UDC 53.087.252 https://www.doi.org/ 10.53355/ZHU.2024.109.4.002

STUDY OF MECHANICAL MOTION BY STROBOSCOPIC METHOD

Abdulayeva A.[1,*] , *Mukhtargali M.*[2]

[1]*Zhetysu University named after I.Zhansugurov, Republic of Kazakhstan, Taldykorgan*
[2]*Zhetysu University named after I.Zhansugurov, Republic of Kazakhstan, Taldykorgan*
**e-mail: abdulayeva9aigerim@gmail.com*

Mechanical motion can be described and analyzed using mathematical models and equations. The principles and laws of mechanical motion play a fundamental role in physics and have a wide range of applications in engineering, astronomy, mechanical engineering, biology and many other fields. To study mechanical motion, it is proposed to use the stroboscopic method. The stroboscopic method provides a powerful tool for studying rapid movement and visualizing processes that would otherwise be inaccessible to observation. It is used in various fields such as mechanics, solid state physics, engineering and medical diagnostics to investigate various aspects of the motion and vibrations of objects.

Keywords: *mechanical motion, stroboscopic method, physical experiment, uniformly accelerated motion.*

Introduction

The study of a new physical phenomenon begins with observation. The observation is directly followed by qualitative analysis, during which some, often not quite definite and clear, ideas about the essence of the phenomenon are formulated, as well as ways of its experimental study are outlined.

Physical experiment as a method of research, although related to observation, is nevertheless significantly different from it. It is the next, qualitatively new stage of sensual perception of the phenomenon under study. The experiment includes observation as a necessary component [1-3].

In the course of the experiment, not only the phenomenon is reproduced, but also its dependence on the accompanying conditions and on the parameters characterizing these conditions is investigated, the necessary measurements are made. Thus, in the process of experiment there is an active intervention in the course of the phenomenon in order to comprehend its essence.

Since in the process of experimentation the researcher actively influences the course of the phenomenon under study, the experiment ultimately acts as a practice.

There are two types of scientific experiment - exploratory and criterial.

An exploratory experiment comes from a scientific problem and is determined by the search task. The exploratory experiment has a problematic character. When starting to conduct an exploratory experiment, the scientist does not set the task of obtaining a certain expected result. An example of an exploratory experiment is Rutherford's experience in studying alpha particle scattering. In a criterial experiment, the researcher sets out from a certain hypothesis, aiming to obtain an expected result. The results of a criterial experiment lead to conclusions about the truth or falsity of the original hypothesis. An example of a criterial experiment is the experimental detection of the antiproton, the existence of which followed from Dirac's hypothesis of antiparticles [4].

In the course of an experiment, new facts are obtained for science, the presence of which, however, does not yet give a more or less adequate reflection of reality. To reveal the deep essence of the phenomenon, it is again necessary to theoretically comprehend the facts obtained in the process of experiment. In this case, the necessary mathematical and conceptual apparatus is formed, the theory of the phenomenon is developed [5-7].

A physical theory explaining the studied phenomenon consists of experimental facts, which it explains and which are ultimately the basis for the mathematical formulation of its basic laws, and a conceptual apparatus that reveals the "physical meaning" of the obtained formulas.

The aim of the study is to investigate the motion of a free-falling ball using the stroboscopic method.

Materials and methods

The study of mechanical motion using the stroboscopic method is a technique that allows the observation and analysis of rapid mechanical motion of objects by repeatedly applying short light flashes (or stroboscopic light) to an object moving at a certain speed. This method is used to study the motion of objects that move at such high speeds that their motion cannot be directly observed [8-10].

When studying mechanical motion using the stroboscopic method, the object whose mechanical motion is to be studied is first selected. It can be, for example, a rotating wheel or a falling object. The stroboscope is then adjusted so that its flash rate or period coincides with the frequency or period of the object's motion.

It is important to synchronize the strobe with the motion of the object. This can be done by changing the frequency of the strobe or selecting a suitable flash phase.

Once the strobe is set up, observations begin. When the stroboscope delivers a short flash of light, the object becomes visible at the time of the flash. Its position and motion can be observed.

The resulting motion data of the object, such as its position and speed at different stages of motion, may be recorded or filmed for further analysis. This analysis may include calculating speed, acceleration, trajectory, and other motion parameters.

Main part

Stroboscopic method is a technique for visualizing the rapid movement of objects by using repeated short flashes of light. This method allows you to observe and analyze the motion of objects that are moving so fast that their motion cannot be observed continuously. The stroboscopic method is often used in scientific research, engineering, and other fields to study various phenomena and processes.

The basic principles of the stroboscopic method include:

- Generation of light flashes. The stroboscope generates short flashes of light at an adjustable frequency. These flashes can be visible light or infrared light, depending on the purpose of the study;
- Synchronization with a moving object. To observe a moving object, the stroboscope must be synchronized with its movement. This means that the light flashes must occur at specific points in time according to the movement of the object;
- Illumination of the object. When the light flash coincides with the position of the object at a certain point in time, the object is illuminated and its position becomes visible for observation;
- Observation and analysis. Observers can record the position of the object at each light flash.

