UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
OPEN ACCESS

Ci.e Nat., Santa Maria, v. 45, spe. n. 1, e84154, p. 01-05, 2023 • https://doi.org/10.5902/2179460X84154
Submitted: 18/06/2023 • Approved: 25/07/2023 • Published: 02/10/2023

Special edition

Experimental physics activity employing an euler's disk

Atividade experimental de física empregando um disco de euler

Bárbara Garcia de Paiva Moraes[I], Marianna Batista Teixeira[I], Cleiton Anderson Trindade de Carvalho[I], Silvana Maldaner[II], Jocenir Boita[I], Lucinéia Fabris[I], Glauber Rodrigues de Quadros[I]

[I] Universidade Federal de Santa Maria, Cachoeira do Sul, RS, Brasil
[II] Colégio Técnico Industrial de Santa Maria, Departamento de Ensino, Santa Maria, RS, Brasil

ABSTRACT

In this work, it is proposed the construction of an Euler's disk for teaching physics. The idea is to analyze the movement of a spinning coin on a table and compare the movement of the coin with the movement of the Euler disc. The Euler's disk was constructed from three hard disks (HD) and a speaker magnet. The disk is set to rotate and the associated kinetic and potential energy were analyzed. To investigate the influence of friction on motion, the disk is set to rotate on different surfaces and the time until the disk comes to rest is measured. In summary, Euler's disk is an apparatus that allows the study of movement, kinetic energy, gravitational potential energy and energy transformation processes. In addition, the influence of frictional forces on the movement of bodies can be studied. In short, Euler's disk is a simple and practical way to study the physics of movement using this experimental apparatus, ensuring effective learning.

Keywords: Euler's Disk; Teaching; Physics

RESUMO

Neste trabalho propõe-se a construção de um disco de Euler para o ensino de física. A ideia é analisar o movimento de uma moeda girando sobre uma mesa e comparar com o movimento do disco de Euler. O disco em questão foi construído a partir de três discos rígidos (HD) e um ímã de alto-falante. Coloca-se o disco para girar e analisa-se a energia cinética e potencial associada. Para analisar a influência do atrito no movimento, coloca-se o disco para girar em diferentes superfícies e mede-se o tempo até o disco atingir o repouso. Em resumo, o disco de Euler é um aparato que permite o estudo do movimento, da energia cinética, da energia potencial gravitacional, de processos de transformação de energia além da influência das forças de atrito no movimento dos corpos. A física do movimento, de uma forma simples e prática, pode ser estudada através deste aparato experimental, garantindo um aprendizado efetivo.

Palavras-chave: Disco de Euler; Ensino; Física

1 INTRODUCTION

The study of the bodies in motion is a common theme in Physics. It is known that if a coin is placed in rotation on a flat surface, after a certain time the movement ceases. Joseph Bendik, in the 1980s, proposed an experimental apparatus called the Euler's disk, the rotational movement of the disk is similar to the movement of a coin rotating on a table, but the motion of Euler's disk is analyzed in terms of rotation and precession in different axes, while the precession frequency increases, the rotation frequency decreases with time until the disk stops abruptly (Vega Bautista, 2020). Moffatt (2000) discusses disk motion based on finite-time singularity motion, showing the complexity and at the same time simplicity of motion of Euler's disk. Thus, in this work, the construction of Euler's disk is proposed to discuss movement based on energy, frictional force and the existence of viscous dissipation between air the disk and the table.

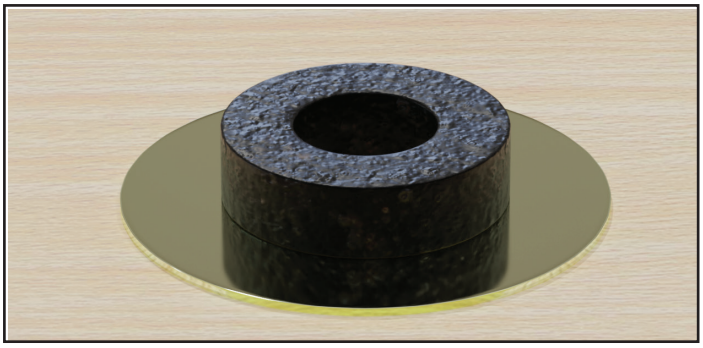
2 MATERIALS AND METHODS

In a primary observation, the movement of the Euler's disk can be described from the analysis of the mechanical energy and the influence of friction on the motion. The apparatus makes it possible to observe and understand several physical phenomena that occur simultaneously. Thus, with the aim of facilitating learning, a low-cost Euler disk prototype is developed. To make the prototype, two hard disks removed from burnt HDs (diameter of 90 mm) , a speaker magnet (diameter 60 mm) and super glue were used to fix them. The components were centralized and coupled using glue to ensure permanent attachment.

