General Lab Guidelines

There are some very strict rules that we must follow at all times in the lab. Please note these are standards set by OSHA and the school district for your safety, and they are policies that are being enforced throughout the science building. Breaking any of these rules may result in large penalties for the school and me. Your cooperation will be greatly appreciated!

No eating or drinking in lab.
No application of cosmetics in lab.
Closed-toe shoes and appropriate clothing must be worn.

You may keep food or drink in your backpack, as long as it is kept out of sight (and not consumed). If you need to eat or drink you may exit the building at any time during the lab for a short break (please let me know beforehand).
In addition, each student must:

(1) Return equipment neatly where you found it—this includes tables and chairs
(2) Work within a lab group
(3) Treat the other lab group members with respect and consideration.
(4) Treat the equipment with care

Failure to meet these responsibilities will result in consequences ranging from a verbal warning, to a grade penalty, a bill for broken equipment, or being dropped from the class.

Lab Report Format

Your grade in lab will be mostly based on your lab reports.
There will be two types of lab reports.

Type I—Informal Lab Reports

These reports will usually be due at the beginning of the next class meeting. Informal lab reports generally consist of worksheets, informal write-ups, and/or data, calculations and graphs.

- *Worksheets*: Many labs will be of a worksheet nature. This may also include lab homework to do outside of lab time.
- *Informal Write-ups*: In some labs you will be required to do a short write-up of the theory, like a homework problem, along with data and calculations. Do these neatly by hand.

Guidelines for turning in a type I lab report:

1) Arrange your papers in neat order—this includes
   a. The lab handout
   b. Any additional data tables, graphs, etc.
2) Staple in upper left corner.
3) Your name and your lab partners' names in upper right corner of first page.

Type II—Short Lab Reports

These reports will usually be due at the beginning of the lab/class period one week following the lab. Short lab reports can be written by hand, but it is strongly encouraged that you use a word processor.

Guidelines for turning in a type II lab report:

1) Arrange your papers in neat order—this includes only your papers, arranged in order with section headings as described below.(you may purchase a composition book with graph paper to keep all the labs organized if you wish)
   *Note: Do NOT turn in the lab handout for a type II report. It must be a self-contained report of your own creation, done in the format described below.
2) Staple in upper left corner.
3) Your name and your lab partners' names in upper right corner of first page.

General Requirements Checklist:

- ❑ See guidelines above
- ❑ Must have correct spelling, punctuation, grammar, sentence structure, etc.
- ❑ Handwritten reports must be ***neatly written and easy to read***
- ❑ Include section headings (see below) for each section of the report: Abstract, Experiment, etc.
- ❑ Double-space if typed

The following format should be followed. Include the section headings in your report. A requirements checklist is included in each section. ***An example Type II report is included later in this document.***

Title:

Requirements Checklist:

- ❑ Your Name and Lab Partners' Names
- ❑ Title of the lab

1. ***Abstract:***

Requirements Checklist:

- ❑ Only need to have a few sentences, maximum
- ❑ Need to highlight the main results of the experiment (specific numerical results if appropriate)

2. ***Experiment**:*
   Requirements Checklist:
   - ❑ In a few sentences at most, describe the apparatus and how it was used
   - ❑ Include a figure of the apparatus. For each figure:
     - o Make a simple sketch, labeled clearly and neatly.
     - o Include a caption describing it.
       - ⇒ A *caption* is a statement of a few sentences that explains specific and important details of the figure, graph or data table.
     - o Assign a figure number; refer to each figure by its figure number in your report.
   - ❑ If the method described in the lab activity was not followed (as suggested by the instructor or otherwise), then you should briefly outline your alternative experimental approach.

3. ***Equations & Definitions**:*
   Requirements Checklist:
   - ❑ No numbers here, just symbols and words
   - ❑ List only the <u>major equations used to make direct calculations</u>, (derivations are <u>not</u> required unless otherwise specified).
   - ❑ For each equation:
     - o Use symbols, no numbers.
     - o Define each symbol in the equation.
     - o Assign an equation number; refer to the equation by its number <u>any time the equation is used for a calculation</u>.
   - ❑ You do not need to redefine a symbol already defined in a previous equation, <u>if it means the same thing in both equations</u>.

4. ***Data, Calculations, and Graphs**:*
   Requirements Checklist:
   <u>*General*</u>
   - ❑ Should be neatly presented in an organized manner (use lists, or tables if appropriate).
   - ❑ Include headings and/or descriptions for data, calculations, etc., from different parts of the experiment (if the experiment has multiple parts)

   <u>*Data*</u>
   - ❑ For data lists, each quantity needs:
     - o Symbol (<u>as you defined it in *Equations & Definitions* section</u>—be consistent)
     - o Number with units, and appropriate number of sig. figs. (usually 2 or 3)
   - ❑ For data tables:
     - o You are encouraged to use a spreadsheet such as Excel to generate both the data tables and the graphs, but this is not required.
     - o Label column headings Quantity (Units); eg., Force (N) or Angle (radians)

    - Assign a figure number; should be referred to by this figure number in the rest of the report
    - Include a caption explaining: What is the data from, what equation(s) were used to calculate which columns (if appropriate), and how will you use the data?

Calculations

- Should refer to the equation being used by equation number
- Percent difference, percent error, or other comparisons should be done here

Graphs

- Graphs should be physically large enough to be easily read and interpreted.
- Graphs done by hand must be very neat and easy to read.
- For each graph:
    - Label axes as Quantity (Units); eg., Force (N) or Angle (radians)
    - Assign a figure number; refer to by this figure number in the rest of the report
    - Include a caption explaining: What quantities are being graphed and what specific information (numerical and/or conceptual) can be obtained from the graph?

