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

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.

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

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:

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

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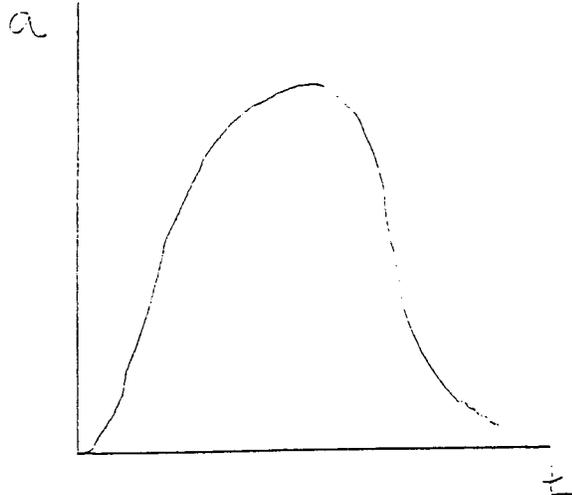
I thought that the cart would start to lose acceleration on the way to the top and be exactly zero meters/second squared at the peak. The cart would then regain its acceleration on the way down.

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:

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

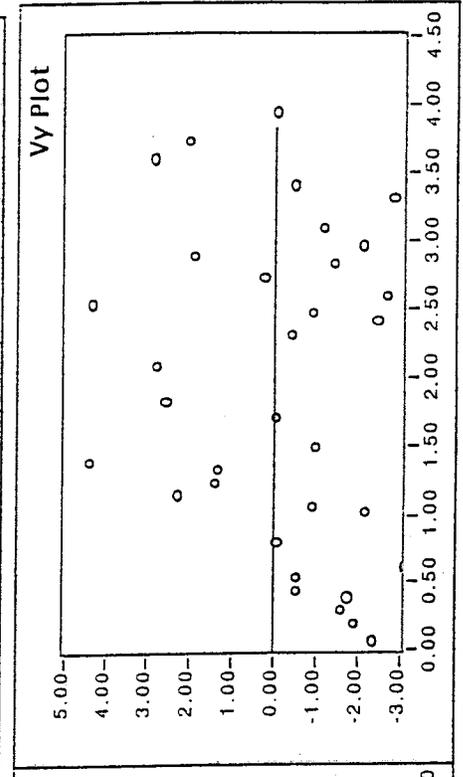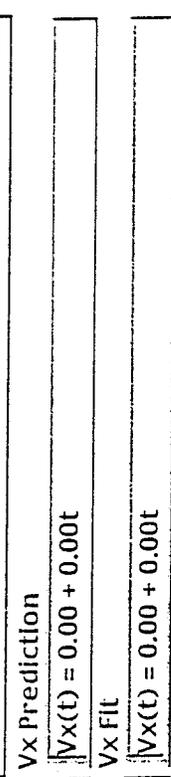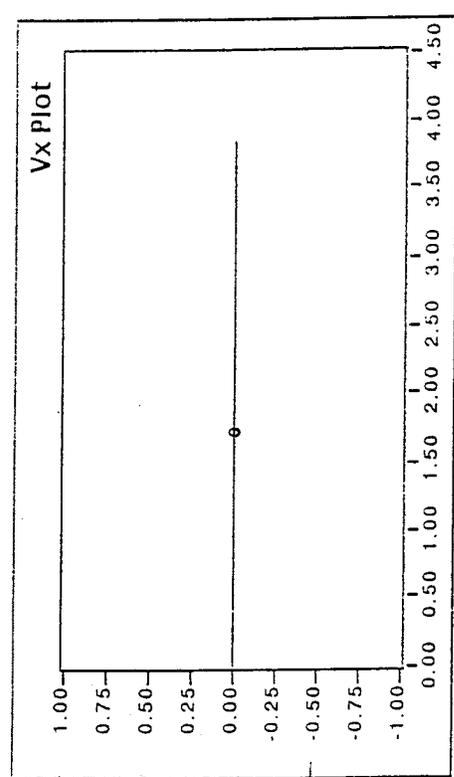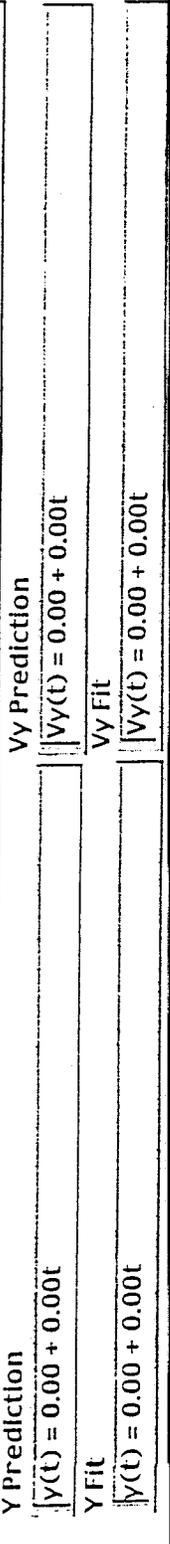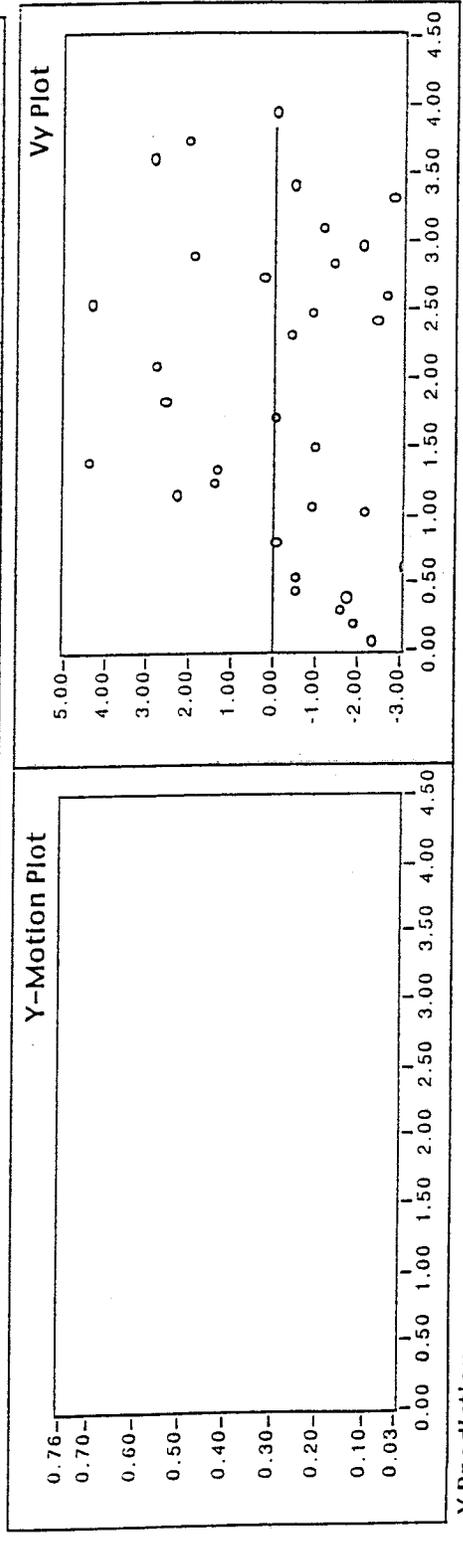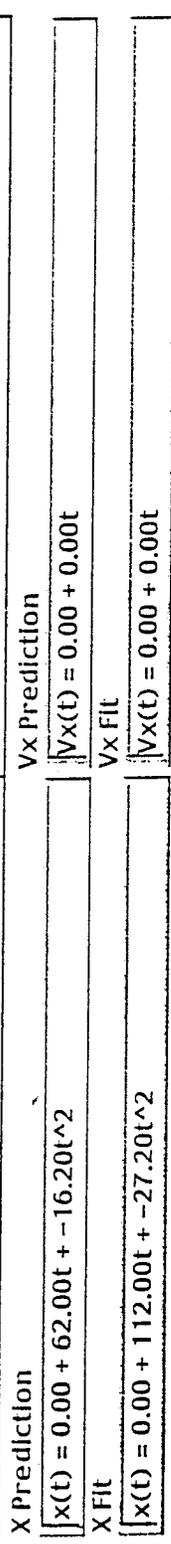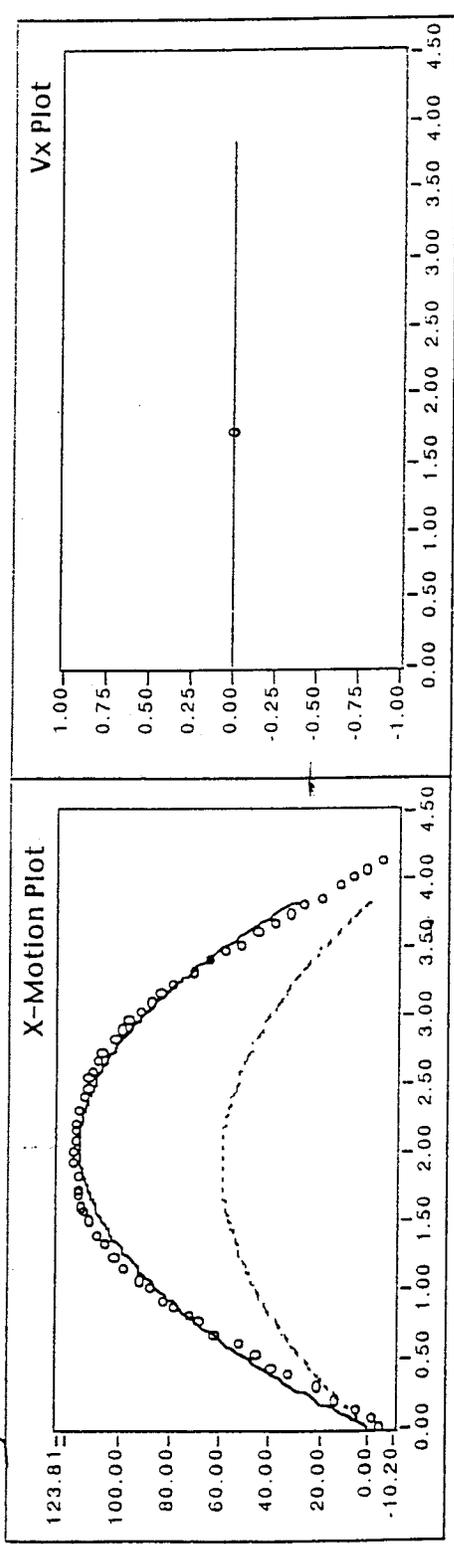To find the speed at zero, I then compared that answer to the answer I got from the velocity equation with 2.0 seconds as the time:

