Evaluating Lab Reports for Communication

- Writing Across the Curriculum
- Defining "Good" and "Bad" Writing
- Expanding Our Vocabulary for Evaluating Writing
- Ways that Writing Factors Apply to Physics Lab Reports
- Quality of Writing Defined: Moving Away from "Good" and "Bad"
- Campus Resources for Writing Support
- Bibliography of Sources for Instructors of Writing-Intensive Courses
- Sample Student Lab Reports and Grading Grids
- Sample Student Lab Reports Showing Progression

Writing Across the Curriculum

The writing-intensive requirement at the University of Minnesota is related to a national movement called "Writing-Across-the-Curriculum," or WAC. This WAC movement advocates the instruction of writing across and within disciplines, as it holds the belief that writing is important to all subject areas and can be effectively instructed in specific disciplinary contexts. In addition, the WAC movement recognizes some basic assumptions about the act of writing:

- Writing is a learning activity that involves problem solving and communication skills
- Writing is a social activity, shaped by contextual factors such as a community of peers
- Writing is not separable from content
- Forms of writing vary from context to context (i.e., Anthropology vs. Physics)
- Certain factors of writing are central to all writing acts, such as audience, purpose, context, organization, support, design, and expression.

For an overview about the Writing-Across-the-Curriculum movement, see the following sources:

Bazerman, Charles, and David R. Russell. *Landmark Essays on Writing Across the Curriculum*. Hermagoras Press, 1994.

Why Writing Intensive Courses are Important

Writing-intensive courses address the idea that writing is important to learning technical content. This concept should be applied with careful consideration. Because writing is a learning activity, instructors should feel free to use writing assignments that allow students to explore new avenues for learning technical content such as problem solving, writing to specific audiences, or writing using discipline-specific formats or genres. Instructors should acknowledge that writing involves more than simply mastering grammar, spelling, and mechanics.

Writing-intensive courses in Physics provide students the opportunity to learn about Physics through written assignments that may involve problem solving, language usage, and organizational skills. Sample assignments include:

- Lab reports
- Feasibility reports/studies
- Instructions
- Resumes
- Abstracts and summaries
- Process explanations
- Progress reports
- Manuals
- Proposals
- Cover letters
- Technical descriptions
- Figures and graphs

Teaching with Writing

At the University of Minnesota, instructors from across the disciplines are *incorporating writing* into their courses. Doing so has *affirmed the enhancing role* that writing activities can play *in student learning*. It has also allowed faculty and students alike to *recognize that language use* and text production take place *within disciplinary language communities*; writing in Law, for instance, looks different, is directed at a different audiences and is produced for a series of different purposes than is writing in Computer Science

Mission of the Writing Requirement at the University

- **Learning to write is a *life-long task* … *refined through* an individual's personal, social, and professional *experiences***
- **Principal means by which all scholars … *inquiries* and *communicate their learning***
- **Learning to write effectively can be one of the most *intellectually empowering* components of a university education**
- **University regards the teaching of writing as a *responsibility shared by all departments***

Thus, the University has established a "*writing across the curriculum*" program

Writing Across the Curriculum:
complementary objectives

Good writers:

1) practice on a continuing basis, so one of the goals of writing-intensive courses is to offer ***ongoing writing practice***
2) are able to write for a variety of audiences; they understand that effective writing depends on context. For this reason, students should ***write in many different kinds of courses, to audiences ranging from their peers to senior scholars and scientists***
3) are able to produce a range of different kinds of writing. So the ***nature of the writing*** done in "writing-intensive" courses ***should vary considerably***
4) Because no one course can meet all these goals, the ***collective goal*** of all these writing-intensive courses is to ***prepare students to communicate effectively in a variety of situations*** at the University, in their future employment, and in their roles as citizens

Center for Interdisciplinary Studies of Writing

Writing Intensive Coursework

1) Course grade is directly tied to the quality of the student's writing as well as to knowledge of the subject matter, so that ***students cannot pass the course who do not meet minimal standards*** of writing competence

