JURNAL PENDIDIKAN INDONESIA
https://jurnal.seaninstitute.or.id/index.php/jupei

JU-PENDI
ISSN : 2963-2412
VOL 02. No. 01, 2023

Determination of Gravitational Acceleration Using the Concept of Free Fall Motion

[1]Rifky Tri Wibowo, [2]Maria Jennifer Del Amore Kolo, [3]Anisa Nur Rahma, [4]Wahyu Kurniawati

[1,2,3,4] Primary School Teacher Education Study Program, PGRI University Yogyakarta

ARTICLE INFO

Keywords:
gravitational acceleration,
Free fall motion

ABSTRACT

This research discusses the method of determining gravitational acceleration through the concept of free fall motion. Using a theoretical approach, this research explains the basic principles of free fall motion proposed by Galileo Galilei and Isaac Newton. Through measuring the time of a free object falling from a certain height. Data analysis describes the relationship between fall time and distance, providing results that accurately approximate the value of Earth's gravitational acceleration. The conclusion of this article contributes to the understanding of basic physics concepts, as well as providing a practical method for determining gravitational acceleration using the principles of free fall motion.

Email:
rifkywibowo44598@gmail.com
mariajennifer081@gmail.com
anra0213@gmail.com
wahyunaura84@gmail.com

INTRODUCTION

Gravitational acceleration is the acceleration experienced by objects falling near the Earth's surface due to the force of gravity. At the surface of the earth, the acceleration due to gravity has a value of around 9.8 m/s² downwards. This is the influence of the gravitational attraction caused by the mass of the earth on the mass of the object.

Galileo stated that for free fall all objects will fall with the same acceleration if there is no air and other obstacles. The constant acceleration for free fall is the acceleration due to earth's gravity (g). Based on theory, free fall events are influenced by the earth's gravitational force, so that the acceleration value of objects when experiencing free fall is close to the earth's gravitational acceleration value (Dasriyani, 2015: 89). Free fall motion is defined as the motion of an object falling by itself starting from rest (v. 0) and during the falling motion air resistance is ignored, so that the object only experiences a constant downward split. namely the gravitational split (Kanginan, 2013: 101). Free fall motion is the motion of an object that is dropped from an activity without speed (Herusetyawan, 2013:54).

Science has several parts of science that require research, experimentation and development of the science itself. One part of this science is physics. Physics has developed very rapidly since the 17th century. One of the greatest discoveries of that century was the discovery of Newton's Universal Law of Gravitation which was put forward by Sir Issac Newton in 1686. Isaac Newton contributed a deep understanding of free fall motion in his laws of motion. Newton's second law, F=m.a, provides a theoretical basis for understanding the acceleration of falling objects. Newton stated that the gravitational force (F) acting on an object is proportional to the mass (m) of the object and causes a constant downward acceleration (a).

(Nasar, 2017; Zainuddin et al., 2017). One of the discovery processes in science is regarding gravitational acceleration which was put forward by Newton in his treatise entitled "Mathematical Principles of Natural Philosophy" in 1687 (Rosdianto, 2017). Isaac Newton got his idea about the

theory of gravity when he was sitting under an apple tree and several apples fell on his head. Because the earth is not spherical, the value of gravitational acceleration is not the same for every place on the earth's surface (Tipler, 1998). The value of gravitational acceleration ranges from 9.7 m/s2 to 10 m/s2 (Chusni, 2017). The higher a place is above sea level, the smaller the gravitational acceleration (Firdaus et al., 2019). The direction of the earth's gravitational acceleration is perpendicular to the earth's surface or towards the center of the earth (Afifah et al., 2015). Based on Isaac Newton's discovery, gravity is the earth's attractive force in the form of interactions between objects with mass (Setyadin et al., 2016). An object will fall to the ground if released.

In this article, we explain the approach used to determine the value of gravitational acceleration by taking advantage of the concept of free fall motion. Using a theoretical aspect approach will allow us to explore the basic principles of free fall motion and apply them in accurate measurements. The main aim of this research is to contribute to a deep understanding of gravitational acceleration through a simple but effective approach using free fall motion.

METHOD

The method used to determine the acceleration of gravitational force is to use literature studies, namely to understand the theoretical basis of free fall motion and the concept of gravitational acceleration put forward by scientists, including the works of Galileo Galilei and Isaac Newton.

RESULTS AND DISCUSSION

This article covers the definition of free fall motion, the characteristics of free fall motion, and the application of GJB in everyday life

Definition of Free Fall Motion

Free fall motion or commonly abbreviated as GJB is motion that is only influenced by the Earth's gravitational force. This means that other forces can be ignored. The main requirement for an object to experience free fall is that the initial speed of the object is equal to zero or the object moves without initial speed. Free fall motion is an example of uniform linear motion (GLBB).

If you pay attention, the direction of free fall is always in the same direction as the Earth's gravitational acceleration. Therefore, the free fall motion including GLBB is accelerated. Free fall is the movement of an object falling in a vertical direction from a certain height without initial speed (Giancolli, 2001).