$$V(t)=112.0-54.4t$$

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.

Figure 1

Movie Name: " Movie 2 "

Data Taken: Wednesday, September 23, 1998, 6:18 PM

Your Graph Title Goes Here!

Vx Plot

X-Motion Plot

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

Vy Plot

Y-Motion Plot

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
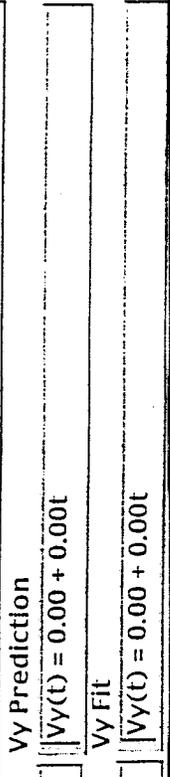
Lab 1 Problem 3

Entire Motion time

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

uncertainty

$3.86 \text{ sec} \pm .04 \text{ sec}$

roundtrip
120 cm   240 cm
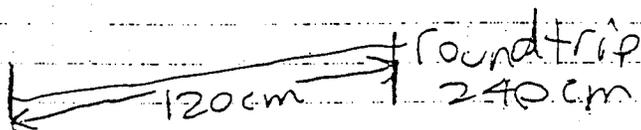
Prediction Equation

$$x(t) = 62.00t - 16.2t^2$$
$$x(t) = 62.00t - 16.2t^2 \left(\frac{dx}{dt}\right)$$
$$V(t) = 62.00 - 32.4t \left(\frac{dv}{dt}\right)$$
$$a(t) = -32.4 \frac{cm}{s^2}$$

Actual Equation

$$x(t) = 112.00t - 27.2t^2$$
$$x(t) = 112t - 27.2t^2 \left(\frac{dx}{dt}\right)$$
$$V(t) = 112 - 54.4t \left(\frac{dv}{dt}\right)$$
$$a(t) = -54.4 \frac{cm}{s^2}$$