2) Courses requiring a significant amount of writing -- ***minimally ten to fifteen finished pages*** beyond informal writing and any in-class examinations. Note that the page guidelines may be met with an assortment of short assignments that add up to the total

3) Courses in which ***students are given instruction on the writing*** aspect of the assignments

4) Courses in which ***assignments include at least one for which students are required to revise a draft and resubmit*** after receiving feedback from the course instructor or graduate teaching assistant. Otherwise, writing assignments may be of various kinds and have various purposes, as appropriate to the discipline

Exercise in Defining "Good" and "Bad" Writing:

What words or characteristics come to mind when trying to define "good" writing?

What words or characteristics come to mind when trying to define "bad" writing?

Example #1

Statement of the problem

In this experiment, we were to determine when two objects stick together after a collision, what is the final velocity of the objects as a function of the initial velocity of the moving object and their masses. First, we took two carts of the same mass and gave the first cart an initial velocity towards a second stationary cart. We then measured the initial velocity of the first cart and the final velocity of the two cart's stuck together using the LabView™. We also did trails for the first cart having more mass and less mass than the stationary cart, although the sum of the masses was always equal. We also calculated the final velocity of the two carts stuck together as a function of the initial velocity of the moving cart, and compared our results.

Predictions

My group predicted that the equation to determine the final velocity when two objects stick together as a function of the initial velocity of the moving object and their masses to be:

$$v_f = m_1 v_i / m_1 + m_2$$

(v_f = the final velocity of the two objects stuck together, m_1 = the mass of the moving object, v_i = the initial velocity of the moving object, m_2 = the mass of the stationary object.)

We came up with this solution by first realizing that the initial momentum of the system was equal to:

$$p_1 = m_1 v_i$$

(p = momentum) This equation is true because momentum is equal to the mass of an object multiplied by the initial velocity of the object. Next, we determined the momentum of the two carts stuck together to be:

$$p_2 = (m_1 + m_2) v_f$$

This equation is true because the sum of the masses (total mass) multiplied by their velocity equals the two cart's momentum when they were stuck together. Then, we came to the conclusion that the momentum in the system would be conserved.

$$p_1 = p_2 \rightarrow m_1 v_i = (m_1 + m_2) v_f$$

Finally, we derived the value of the final velocity from the equation of momentum conservation.

$$m_1 v_i = (m_1 + m_2) v_f \rightarrow v_f = m_1 v_i / (m_1 + m_2)$$

This equation is correct because the units of measurement are also correct.

$$m/s = (kg \bullet m/s) / (kg + kg) \rightarrow m/s = m/s$$

Data and Results

First, we measured the masses of the carts for all three trials. Then, we used the LabView™ to experimentally determine the velocities of the carts before the collision and after the collision when they were stuck together.

In our first trial, when the masses of the carts were equal the initial velocity of the moving cart equaled:

$$X = 0 + .40t \rightarrow v_i = .40 \text{ m/s}$$

After the carts stuck together we also measured their final velocity to be:

$$X = 0 + .19t \rightarrow v_f = .19\text{m/s}$$

We repeated this procedure for the other two trials when the mass of the moving cart was greater than the stationary cart, and the mass of the moving cart was less than the stationary cart.

Mass of the moving cart	Mass of the stationary cart	Initial velocity	Final velocity
.77150 kg	.77150 kg	.40 m/s	.19 m/s
1.03650 kg	.50650 kg	.31 m/s	.19 m/s
.50650 kg	1.03650 kg	.43 m/s	.14 m/s

The uncertainty of the mass measurements comes from the systematic error of the balance, which is as high as (+/-) .01 g or .00001 kg. The uncertainty of the initial and final velocity measurements could be as high as (+/-) .01 m/s and this was shown in the discrepancies of the data points on the LabView™ Vx plot.

