Physics 2A
Lab 1
Measuring Human Reaction Time

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Overview

- Discussion of laboratory work
- Theory
- Equipment
- Procedure

Why we do lab work

To confirm or disprove hypotheses

To get insights for new hypotheses

Integrity is very important.

Assessment

- lab book & lab worksheets each week (50%)
- lab report - a write up of one of the experiments (20%)
- lab final (30%)

Guidelines for lab books

- Write in pen.
- Put your name and section number on the outside front cover.
- Lab books stay in the lab.
- Save the first two pages of the lab book for a table of contents.
- Number the rest of the pages of the lab book in the top corner to refer to in your table of contents; do this now! Complete your table of contents as the lab progresses.

Guidelines for lab books

- In your book write only in pen. Pencil can only be used to plot points on your graphs.
- Do not erase or white-out anything you have written in your lab book. If you think you've made a mistake, then cross out what you wrote (so you can still read it!) and re-write the correct version near it.
- If you need to cross out data, make a note next to it the correction explaining the change.
- No scratch paper is to be kept outside of your lab book.
- When a graph is required, it should be drawn while the data is taken.
- Plot **big** graphs.

Recording data in lab books

Write the names of your lab partners for each lab in your lab book (and on the worksheet).

When you use a measuring device, record the what device is being used **and** the unique device number in your lab book.

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Every measurement value should have units!

Where appropriate record your data in a table. This will make it easy for you to plot or analyze, and easy to refer to in your conclusions.

When computing uncertainties, show the formula used, and one example calculation in your lab book.

Worksheets

You will also summarize your data and answer a few questions on a worksheet for each lab.

Each person must hand in their own worksheet and they will be graded.

Make sure any data you write on your worksheet is also in your lab book. (You will be allowed to use your lab books in the lab final; you will not be allowed to use the worksheets.)

Analysis and Conclusions

The point of doing labs is

- to learn good laboratory habits and
- to investigate the relationship between physical quantities for yourself.

This means that you must analyze your results to understand what your data means.

On lab worksheets, you will often be asked questions about interpreting your results.

Analysis and Conclusions

You will need to answer any questions on the lab worksheet.

You will often be asked to consider errors. In particular, this means unwanted effects in your experimental process that may not be considered in your calculated uncertainties.

These errors could make your results larger or smaller than the true value.

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Occasionally during these labs you will use equipment that has fast-moving parts, can shoot pieces of metal, or is heavy, long, or awkward.

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Look where you walk. Communicate clearly with your partner what you are doing, so that you don't catch one another by surprise.

You can also damage equipment if you are careless with it and we may not be able to replace it for many years.

Be careful not to drop equipment, no matter what it is.

If you are concerned about anything, ask me first!

Purpose of the Lab

To investigate human reaction time for visual stimulus, by applying simple principles of kinematics.

Using a falling ruler or meter stick we can relate reaction time to the distance the ruler falls.

Theory: Kinematics Definitions

Displacement, $\boldsymbol{\Delta x}$: the change in position of an object.

Velocity, $\mathbf{v}$: the rate of change of position.

Acceleration, $\mathbf{a}$: the rate of change of velocity.

Theory

An object (such as a ruler) that is released near the surface of the Earth will accelerate downwards with a nearly constant acceleration due to gravity.

This acceleration has the fixed value of

$$g = 9.8 \text{ m/s}^2$$

regardless of the mass of the object.