Measurement Check

Using the acceleration I will find the velocity at 2.0 se

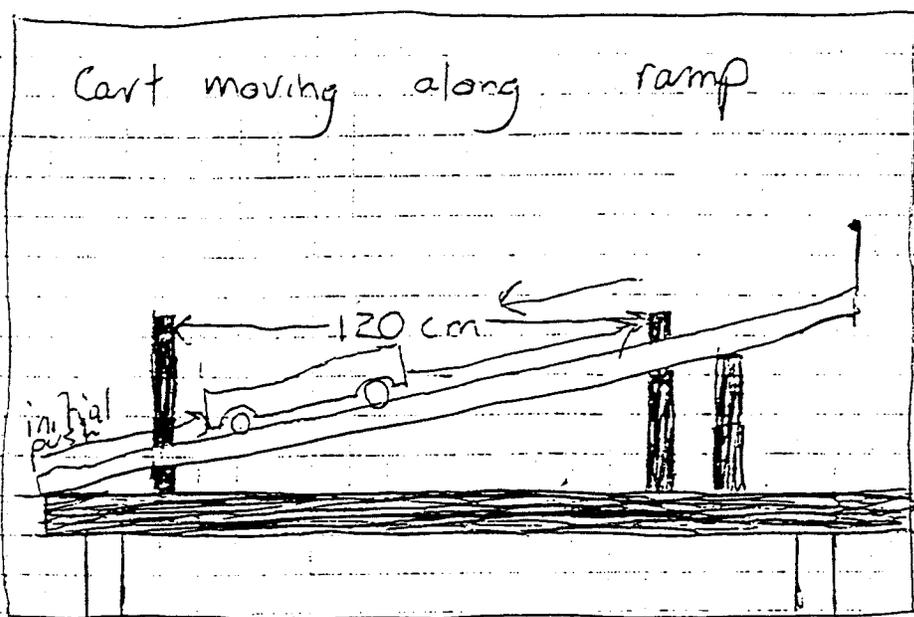$$\Delta X = V_0(\Delta t) + \frac{1}{2}\Delta t^2$$

$$115.2 = 2V_0 + \frac{1}{2}(54.4)(2)^2 \quad c \quad 115.2 = 2V_0 + 108.8$$
$$\frac{6.4}{2} = \frac{2V_0}{2} \; ; \quad V_0 = 3.2 \frac{cm}{s}$$

CHECK $V(t) = 112 - 54.4(2)$
$$V(2) = 3.2 \frac{cm}{s}$$

Cart moving along ramp

120 cm

initial push

Equiptment: Ramp, cart, meter stick, stopwatch, video camera, 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 video tapes it and operates LabVIEW system. Another times cart's entire motion on several trials.

Expanding Our Vocabulary for Evaluating Writing

Although different situations require that writing take different forms (i.e., resume versus lab report), certain factors are important to ALL writing situations. These factors—while general— can be adapted or explained in terms that are specific to each writing situation. Below is a list of eight communication factors that apply to writing situations. I encourage you to begin using this vocabulary to describe writing.

Content:	Has the student included technical or scientific *Content* accurately and thoroughly? Does the student address accurate information such as definitions, formulas, theorems, explanations, or data?
Context:	Has the student communicated in a way appropriate for the situation or *Context* in which the document /presentation/visual will be received? Have the requirements of the assignment been met?
Audience:	Has the student addressed the *Audience* with appropriate language and technical content, vocabulary, level of knowledge, and register (informal or formal)?
Purpose:	Has the student identified the *Purpose* of their communication, such as to inform, persuade, instruct, or demonstrate?
Support:	Has the student included appropriate *Support* in the form of documentation, facts, statistics, formulas, illustrations, or evidence?
Design:	Does the student use effective *Design*, both for page design and for the integration of verbal explanations and visual illustrations? Does the student display neatness and cross-references at appropriate points?
Organization:	Has the student *Organized* the communication into logical sections, paragraphs, topic sentences, and headings?
Expression:	Has the student *Expressed* written work clearly, efficiently, and effectively, and has the student used correct grammar and mechanics?

Ways that Writing Factors Apply to Physics Lab Reports

Although evaluation sheets for lab reports may not exclusively address the eight factors mentioned above, many are implicitly included. For example, the worksheet used by Physics to assess lab reports includes words such as "clear and readable," "stated correctly," "section headings provided," "correct grammar and spelling," and "use of labels on graphs." I would consider each of these criteria that address communication.

