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Experimental and General Solution of Buquoy's Problem

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The Buquoy problem represents an interesting example of a one-dimensional motion of a uniform thin fibre which is pulled upwards from a horizontal plane by a constant vertical force exerted against the homogeneous gravitational field. The solution of the problem includes several interesting concepts that are often developed within the introductory university physics course – a motion with a variable mass, utilization of the effective potential and a solution of a non-linear ODE of the second order, which provides an opportunity for some kind of numerical modelling of the motion. In this sense it is an appealing and rich problem, which represents a specific example of damped oscillations and according to our experience it can be discussed e.g. in a classical mechanics course.

Our contribution concentrates on the correspondence between a theoretical model and an experimental realization of this problem which can be demonstrated in a standard classroom. In our set, the upward force is represented by a buoyancy acting on a helium filled balloon. We briefly discuss a suitable material for the fibre and the determination of the fibre linear density. The experiment helps to support some other competences of the students – a video analysis of the motion with a Tracker video analysis and modelling tool and the fitting of the theoretical model parameters to match with the video analysis data. The experiment also naturally leads to a little more general theoretical model and an equation for this kind of oscillatory motion that counts in the constant mass of the used helium ball.

In this way we would like to draw attention to an interesting physical problem the solution of which is more complicated than standard damped linear harmonic oscillator, but still accessible for undergraduate physics majors and provides an opportunity to discuss some aspects in a wider context.

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