Next, we were to compare our experimental values to our calculated values. To find our calculated results, we used the equation to find the final velocity of the carts stuck together as a function of the initial velocity of the moving cart.

$$v_f = m_1 v_i / m_1 + m_2$$

We then plugged in our experimental values for the masses of the carts and the initial velocity of the moving cart to calculate the final velocity.

$$v_f = m_1 v_i / m_1 + m_2 \rightarrow v_f = (.77150 \text{ kg})(.40\text{m/s}) / (.77150 \text{ kg}) + (.77150 \text{ kg}) = .20 \text{ m/s}$$

We repeated this procedure for the other two trials when the mass of the moving cart was greater than the stationary cart, and the mass of the moving cart was less than the mass of the stationary cart.

Mass of the moving cart	Mass of the stationary cart	Initial velocity	Final velocity
.77150 kg	.77150 kg	.40 m/s	**.20 m/s**
1.03650 kg	.50650 kg	.31 m/s	**.21 m/s**
.50650 kg	1.03650 kg	.43 m/s	**.14 m/s**

The uncertainty of the mass measurements comes from the systematic error of the balance, which is as high as (+/-) .01 g or .00001 kg. The uncertainty of the initial velocity measurements could be as high as (+/-) .01 m/s and this was shown in the discrepancies of the data points on the LabView™ Vx plot. Although, the uncertainty of the final velocity in this case is hard to determine because it is a combination of the uncertainty of the mass measurement and the uncertainty of the initial velocity of the moving cart.

Conclusion

We experimentally determined and calculated the final velocities of the carts to be:

Mass of the moving cart	Mass of the stationary cart	Final experimental velocity	Final calculated velocity
.77150 kg	.77150 kg	.19 m/s	.20 m/s
1.03650 kg	.50650 kg	.19 m/s	.21 m/s
.50650 kg	1.03650 kg	.14 m/s	.14 m/s

In conclusion, I feel that our experimental results were accurate because in comparing them with our calculated results, they were consistently close to one another. The highest percent error between any of the measurements was:

$$(.21 \text{ m/s} - .19\text{m/s}) / (.21 \text{ m/s}) \bullet 100\% = 9.5\%$$

I believe our results turned out well because my group did a good job in measuring the masses of the carts and the initial and final velocity. Our careful experimental procedure eliminated some of the uncertainty in the experiment. Although, the uncertainty of the mass measurements comes from the systematic error of the balance, which is as high as (+/-) .01 g or .00001 kg. The uncertainty of the initial velocity measurements could be as high as (+/-) .01 m/s, and this was shown in the discrepancies of the data points on the LabView™ Vx plot.

Example #2

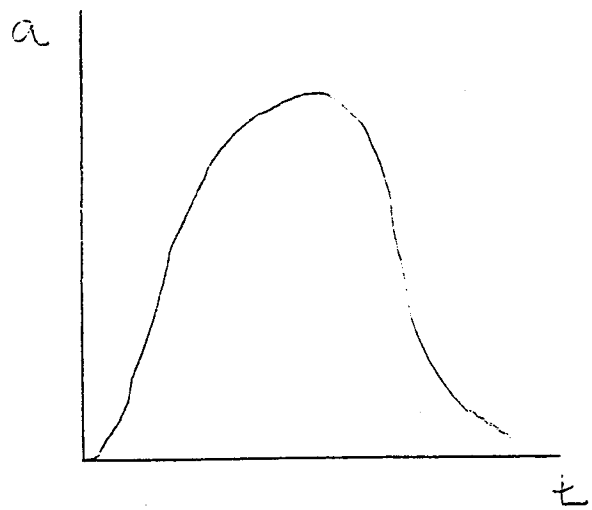
Statement of Problem

The problem my group was trying to solve was to find the acceleration of an object moving up and down a ramp at all times during its motion. We tilted a ramp at a fairly low angle and gave a cart an initial push toward the top. We clocked the time and measured the distance that the cart traveled throughout the entire motion, which turned out to be a distance of 120 centimeters.