3 RESULTS AND DISCUSSION

Figure 1 presents the Euler's Disk educational prototype that was developed from the materials presented in Section 2.

Figure 1 – Euler's disk



The motion of the Euler's disk was observed on two different surfaces, a plastic table and a glass-topped table. During the movement, the time that the disc remained in motion was observed. On the plastic table, the disk remained in rotation for 12.5 seconds, while on the glass surface, it remained for 31 seconds. It was possible to observe that the performance of the constructed disk was better on the glass surface.

4 CONCLUSIONS

The Euler's Disk designed and exhibited at the 1st Science, Technology and Innovation Fair - UFSM-CS, allowed for the presentation and discussion of various Physics contents based on experimentation. Although it is difficult to analyze the possible causes of energy dissipation associated with motion, the apparatus is still quite interesting to be used in schools.

ACKNOWLEDGMENTS

The study also has been partially supported by Brazilian funding agencies CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico), grant nº 407643/2021-4 and FAPERGS (Fundação de Amparo à Pesquisa do Estado do RS).

REFERENCES

MOFFATT, H. K. Euler's disk and its finite-time singularity. **Nature**, v. 404, n. 6780, p. 833-834, 2000.

VEGA BAUTISTA, Javier de la. **Estudio de ingenios científicos con aplicaciones en educación y divulgación**. 2020. Trabalho de Conclusão de Curso (Graduação em Engenharia em Tecnologias Industriais) - Escuela Técnica Superior de Ingenieros Industriales, Universidad Politécnica de Madrid, Madri, Espanha, 2020.

Authorship contribution

1 – Barbara Garcia de Paiva Moraes

Degree in progress in Mechanical Engineering
https://orcid.org/0009-0006-5675-636X • babygm@hotmail.com
Contribution: Writing and preparation of the work.

2 – Cleiton Anderson Trindade de Carvalho

Degree in progress in Mechanical Engineering
https://orcid.org/0000-0002-4754-0720 • cleiton.trindade@acad.ufsm.br
Contribution: Writing and preparation of the work.

3 – Marianna Batista Teixeira

Degree in progress in Electrical Engineering
https://orcid.org/0009-0006-8354-8443 • marianna.teixeira@acad.ufsm
Contribution: Writing and preparation of the work.

4 – Silvana Maldaner

Physics, PhD in Physics
https://orcid.org/0000-0001-9060-4614 •silvana.maldaner@ufsm.br
Contribution: Writing and preparation of the work.

5 – Jocenir Boita

Physics, PhD in Physics
https://orcid.org/0000-0002-1433-3610•jocenir.boita@ufsm.br
Contribution: Writing and preparation of the work.

6 – Lucinéia Fabris

Mathematics, PhD in Mathematics
https://orcid.org/0000-0003-0581-5586•lucineia.fabris@ufsm.br
Contribution: Writing and preparation of the work.

7 – Glauber Rodrigues de Quadros

Mathematics, PhD in Mathematics
https://orcid.org/0000-0002-6182-7525 •glauber.quadros@ufsm.br
Contribution: Writing and preparation of the work.

How to quote this article

MORAES, B. G. de P.; TEIXEIRA, M. B., CARVALHO, C. A. T. de; MALDANER, S.; BOITA, J.; F, L.; QUADROS, R. G. de. Experimental physics activity employing an euler's disk. **Ciência e Natura**, Santa Maria, v. 45, spe. n. 1, e84154, 2023. DOI: https://doi.org/10.5902/2179460x84154 Available in: https://periodicos.ufsm.br/cienciaenatura/article/view/84154 Accessed in: em: day month abbr. year.