SAMPLE COVER SHEET

PHYSICS ___ LABORATORY REPORT
LABORATORY I

Name and ID#: _____

Date performed: _____ Day/Time section meets: _____

Lab Partners' Names: _____

_____

_____

Problem # and Title: _____

Lab Instructor Initials: _____   *Communication Factors*

Grading Checklist	Points
LABORATORY JOURNAL:	
PREDICTIONS (individual predictions completed in journal before each lab session)	
LAB PROCEDURES (measurement plan recorded in journal, tables and graphs made in journal as data is collected, observations written in journal)	
PROBLEM REPORT:	
ORGANIZATION (clear and readable; correct grammar and spelling; section headings provided; physics stated correctly)	
DATA AND DATA TABLES (GROUP PREDICTIONS) (clear and readable; units and assigned uncertainties clearly stated)	
RESULTS (results clearly indicated; correct, logical, and well-organized calculations with uncertainties indicated; scales, labels and uncertainties on graphs; physics stated correctly)	
CONCLUSIONS (comparison to prediction & theory discussed with physics stated correctly ; possible sources of uncertainties identified; attention called to experimental problems)	
TOTAL(incorrect or missing statement of physics will result in a maximum of 60% of the total points achieved; incorrect grammar or spelling will result in a maximum of 70% of the total points achieved)	
BONUS POINTS FOR TEAMWORK (as specified by course policy)	

handwritten annotations: expression, content, expression and page design *(left side); expression, organization, support, content (right side)*

* An "R" in the points column means to <u>rewrite that section only</u> and return it to your lab instructor within two days of the return of the report to you -- no exceptions.

Quality of Writing Defined: Moving Away from "Good" and "Bad"

It is not enough to recognize the general factors of communication. Graders must also be able to assess the ability of writers to communicate well. Communication involves a number of factors, resulting in a spectrum for evaluation. Below are listed the eight factors of writing and how each of these factors may be assessed according to the scale of "excellent," "average," and "poor" for a lab report.

	Excellent	Average	Poor
Addresses Content accurately and thoroughly	Includes accurate and complete technical information, including formulas, explanations, theorems, and data.	Includes accurate technical information, but has missed some important information.	Does not include accurate or complete information.
Writes to the appropriate Context or situation of assignment	Meets the requirements of the assignment; includes proper format and sections that assignment requires	Adequately meets requirements of the assignment; does not always display proper format.	Does not meet the requirements of the assignment as specified in the assignment sheet.
Addresses audience appropriately	Writes appropriately for the intended audience, including proper terms or vocabulary, explanations of concepts, formal register	Indicates audience but does not always include proper terms, concepts, or register (perhaps is too informal)	Does not recognize audience at all; does not include proper terms, concepts, or register to effectively address audience.
Indicates clear purpose for writing	Indicates purpose of the report (to solve a problem, to instruct, to explain, to demonstrate, etc.) in the beginning of the report.	Purpose of the lab report is not clearly indicated by the writer, or is indicated incorrectly.	Purpose of the lab report is not indicated at all. No effort has been made to indicate purpose of writing.
Organizes writing well	Includes complete, yet concise, paragraphs; includes strong topic sentences that indicate focus of paragraph or section; includes strong forecasting statements; includes appropriate headings and subheadings; demonstrates coherence throughout report.	Includes adequate overall format; does not display concise paragraphs or topic sentences; does not include all appropriate headings and subheadings; paragraphs do not cohere very clearly.	Does not use appropriate headings or subheadings; does not apply conciseness to paragraphs; paragraphs do not logically connect; topic sentences are not effective.
Includes adequate support (documentation and illustrations)	Includes illustrations or visual figures necessary for the report. Refers to appropriate readings, theories, and relevant background information; includes proper citation formats; includes relevant charts, graphs, or tables;	Refers to appropriate readings and background information, but does not use correct citation methods; includes tables, graphs, and charts, but does not include	Does not include necessary support in the form of citations, background information, tables, charts, graphs, labels, and cross-references.

	includes proper labeling and cross-references to figures, tables, charts, and graphs.	complete labeling or cross-references.	
Applies an appealing design	Report and figures are clear and legible. Visuals are balanced on the page with appropriate verbal explanations nearby. Report is neat; headings, subheadings, and titles have similar font and style to indicate hierarchy of information; sufficient white space allows for easy reading.	Report and figures are legible, but some areas are difficult to read. Figures and illustrations are not as neat as they could be. Headings and subheadings are indicated, but do not demonstrate hierarchy of information.	Report and figures are messy and difficult to read. Visuals and verbal explanations are not placed in a way convenient for the reader. Headings and subheadings are not clearly indicated.
Uses clear expression	Clear, readable prose. Uses complete sentences and proper subject-verb constructions. No spelling errors. Uses commas, periods, semi-colons, colons, punctuation marks, and dashes correctly. Uses correct abbreviations and capitalizations. Uses appropriate vocabulary and writes in a tone that clearly conveys ideas or concepts. Uses active voice to describe activities conducted by lab participants. Uses semi-formal tone.	Uses readable tone, but is not clear at all times. Includes occasional spelling errors. May occasionally misuse punctuation such as periods, commas, and colons. Does not use consistent tone or voice throughout the report.	Includes multiple spelling, grammar, or punctuation errors. Is difficult to read and understand due to misuse of language. Should be referred to a tutorial service (see Writing Support Network) for additional help.