Results and discussions

Uniformly accelerated motion is a type of motion in which an object changes its velocity with constant acceleration along a chosen trajectory. The acceleration in this case remains constant and does not change with time.

If a body moves uniformly accelerated without initial velocity, the paths traveled by the body in consecutive equal time intervals relate to each other as a consecutive series of odd numbers.

If, when studying the motion of a free-falling body, we find that this relation is satisfied, we can conclude that the motion of a free-falling body is a uniformly accelerated motion.

When studying the motion of a free-falling body, the following formulas were used:

$$a = \frac{2S}{\tau^2} \tag{1}$$

Table 1 – Table of measurements and results

Time interval from the start of the fall τ, s	**Ball coordinate x, m**	**a, m/s^2**
0,05	0.0125	10
0,1	0.0491	9.82
0,15	0.1111	9.88
0,2	0.1956	9.78
0,25	0.3046	9.75

When a body falls, the paths traveled during consecutive equal time intervals relate to each other as a consecutive series of odd numbers. Consequently, free fall is an equally accelerated motion.

The applications of the stroboscopic method are diverse. For example, to study the dynamics of moving objects, including in mechanics, optics and electronics, to analyze and test motors, mechanical systems, oscillations and resonances, to study biological processes such as heartbeats and muscle movement, to analyze vibrations and sound waves.

Conclusion

Physical experiment is not only an illustration of certain phenomena and laws: it serves as a means of proving the validity of various theoretical statements, contributes to the development of conviction in the cognizability of natural phenomena, develops the skills of students.

Properly organized school physics experiment also serves as an effective means of education of such personality traits as perseverance in achieving the goal, thoroughness in obtaining facts, neatness in work, the ability to observe and highlight in the phenomena under consideration their essential features, etc.

Structurally, the physical experiment is presented in the form of the following interrelated components: the experimenter and his activity as a cognitive subject; the object or subject of experimental research; means of experimental research. In the relationship of these structural elements, the first of them represents the subjective, and the second and third objective side of the experiment.

The use of the stroboscopic method makes it possible to visualize and analyze the equivariant motion of an object with high accuracy and temporal resolution, which makes it a useful tool in physical and engineering research.

LITERATURE:

1. Kaya H., Boyuk U. Attitude towards Physics Lessons and Physical Experiments of the High School Students //European journal of physics education. – 2011. – Т. 2. – №. 1. – С. 23-31.
2. Шевцов А. И. Роль физического эксперимента на уроках физики //Психология и педагогика: методика и проблемы практического применения. – 2017. – С. 148-150.
3. Chiaverina C., Vollmer M. Learning physics from the experiments //Retrieved from h ttp://www. girep2005. fmf. uni-lj. si/dwreport/dwb. pdf. – 2005.
4. Аллабергенов С. А., Алешкевич Н. А. Роль экспериментальных задач по физике в формировании исследовательских компетенций. – 2019.
5. Sedov L. I. Similarity and dimensional methods in mechanics. – CRC press, 2018.
6. Холина С. А. Требования к достижениям учащихся при изучении механического движения в курсе физики основной школы //Вестник Московского государственного областного университета. Серия: Физика-математика. – 2012. – №. 1. – С. 115-121.
7. Ямашева Т. В., Гладких Ю. П. Учебный физический эксперимент при изучении темы: "основы кинематики" в курсе средней школы //Вестник современных исследований. – 2018. – №. 6.1. – С. 478-479.
8. Mayer V. V., Varaksina E. I. A stroboscopic light source for experiments in mechanics //Physics Education. – 2017. – Т. 52. – №. 6. – С. 065015.
9. Michaelis M. M. Stroboscopic study of the inverted pendulum //American Journal of Physics. – 1985. – Т. 53. – №. 11. – С. 1079-1083.
10. Вуколов А. Ю., Головин А. А., Умнов Н. В. Исследование кинематики походки лошади на аллюре" шаг" методом высокоскоростной стробоскопической фотосъемки //Вестник Московского государственного технического университета им. НЭ Баумана. Серия «Машиностроение». – 2011. – №. 2. – С. 35-43.