The equipment we used included a video camera, the LabVIEW program on a computer, a stopwatch, a meter stick, small cart, and the ramp apparatus. The reason we chose this equipment is because of its size. We needed an accurate interpretation of an amusement park cart and figured that this way with this gear would be the best method. The LabVIEW program allows us to analyze the motion with a more thorough method than strictly human measurement and computation.

Prediction

I predicted that the graph of the entire motion of the cart would look something like this:



I thought that the cart would start to lose acceleration on the way to the top and be exactly zero meters/second squared at the peak. The cart would then regain its acceleration on the way down.

I decided that the best relationship between acceleration would be:

A=v1-v0/t1-t0

We came up with this because we thought that we would be able to solve for the initial and final velocity of the cart at two given points on the graph and find the acceleration. We also knew than acceleration could be derived from an equation be taking the second derivative of that equation:

$$A=d/dt(dv/dt)$$

When the group made a prediction graph on the LabVIEW program it looked different from all our original predictions. It is included in this report marked figure 1; the program also gave us a prediction equation. From it we derived an equation for the acceleration at any given point.

Data and Results

The first step in our lab was setting up our ramp to the degree that we wanted. Then we had to fit the fixed distance we wanted our cart to travel to the screen on the computer. To do this we tried different camera angles and adjusted the zoom on the lens until the picture fit perfectly. Next we simply gave the cart its initial push and recorded it with the video camera. Lastly we integrated the movie into the LabVIEW program on the computer and took our time trials of the round trip.

When the cart went up and down the track we took three different measurements of time: 3.91s, 3.81s, and 3.85s. The average time turned out to be 3.86 seconds, and the average deviation was 0.04 seconds.

There was a problem in collecting all this data, that is the human error. Time is what we had the most trouble with; our time trials were not all that far apart, yet they are not all that close together. There was also a lot of uncertainty in our measured fixed distance. It is impossible to have a person push a cart an exact distance on that ramp. We had to estimate from our movie the distance, we decided on 120 centimeters, we could be off by a centimeter or two.

I mathematically calculated the uncertainty of our time trials; the average deviation was 0.04 seconds so the uncertainty is 3.86+/-0.04 seconds. The uncertainty of the distance the cart traveled is estimated at +/-1.50 centimeters.

Conclusions

Our graph indicates that displacement is dependent upon time in this experiment. Our equation led us mathematically to discover that the acceleration of the cart during the trip is 54.4 centimeters/second squared.

Our predicted graph was quite a bit smaller than the actual graph. By saying it was smaller I mean that the peak of the graph (where the acceleration is zero) is not at as high of a displacement value as it should be. The predicted equation was:

X(t)=62.00t-16.2t^2

Although all the variables are in the right spots and the powers are correct, both of the coefficients are incorrect. The actual equation is:

X(t)=112.0t-27.2t^2

When the second derivative is taken of this equation you get the correct acceleration value for the cart.

To check and make sure the answer is correct I plugged the acceleration into the equation:

X1-X0=v0(t1-t0)+.5a(t1-t0)

To find the speed at zero, I then compared that answer to the answer I got from the velocity equation with 2.0 seconds as the time:

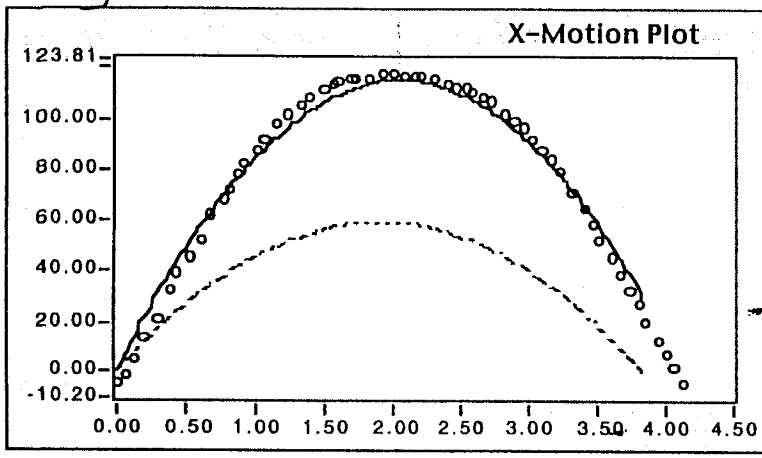
V(t)=112.0-54.4t

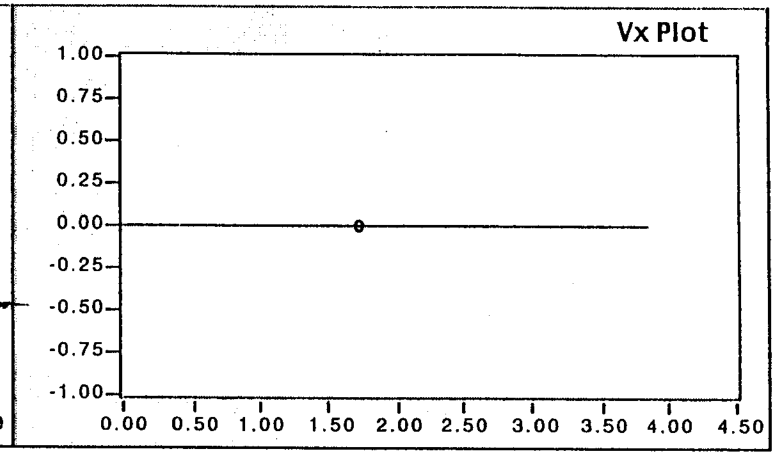
The answers turned out to be the same, 3.2 centimeters/second, which brings me to the conclusion that the acceleration for the cart along the motion is 54.4 centimeters/second squared.

Movie Name: " Movie 2"
Data Taken: Wednesday, September 23, 1998, 6:18 PM

Your Graph Title Goes Here!