Discussion of Sample Physics Report with Annotations Regarding Communication

Review the sample report included in the Physics coursepack.

What characteristics of writing does the report display well?

What characteristics are not displayed well?

Appendix F: Sample Laboratory Report

There is no set length for a problem report but experience shows the good reports are usually no more than three pages long. Graphs and photocopies of your lab journal make up additional pages. Complete reports will include the terminology and the mathematics relevant to the problem at hand. Your report should be a clear, concise, logical, and honest interpretation of your experience. You will be graded based on how well you demonstrate your understanding of the physics. Because technical communication is so important, neatness, and correct grammar and spelling are required and will be reflected on your grade.

Note: As with Problem 1 of Lab 1, the double vertical bars indicate an explanation of that part of the report. These comments are not part of the actual report.

Statement of the problem — *Also indication of purpose (reason for writing)*

In a complete sentence or two, state the problem you are trying to solve. List the equipment you will use and the reasons for selecting such equipment.

Addresses purpose of report — The problem was to determine the dependence of the time of flight of a projectile on its initial horizontal velocity. We rolled an aluminum ball *→ use of active voice expression* down a ramp and off the edge of a table starting from rest at two different positions along the ramp. Starting from the greater height up the ramp meant the ball had a larger horizontal velocity when it rolled along the table. Since the table was horizontal, that was the horizontal velocity when it entered the air. See Figure 1 from my lab journal for a picture of the set-up.

strong forecasting statement — We made two movies with the video equipment provided, one for a fast rolling ball and one for a slower one. These movies were analyzed with LabVIEW™ to study the projectile's motion in the horizontal and vertical directions.

Prediction ← *use of clear headings: organization*

Next comes your prediction. Notice that the physical reason for choosing the prediction is given. In this case there is a theoretical relationship between Δt and v_o. There is a reference to real life experience: the example of the bullets. Also, note that this prediction is wrong. The prediction does not need to be correct, it needs to be what you really thought before doing the lab; that is why it is called a prediction. The prediction is supposed to be a complete and reasonable attempt by your group to determine the outcome of the problem.

Our group predicted that the time the ball took to hit the ground once it left the table would be greater if the horizontal velocity were greater. We

have observed that the faster a projectile goes initially, the longer its trajectory. Since the gravitational acceleration is constant, we reasoned that the ball would take more time to travel a larger distance.

Mathematically, we start from the definition of acceleration:

$$a = \frac{d}{dt}\left(\frac{dy}{dt}\right)$$

accuracy of content

and integrate twice with respect to time to see how a change in time might be related to initial velocity. We found that:

$$y - y_0 = v_0\Delta t + 0.5a\Delta t^2 \qquad (1)$$

With up being the positive y-axis, we know the acceleration is -g. We also know that v_0 is the initial velocity, and $y_0 - y$ is h, the height of the table. Solving for Δt one finds:

$$\Delta t = \frac{v_0 \pm \sqrt{(v_0^2 + 2hg)}}{g} \qquad (2)$$

Good expression — *use of complete sentences*

Faced with a choice in sign, our group choose the solution with the positive sign, deciding that a possible negative value for elapsed time is nonsense. From equation (2), we deduced that if v_0 increased, then the time of fall also increases. This coincided with our prediction that a projectile with fastest horizontal velocity would take the most time to fall to the ground. For a graph of our predicted time of flight versus initial horizontal velocity, see Graph A from the lab journal.

correct use + capitalization of name (expression)

LabVIEW™ generated graphs of x and y positions as functions of time. Our prediction for the vertical direction was equation (1). Since the ball only has one acceleration, we predicted that equation (1) would also be true for the horizontal motion:

$$x - x_0 = v_0\Delta t + 0.5a\Delta t^2$$

The dotted lines on the printed graphs represent these predictions.

The Example of Two Bullets

Our TA asked us to compare a bullet fired horizontally from a gun to a bullet dropped vertically. Our group decided the bullet which is fired

horizontally will take longer to hit the ground than the one that is simply dropped from the same height.