REFERENCES:

1. Kaya H., Boyuk U. Attitude towards Physics Lessons and Physical Experiments of the High School Students //European journal of physics education. – 2011. – Т. 2. – №. 1. – С. 23-31.
2. Shevcov A.I. Rol fizicheskogo eksperimenta na urokah fiziki [The role of a physical experiment in physics lessons] // Psychology and Pedagogy: methodology and problems of practical application. – 2017. – P. 148-150.
3. Chiaverina C., Vollmer M. Learning physics from the experiments //Retrieved from h ttp://www. girep2005. fmf. uni-lj. si/dwreport/dwb. pdf. – 2005.
4. Allbergenov S.A., Aleshkevich N.A. Rol eksperimentalnyh zadach po fizike v formirovanii issledovatelskih kompetencii [The role of experimental problems in physics in the formation of research competencies] – 2019.
5. Sedov L. I. Similarity and dimensional methods in mechanics. – CRC press, 2018.
6. Holina S.A. Trebovaniya k dostizheniyam uchashihcya pri izuchenii mehanicheskogo dvizheniya v kurse fiziki osnovnoi shkoly [Requirements for the achievements of students in the study of mechanical motion in the physics course of primary school] // Bulletin of the Moscow State Regional University. Series: Physics-Mathematics. – 2012. – №. 1. – P. 115-121.
7. Yamasheva T.V., Gladkih Iu. P. Uchebnyi fizicheskiy eksperiment pri izuchenii temy “Osnovy kinematiki” v kurse srednei shkoly [Educational physical experiment in the study of the topic: "fundamentals of kinematics" in the course of secondary school] // Bulletin of Modern Research. – 2018. – №. 6.1. –P. 478-479.
8. Mayer V. V., Varaksina E. I. A stroboscopic light source for experiments in mechanics //Physics Education. – 2017. – Т. 52. – №. 6. – С. 065015.
9. Michaelis M. M. Stroboscopic study of the inverted pendulum //American Journal of Physics. – 1985. – Т. 53. – №. 11. – С. 1079-1083.
10. Vukolov A.Iu., Golovin A.A. Umnov N.V. Issledovanie kinematiki pohodki loshadi na alliure “shag” metodom vysokoskorostnoi stroboskopicheskoi fotosemki [Investigation of the kinematics of the horse's gait at the gait "step" by the method of high-speed stroboscopic photography] // Bulletin of the Moscow State Technical University. N. E. Bauman. The series "Mechanical Engineering".– 2011. – №. 2. – P. 35-43.

СТРОБОСКОПИЯЛЫҚ ӘДІСПЕН МЕХАНИКАЛЫҚ ҚОЗҒАЛЫСТЫ ЗЕРТТЕУ

Абдулаева Ә.Б.[1], Мұхтарғали М.М.[2]

[1]І.Жансүгіров атындағы Жетісу университеті, Қазақстан Республикасы, Талдықорған қ.
[2]І.Жансүгіров атындағы Жетісу университеті, Қазақстан Республикасы, Талдықорған қ.
**e-mail: abdulayeva9aigerim@gmail.com*

Механикалық қозғалысты математикалық модельдер мен теңдеулерді қолдану арқылы сипаттауға және талдауға болады. Механикалық қозғалыс принциптері мен заңдары физикада іргелі рөл атқарады және инженерия, астрономия, машина жасау, биология және басқа да көптеген салаларда кең ауқымды қолданбалы мағынаға ие. Мақалада механикалық қозғалысты зерттеу үшін стробоскопиялық әдісті қолдану ұсынылады. Стробоскопиялық әдіс жылдам қозғалысты зерттеуге және басқаша бақылау мүмкін болмайтын процестерді визуализациялауға арналған қуатты құрал болып табылады. Страбоскопиялық әдіс денелердің қозғалысы мен вибрациясының әртүрлі аспектілерін зерттеу үшін механика, қатты дене физикасы, инженерия және медициналық диагностика сияқты әртүрлі салаларда қолданылады.

Кілт сөздер: *механикалық қозғалыс, стробоскопиялық әдіс, физикалық эксперимент, бірқалыпты үдемелі қозғалыс.*

ИЗУЧЕНИЕ МЕХАНИЧЕСКОГО ДВИЖЕНИЯ СТРОБОСКОПИЧЕСКИМ МЕТОДОМ

Абдулаева Ә.Б.[1], Мұхтарғали М.М.[2]

[1]Жетысуский университет имени И.Жансугурова, Республика Казахстан, г. Талдыкорган
[2]Жетысуский университет имени И.Жансугурова, Республика Казахстан, г. Талдыкорган
**e-mail: abdulayeva9aigerim@gmail.com*

Механическое движение может быть описано и анализировано с использованием математических моделей и уравнений. Принципы и законы механического движения играют фундаментальную роль в физике и имеют широкий спектр применений в инженерии, астрономии, машиностроении, биологии и многих других областях. Для изучения механического движения предложено использовать стробоскопический метод. Стробоскопический метод предоставляет мощный инструмент для исследования быстрого движения и визуализации процессов, которые в противном случае были бы недоступны для наблюдения. Он используется в различных областях, таких как механика, физика твердого тела, инженерия и медицинская диагностика, чтобы исследовать различные аспекты движения и вибраций объектов.

Ключевые слова: *механическое движение, стробоскопический метод, физический эксперимент, равноускоренное движение.*