Figure 1





X Prediction

x(t) = 0.00 + 62.00t + −16.20t^2

X Fit

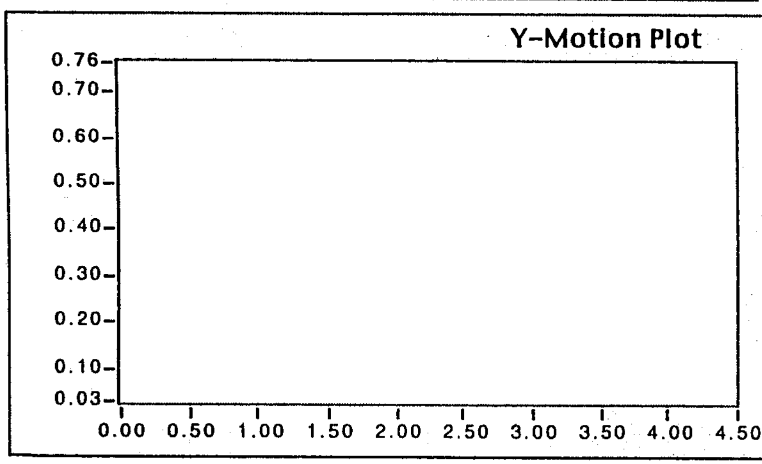
x(t) = 0.00 + 112.00t + −27.20t^2

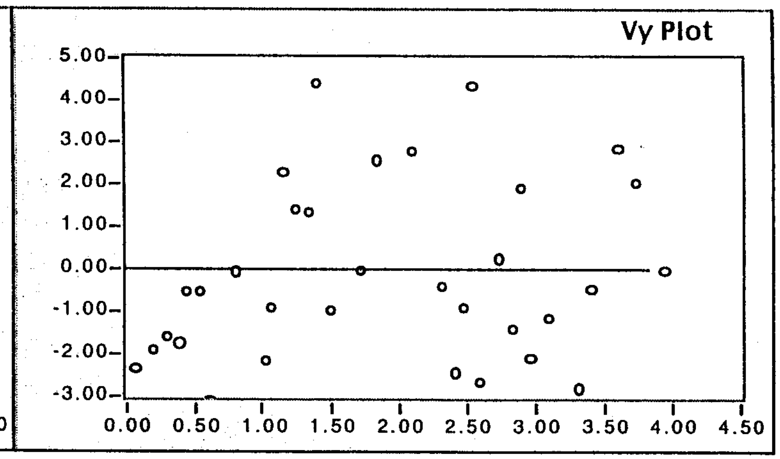
Vx Prediction

Vx(t) = 0.00 + 0.00t

Vx Fit

Vx(t) = 0.00 + 0.00t





Y Prediction

y(t) = 0.00 + 0.00t

Y Fit

y(t) = 0.00 + 0.00t

Vy Prediction

Vy(t) = 0.00 + 0.00t

Vy Fit

Vy(t) = 0.00 + 0.00t

Lab 1 Problem 3

Entire Motion time

trial	time (S)	deviation
1	3.91	.05
2	3.81	.05
3	3.85	.01
Average	3.86	.04

uncertainty
3.86 sec $\pm$ .04 sec

120cm roundtrip 240cm

__Prediction Equation__

$x(t) = 62.00t - 16.2t^2$

$x(t) = 62.00t - 16.2t^2 \left(\frac{dx}{dt}\right)$

$V(t) = 62.00 - 32.4t \left(\frac{dv}{dt}\right)$

$a(t) = -32.4 \frac{cm}{s^2}$

__Actual Equation__

$x(t) = 112.00t - 27.2t^2$

$x(t) = 112t - 27.2t^2 \left(\frac{dx}{dt}\right)$

$v(t) = 112 - 54.4t \left(\frac{dv}{dt}\right)$

$a(t) = -54.4 \frac{cm}{s^2}$

$\boxed{\text{Measurement Check}}$

Using the acceleration I will find the Velocity at 2.0 se

$\Delta X = V_0(\Delta t) + \frac{1}{2}\Delta t^2$

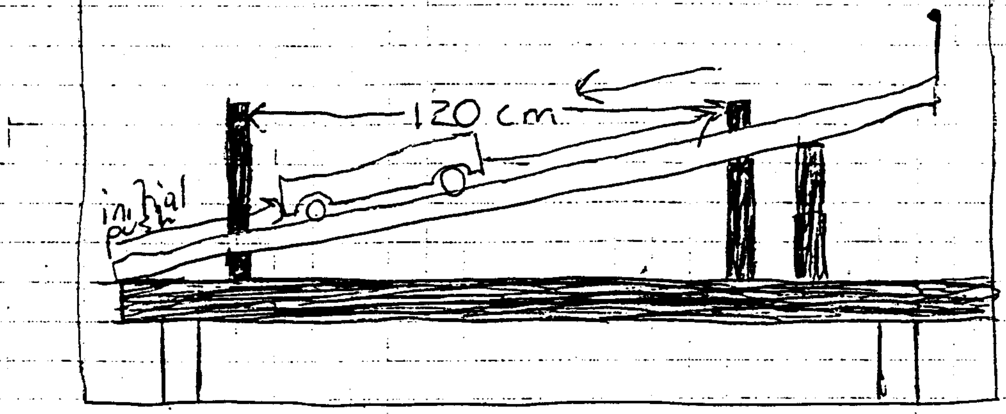
$115.2 = 2V_0 + \frac{1}{2}(54.4)(2)^2 = 115.2 = 2V_0 + 108.8$

$\frac{6.4}{2} = \frac{2V_0}{2}$; $V_0 = 3.2 \frac{cm}{s}$

$\boxed{\text{CHECK}}$ $V(t) = 112 - 54.4(2)$

$V(2) = 3.2 \frac{cm}{s}$

Cart moving along ramp



Equiptment: Ramp, cart, meter stick, stopwatch, videocamera, computer, distance markers.

Purpose: Find acceleration of cart's entire motion.

Method: One person gives cart push up ramp and catches it when it comes down. One person videotapes it and operates LabVIEW System. Another times cart's entire motion on several trials.