Data and results

This section describes your experimental method, the data that you collected, any problems in gathering the data, and any crucial decisions you made. Your actual results should show you if your prediction was correct or not.

Excellent organization

To ensure the ball's velocity is completely horizontal, we attached a flat plank at the end of the ramp. The ball rolls down the ramp and then goes onto the horizontal plank. After going a distance (75 cm) along the plank, the ball leaves the edge of the table and enters projectile motion.

Good paragraph structure

We measured the time of flight by simply counting the number of video frames that the ball was in the air. The time between frames is 1/30 of a second since this is the rate a video camera takes data. This also corresponds to the time scale on the LabVIEW™ graphs. We decided to compare the times of flight between a ball with a fast initial velocity and one with a slow initial velocity. To get a fast velocity we started the ball at the top of the ramp. A slower velocity was achieved by starting the ball almost at the bottom of the ramp.

strong topic sentences

logical order of paragraphs (chronological)

During the time the ball is in the air, the horizontal velocity is a constant as shown by the velocity in the x-direction graphs for slow and fast rolling balls. From these graphs, the slowest velocity we used was 1.30 m/s, and the fastest was 2.51 m/s.

After making four measurements of the time of flight for these two situations, we could not see any correspondence between time of flight and initial horizontal velocity. (See table 1 from lab journal) As a final check, we measured the time of flight for a ball that was started approximately halfway up the ramp and found it was similar to the times of flight for both the fast and the slow horizontal velocities. (See table 2 from lab journal)

Good Support: cross references to tables

A discussion of uncertainty should follow all measurements. No measurement is exact. Uncertainty must be included to indicate the reliability of your data.

Most of the uncertainty in recording time of flight comes from deciding the time for the first data point when the ball is in the air and the last data point before it hits the ground. We estimated that we could be off by one frame which is 1/30 of a second. To get a better estimate of this uncertainty, we repeated each measurement four times. The average deviation served as our experimental uncertainty. (See Table 1 from lab journal) This uncertainty

Content: uncertainty clearly stated

matches our estimate of how well we could determine the first and the last frame of the projectile trajectory.

Conclusions

This section summarizes your results. In the most concise manner possible, it answers the original question of the lab.

Our graph indicates that the time of flight is independent of the ball's initial horizontal velocity. (See lab journal, Graph A) We conclude that there is no relationship between these two quantities.

content: results clearly indicated

A good conclusion will always compare actual results with the predictions. If your prediction was incorrect, then you must discuss where your reasoning went wrong. If your prediction was correct, then you should review your reasoning and discuss how this lab served to confirm your knowledge of the basic physical concepts.

Our prediction is contradicted by this independence between time of flight and initial horizontal velocity. We thought that the ball would take longer to fall to the floor if it had a greater initial horizontal velocity. After some discussion, we determined the error in our prediction. We did not understand that the vertical motion is completely independent of the horizontal motion. Thus, in the vertical direction the equation

$$y - y_0 = v_0 \Delta t + 0.5 a \Delta t^2$$

means that the v_0 is the only the y-component of initial velocity. Since the ball rolls horizontally at the start of its flight, v_0 in this equation equals zero.

The correct equation for the time of flight, with no initial vertical component of velocity, is actually:

$$y - y_0 = 0.5 a \Delta t^2$$

In this equation, there is no relationship between time of flight and initial horizontal velocity.

Content: clearly distinguishes results from predictions

Furthermore, the graphs we generated with LabVIEW™ showed us that velocity in the y-direction did not change when the initial horizontal velocity changed. Velocity in the y-direction is always approximately zero at the beginning of the trajectory. It is not exactly zero because of the difficulty our camera had determining the position when the projectile motion begins. We observed that the y-velocity changed at the same rate (slope of v_y plots, graphs 1 and 2) regardless of the horizontal velocity. In other words, the acceleration in the y-direction is constant, a fact that confirms the independence of vertical and horizontal motion.

After you have compared your predictions to your measured results, it is helpful to use an alternative measurement to check your theory with the actual data. This should be a short exercise demonstrating to yourself and to your TA that you understand the basic physics behind the problem. Most of the problems in lab are written to include alternative measurements. In this case, using the time of fall and the gravitational constant, you can calculate the height of the table.

