Terminal Velocity

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Experiment Overview

This experiment serves as an extension to the Mechanics module undertaken in lectures by first year students in the Regular physics stream.

Students drop paper gliders (1, 2, 4, 8 and 16 stacked muffin cases) from a height of approximately 2 metres, and using a motion detector, measure the distance fallen, the velocity and acceleration during the fall. Students then determine the terminal velocities of each stack, and analyse and graph, using *log-log* paper the motions of the glider stacks.

Learning Experience

We have undertaken a major rewrite and reorganisation of this experiment. We would greatly appreciate ASELL input for our second version for 2012.

Aims and Objectives

On completion of this session, students should:

- have measured the terminal velocity of a paper glider,
- determined how the terminal velocity depends on the mass of the paper glider,
- have gained experience in using logarithmic graphs.

Level of Experiment

This experiment is designed for first year students in their first semester of university Physics. It is either the first, second or third experiments undertaken by students in the Regular stream. The Physics Regular course has been developed for students whose year 12 (or equivalent) physics marks were 65 < yr 12 mark < 88. Students with physics marks in excess of 88, or with an ATAR ≥ 96, are encouraged to enrol in the Advanced stream. The Regular stream is our largest 1st year physics cohort with student numbers ca. 650, ≈ 60% of the student total. Most Regular students are enrolled in Engineering or Science and will undertake only one year of physics, although a few continue on to second year or major in physics.

Keyword Descriptions of the Experiment

Domain
mechanics, fluid flow

Specific Descriptors
terminal velocity, turbulence, linear drag, quadratic drag, power law

Course Context

PHYS 1001 Physics 1 (Regular)

Prerequisite Knowledge and Skills

The students require a basic knowledge of velocity, acceleration, the equations motion, and sufficient mathematical proficiency to undertake some simple manipulations of powers and logarithms.

Time Required to Complete

Prior to Lab: 1 hour
In Laboratory: 3 hours
After Laboratory: none

Experiment History

A version of this experiment has been used within the School of Physics with little change for many years. This year, a major rewrite of the experiment was undertaken (largely by Richard Thompson) to incorporate the use of a motion detector, allowing accurate determination of the distance fallen, the velocity and the acceleration of the paper glider. In addition, a more sophisticated treatment of linear and quadratic drag was included.

Comments

The students carry out the preparatory work downloaded from The University of Sydney *eLearning* site and completed prior to beginning the laboratory session. Students who have not completed the prework by the start of the laboratory session lose 1 (of a possible 4) checkpoints for the session.

The students perform the experiment in teams of three using a single team logbook. The laboratory notes are in the bound laboratory manual, containing all of the semester's experiments, as well as general introductory material including OH&S requirements, laboratory rules, notes on experimental methods, and some sample logbook entries. At back of the manual (which each student is required to purchase) are extensive pages of relevant formulae, methods of data analysis including calculation and propagation of errors, drawing of graphs, and a brief primer on using Microsoft EXCEL for analysing and plotting data.

The experiment notes in the laboratory manual are written as a series of logbook points, designed to encourage the students to think, discuss and work as a team. At each of the several checkpoints, a tutor discusses the logbook entries with the group and provides feedback. If the work is satisfactory the checkpoint is awarded and the group may then proceed. If not, the work is revised until a checkpoint is awarded.

References

Young and Freedman, *Universtiy Physics*, Pearson, *12th Ed. 2008*