonstrations physicists, we can say that they can complement each other in terms of what mini-models can replace complex and dangerous devices that do not exist can't in the school lab. As for the demo models, It seems reasonable to replace them with mini models, as working with mini models can conducted individually and in pairs. It sometimes happens that from distant desks is difficult consider what the teacher demonstrates in the department, and it’s not always convenient to ask a question about the behavior of the installation in the process of explanation. In individual work the student has the opportunity, if necessary, to repeat the experience himself and understand or obscure aspects, raising a hand and asking the teacher [4].

In addition, the validity of complex demonstration models is dubious. Despite their complexity, these models remain models that explain visualizing real processes. And the complexity of the model can only interfere understanding. I will give an example of a demonstration model of the Stern experiment, which is a metal disk that can rotate around an axis, passing through its center.

On its edge, the disk is limited to vertical side. With the help of vertical partitions attached to the side with inside, along the edge of the disk there are many cells. In the tripod foot clamp the inclined trough so that the ball, rolling along it, comes off
gutters, having a horizontal directional speed, at a certain height above the center of the disk.

Roll the ball when stationary and rotating drive. In this case, the ball enters into various cells on the edge of the disk. This The demo model has several disadvantages before the mini-installation. Firstly, it is difficult for students to compare the model described in the textbook and this model (the question arises "where is the second cylinder and where is the slit"). Secondly, the ball rolls too fast to follow the trajectory of its movement. Thirdly, the disk rotates in a horizontal plane, and to students from their places it's hard to see anything.

Conclusion: the proposed method of modeling mini-installations for the purposes of explanations of complex physical phenomena are not only better than computer modeling and demo models, it can help physics teachers from schools with a weak laboratory base, due to the fact that all such mini-Installations can be made by hand and available materials.

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