5. ***Conclusion****:*

Requirements Checklist:

- A few sentences outlining the major results of experiment
- Make at least one specific and practical suggestion **for improving the experimental apparatus and/or methods used in the lab**.

Grading

Your grade on each lab will be based on a 10 point scale.

- Content will account for 8 points.
- Style will receive 1 point. (i.e. your lab is neat and easy to read)
- Participation will also receive 1 point. (i.e. how much are you contributing to your group during the lab)

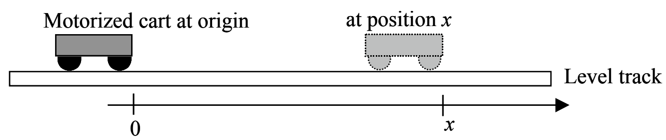
Example Type II Lab Report

Name: Pat Lennon
Lab Partners: Ben, Jess, Dan, and Dawn

Title: Motion with Constant Velocity, and Motion with Constant Acceleration

Abstract:
A motorized cart traveled at constant velocity on a level track. Position vs. time data was taken and graphed. The slope of the position vs. time graph is the best estimate of the velocity of the cart, 0.21 m/s. The track was then tilted and a non-motorized cart was released from rest, and it accelerated down the track. The experimental acceleration was 3.0 m/s^2, which was approximately 12% lower than the theoretical acceleration of 3.4 m/s^2.

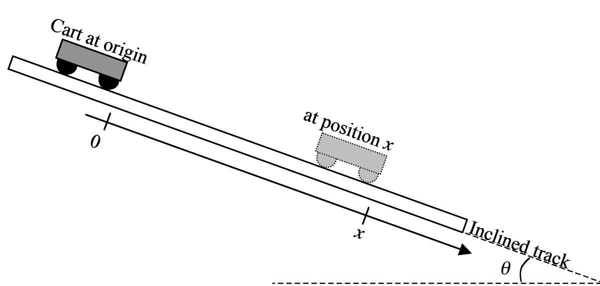
Experiment:
As shown in Figure 1, the cart's motor was turned on, and position vs. time data was



collected.

Figure 1: The motorized cart traveled along the track. The position x was measured relative to an origin. Time was measured with a stopwatch.

The track was then tilted at an angle of $\theta = 20$ degrees from the horizontal, and a non-



motorized cart was released from rest, as shown in Figure 2.

Figure 2: The cart started from rest at the origin. The time was measured as the cart passed position x. The angle was set at 20 degrees.

Equations & Definitions:
Equation 1: position vs. time for the motorized cart with constant velocity on a horizontal track $x = v\,t$

x = position, or distance from origin (measured)
v = velocity, assumed to be constant (should be equal to slope of x vs. t graph)
t = time since cart was at origin (measured)

Equation 2: experimental acceleration of a cart on inclined track $a_e = \dfrac{2x}{t^2}$

a_e = experimental acceleration, assumed to be constant (initial velocity assumed to be zero)

Equation 3: theoretical acceleration of a cart on inclined track $a_t = g \sin\theta$

a_t = theoretical acceleration, assumed to be constant (also assuming no friction)

θ = angle track makes with the horizontal (measured)

g = acceleration due to gravity on earth (constant)

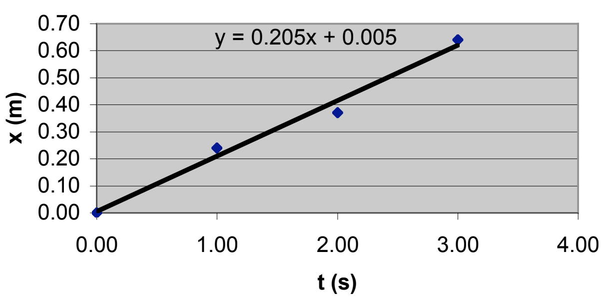
Data, Calculations & Graphs:

Motorized cart on level track

Figure 3: *x* vs. *t* data – cart moving at a constant speed on level track.

t (s)	*x* (m)
0.00	0.00
1.00	0.24
2.00	0.37
3.00	0.64

Figure 4: Graph of *x* vs. *t*, from data in *Figure 3*. *Equation 1* indicates that the slope of the best-fit line gives the best estimate of the cart's velocity, or *v* = 0.205 m/s.



Cart on inclined track:

Data:

x = 1.00 m (fixed distance for cart to travel)

t = 0.81 s (average of 5 readings: 0.80, 0.83, 0.81, 0.82, 0.79 s)

$\theta = 20^\circ$ (measured with protractor)

g = 9.8 m/s^2 (known constant)

Calculations:

Using Equation 2: $a_e = 3.0$ m/s^2

Using Equation 3: $a_t = 3.4$ m/s^2

$$\% \text{ Error} = \frac{a_e - a_t}{a_t} \times 100\% \cong -12\% \quad \text{(experimental value is 12\% low)}$$

Conclusion:
For the cart on the level track, the slope of the graph gave a reasonable value for the velocity of the cart, 0.21 m/s. On the inclined track, the experimental acceleration of 3.0 m/s^2 is about 12% low. The most likely reasons for this are friction in the cart's wheels, and irregularities in the track surface.

Specific and practical suggestion: For the part on the inclined track, the use of the stopwatch introduced significant error, which was mostly eliminated through repeated trials. However, a Smart Timer connected to a photogate on the track would make more accurate measurements of the time, and would eliminate the need for so many repeated trials, thus making for a more efficient and accurate measurement.