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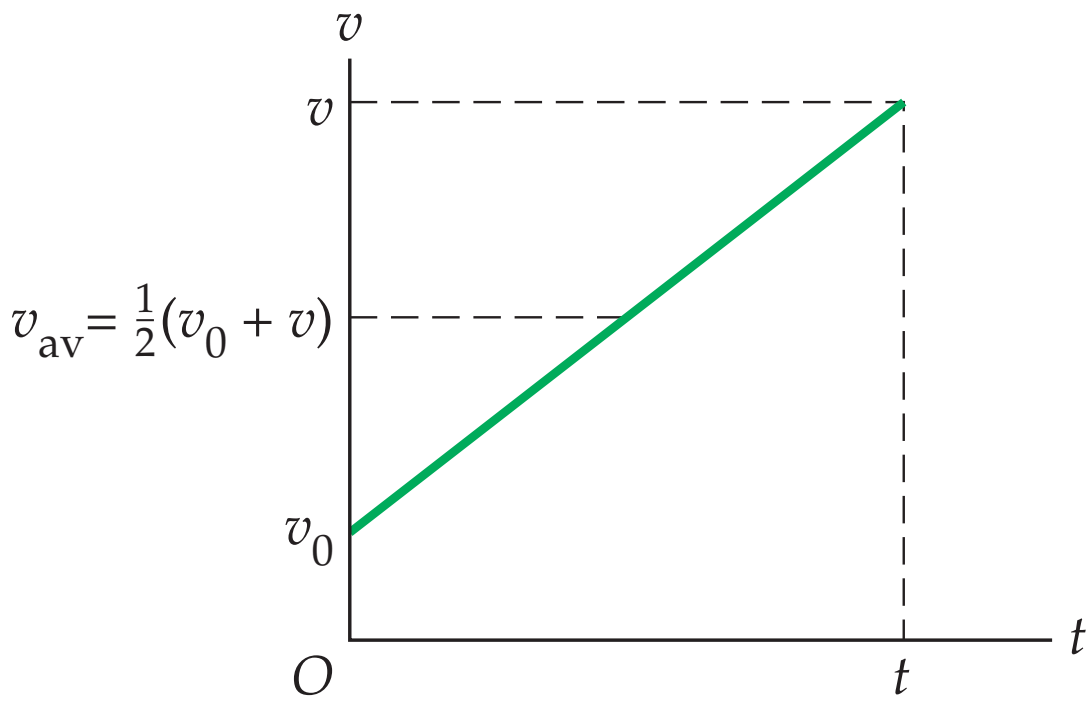
We will now find an equation to relate the distance of fall and acceleration to the time of fall.

Average Velocity

IF the acceleration of an object is constant, then the velocity-time graph is a straight line,



$$\mathbf{v}_{avg} = \frac{1}{2}(\mathbf{v}_0 + \mathbf{v})$$

Kinematics Equations (const. acceleration)

The definition of average velocity:

$$\mathbf{v}_{avg} = \frac{\Delta \boldsymbol{x}}{t}$$

and, when acceleration is constant: $\mathbf{v_{avg}} = \frac{\mathbf{v}_0 + \mathbf{v}}{2}$

Equating them, and multiplying by t:

$$\Delta \boldsymbol{x} = \left(\frac{\mathbf{v}_0 + \mathbf{v}}{2}\right) t \tag{1}$$

Kinematics Equations (const. acceleration)

Using the equation

$$\Delta \boldsymbol{x} = \left(\frac{\mathbf{v}_0 + \mathbf{v}}{2} \right) t$$

and the definition of acceleration

$$\mathbf{a} = \frac{\Delta \boldsymbol{v}}{t} = \frac{\mathbf{v} - \mathbf{v}_0}{t} \quad \Rightarrow \quad \mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$$

to replace $\mathbf{v}$ in the first equation.

$$\Delta \boldsymbol{x} \quad = \quad \left(\frac{\mathbf{v}_0 + (\mathbf{v}_0 + \mathbf{a}t)}{2} \right) t$$

Rearranging:

$$\Delta \boldsymbol{x} = \mathbf{v}_0 t + \frac{1}{2} \mathbf{a} t^2 \tag{2}$$

Theory

In this case, we consider a ruler falling from rest, so $v_0 = 0$.

Let $\Delta x = d$ be the distance the ruler falls.

The acceleration $a = g$, the acceleration due to gravity.

Therefore,

$$d = \frac{1}{2} g t^2 \tag{3}$$

Theory exercise: Rearrange this equation to find an expression for reaction time, t.

Lab Activity

You will measure your own reaction time and your partner's.

- Place your forearm on the lab bench with your hand overhanging the edge.
- Your partner will suspend the ruler or meter stick between your thumb and finger, held about 1 cm apart, so that the zero mark (or another convenient value) is precisely at the level of the top of your fingers. Then (s)he will drop the ruler suddenly and without any audible warning while you attempt to catch it as quickly as possible.
- Record the distance the ruler fell.
- Repeat 10 times.

Lab Activity, continued

- Calculate your reaction time for each run and then calculate your average reaction time.
- Change places with your partner and repeat the experiment.
- Put your average reaction time and age in the spreadsheet, for the class to compare the data.

$$t_{\text{avg}} = \frac{1}{n} \sum_{i=1}^{n} t_i$$

Record all data for yourself and your partner in your lab book. Copy your own data onto the lab worksheet.

Answer the questions on the lab worksheet.