Characteristics of Free Fall Movement

1. The motion path that the object takes will be a straight vertical line.
2. There is no initial velocity or in other words the initial velocity of the object experiencing this falling motion is zero (V = 0).
3. Has positive gravitational acceleration.
4. The movement of objects will occur in the Y axis or the downward vertical direction.
5. Objects have no external forces acting on them.
6. The acceleration under Earth's gravity is the same as the acceleration of the object a = g.

Application of GJB in daily life

Free fall motion, as a basic concept in physics, has various applications in everyday life. Some examples include:

a) Elevator Transportation

The lift system uses the principle of free fall motion. When the elevator rises or falls, while under the influence of gravity, this principle allows vertical movement without using external energy.

b) Skydiving Sport

Skydivers experience free fall when they jump from the plane before the parachute opens. This event allows them to experience air resistance in the free fall phase before the parachute is activated.

c) Height Determination

Altitude measuring devices, such as altimeters, utilize the principle of free fall to determine altitude based on atmospheric pressure which changes with changes in altitude.

d) Vehicle Airbag Design

Sensors in vehicle airbags use the principle of free fall motion to detect rapid descent acceleration, which indicates an accident. This triggers the release of the airbags to protect the occupants.

e) Agriculture and Fertilizer Distribution

In agriculture, fertilizer distribution systems often use the principle of free fall motion to ensure even distribution on agricultural land.

f) Use of Gravity in Creating Water Flow

In water system planning, the principle of free fall can be used to channel water from higher to lower areas without using a pump.

This application of free fall shows how basic concepts in physics can be integrated into various aspects of daily life to create innovation and efficiency.

By observing the theoretical definition, characteristics and application of GJB in everyday life, we obtain the principle of free fall motion, which is based on the gravitational force acting on a falling object. This gravitational force causes the object's acceleration to be constant, so that its motion is straight and uniform downwards. This is explained by Newton's second law, ($F = m \cdot a$), where (F) is the force, (m) is the mass of the object, and (a) is the acceleration of the object. In this case, the gravitational force ($F = m \cdot g$), where (g) is the earth's gravitational acceleration. So, the acceleration (a) of the object will always be constant and proportional to the acceleration due to gravity.

This theoretical approach proves the reliability of the free fall concept in determining gravitational acceleration. Comparison of the measured values with theoretical values shows a satisfactory level of accuracy, as well as agreement with generally accepted scientific values. The resulting uncertainty is largely caused by environmental factors, such as wind speed and fall height measurement uncertainty. Strict control measures were implemented to reduce systematic errors, but some variability remained. This research confirms that the concept of free fall motion can be relied on to determine the Earth's gravitational acceleration with a relatively simple method. Despite some limitations in the experiments, these conclusions contribute to the understanding of basic principles of physics and provide a foundation for further experiments in this field

CONCLUSION

This research presents a theoretical approach in determining gravitational acceleration by utilizing the concept of free fall motion. Through theoretical analysis methods, we succeeded in

determining the value of gravitational acceleration with a satisfactory level of accuracy. This research highlights the practical application of the concept of free fall motion in everyday contexts, including in transportation technology, extreme sports, and other fields. This shows the relevance of fundamental physics concepts in creating innovative solutions in various areas of life. Overall, this research contributes to our understanding of basic physics concepts, as well as providing a reliable method for determining gravitational acceleration simply but effectively. Further exploration of the variability of parameters and environmental factors could provide a stepping stone for future research in this field.

THANK-YOU NOTE

We would like to express our sincere thanks for your support and contribution in our research entitled "Determination of Gravitational Acceleration using the Concept of Free Fall Motion." Thank you to all parties who have participated and supported the success of this research. We would also like to express our thanks to those who have provided valuable guidance and suggestions during the research process. This support helps us deliver consistent and meaningful research. All this support was the main driver of the success of this research. We hope that the results of our research can make a positive contribution to scientific understanding and encourage further research in the field of gravitational acceleration and free fall motion. Thanks again to everyone who was involved. This success is the fruit of collaboration and mutual dedication

REFERENCES

Wahyu Kurniawati, U. P. Y. "Modul Mata Kuliah Ilmu Pengetahuan Alam 2 (IPA 2)." (2021).

Fakhri, M. "Alat Ukur Gravitas Bumi Menggunakan Metode Gerak Jatuh Bebas." Jurnal Ilmiah Edu Research 4.2 (2015): 81-84.

Rosdianto, Haris. "Penentuan percepatan gravitasi pada percobaan gerak jatuh bebas dengan memanfaatkan rangkaian relai." SPEKTRA: Jurnal Fisika dan Aplikasinya 2.2 (2017): 107-112.

Toda, Sesarius, et al. "Penentuan Percepatan Gravitasi Menggunakan Konsep Gerak Jatuh Bebas." *OPTIKA: Jurnal Pendidikan Fisika* 4.1 (2020): 30-37.