PAPER

The Poggendorff experiment: a study using the Newtonian and Lagrangian formalisms

Lucas Tolentino Neves, João Vitor Borges Ferreira and Lucas Marcelo Cavalari Nardi*

Published 26 December 2025 •

European Journal of Physics, Volume 47, Number 1

Citation Lucas Tolentino Neves *et al* 2026 *Eur. J. Phys.* **47** 015008

DOI 10.1088/1361-6404/ae2444

Abstract

We report on an experimental and theoretical investigation of the Poggendorff balance, which is an Atwood machine attached to a weight balance devised by J. C. Poggendorff. We have designed and constructed a modern version of the apparatus in which the Atwood machine (with a finite-mass pulley) is attached to a rigid aluminum rod with a counterweight, with its equilibrium maintained by a small thread holding the pulley motionless. Upon burning, the small thread disappears, and the system undergoes motion. On the one hand, we measure the time-dependent angle $\alpha(t)$ of the balance arm with respect to the horizontal using a potentiometer—Arduino assembly and record data at high temporal resolution. On the other hand, theoretical predictions are obtained via the following approaches: a Newtonian analysis accounting for the pulley's mass and non-inertial effects; and two Lagrangian formalisms for 'parallel' and 'perpendicular' pulley orientations, each numerically integrated in a simple program developed in Fortran. All three models yield nearly identical results, and they are in qualitative agreement with the experimental results. Quantitative deviations are attributed to the manual synchronization of thread burnout and data capture, as well as frictional effects in the potentiometer. As a secondary goal, we discuss the educational value of this historically neglected experiment in illustrating the distinction between force as cause versus consequence of motion and argue for its pedagogical utility in comparing Newtonian and Lagrangian formalisms. Future work will focus on full automation and synchronization.