Experiment 3: The Fall

Program Manual

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In this experiment a hypothetical ball of mass m is released from a height of h in the presence of gravity g and linear air drag.

$$\mathbf{F}_{\text{drag}} = -\alpha \mathbf{v} \tag{1}$$

The provided `.exe` file will input the height and mass from you and return the time that the ball hits the ground. Your task is to find the values of g and α.

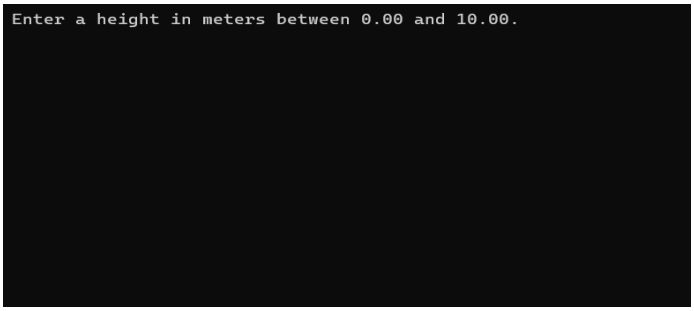

Fig 1, Program Interface

The times given to you include random error; therefore, standard statistical methods are required here.

Program Guide

Notes :

1. ALWAYS enter data in the requested format, DO NOT enter characters when numbers are asked for.
2. The program keeps running until you shut it down by using the `EXIT` command when prompted.
3. If your PC tells you that the program is from an unknown publisher and gives a warning, ignore it. There is no matter of concern.
4. Perform your calculations in Microsoft Excel.
5. Note that you can copy numbers from the program; to do so, select that part and use `ctrl + c` to copy it. You can also use `ctrl + v` to paste.
6. To close the program by other means, use `ctrl + c` when no text is selected, closing the window is also possible.

The Problem

a) Derive an equation relating the quantities $g,\ h,\ t,\ \gamma = \frac{\alpha}{m}$.

b) Construct a table to document your data points and their errors, and any other quantities you may have defined.

c) From your data and regressional analysis, find the values of α and g.

Mathematical Reference

Integrals:

$$\int e^x\ dx = e^x + C \qquad C \in \mathbb{R} \tag{2}$$

$$\int x^n\ dx = \frac{x^{n+1}}{n+1} + C \qquad C \in \mathbb{R} \text{ and } n \neq -1 \tag{3}$$

Differential Equations:

$$\frac{dy}{dx} + P(x)y = Q(x)\ \Rightarrow\ y = e^{-\int P(x)dx}\left(\int Q(x)e^{\int P(x)dx}dx + C\right) \tag{4}$$

Good Luck! -Mohammad Amin Haghjoo.