Alternative Analysis

Since $y_0 - y = h$ and $a = -g$ we can check to see if our measured time of flight gives us the height of the table. From our graph, we see that the data overlap in a region of about 0.41 sec. With this as our time of flight, the height of the table is calculated to be 82.3 cm. Using a meter stick, we found the height of the table to be 80.25 cm. This helped convince us that our final reasoning was correct.

The example of the two bullets discussed in the Prediction section was interpreted incorrectly by our group. Actually, both bullets hit the ground at the same time. One bullet travels at a greater speed, but both have the same time of flight. Although this seems to violate "common sense" it is an example of the independence of the horizontal and vertical components of motion.

The following are pages photocopied from my lab journal:

Sample Lab Journal   July 13th, 1998

h = height of table

H = balls starting height
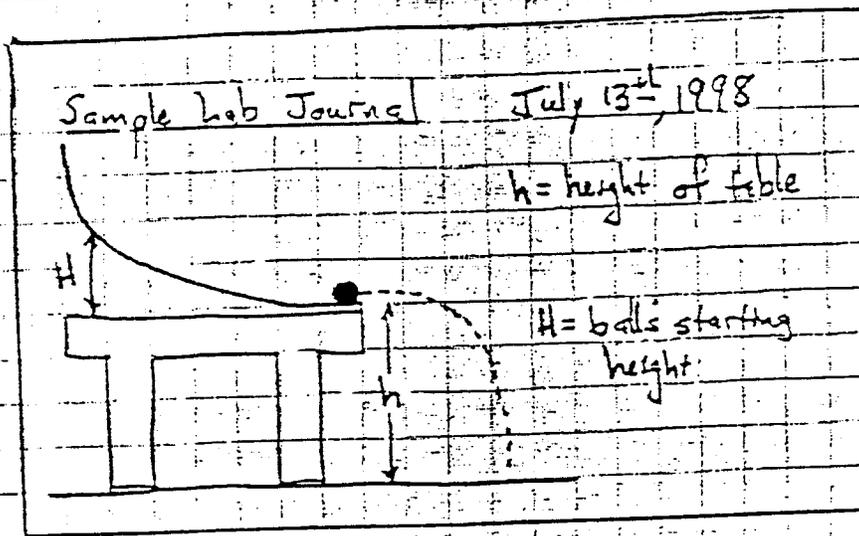
Equipment: ramp, aluminum ball, video camera, computer, meterstick

Purpose: Determine if Time of flight depends on initial horizontal velocity

Method: One person releases ball, another operates video camera. Count frames with ball in the air to find time of flight.

Expiration: Larger H results in larger horizontal $\bar{v}$.

Design: Neatly written
Page design has adequate white space so it is easy to read

Organization: Sections are clearly labeled proper labels are used

Support: proper labels are used

Grading Grid

	Satisfactory	Adequate	Poor
Addresses Content accurately and thoroughly			
Write to the appropriate Context or situation of assignment			
Addresses Audience appropriately			
Indicates clear Purpose for writing			
Organizes writing well			
Includes adequate Support (documentation and illustrations)			
Applies an appealing Design			
Uses clear Expression			

Comments:

Grade: _____

Campus Resources for Writing Support

Writing Support Network. The Writing Support Network is a web page that lists support services for students in writing classes. All writing centers home pages are listed. See:

http://www.writinghelp.umn.edu/

Center for the Interdisciplinary Studies of Writing. CISW offers workshops for TAs and faculty teaching writing-intensive courses. You can also find on their website sources for sample courses, syllabi, and assignments that are writing-intensive. See:

http://CISW.cla.umn.edu/

Writing-Intensive Resources for Scientific and Technical Disciplines. This web site provides information for faculty and students in scientific and technical disciplines. Faculty information includes suggestions for evaluating written reports, integrating writing in assignments, and incorporating revision and peer review. Student information provides a number of online handouts on writing topics such as writing and revising, editing, oral presentations, and student collaboration. Students can also find helpful links to other resources about writing such as other writing centers and sources for documentation. See:

http://www.agricola.umn.edu/writingintensive

Writing Support Network

Welcome to the Writing Support Network! Do you need help with your writing? The Centers listed below are rich sources of information for you. You can take your assignment to a walk-in center, submit a question to an online center, or explore handouts on everything from how to organize a paper to how to document sources.

Writing Centers provide help for all students: writers at *all* levels of ability and experience, those who would like help with English as a second language, and those who want assistance because of learning or physical disabilities.

Student Writing Center

This center provides walk-in assistance with all aspects of writing. Consultants can help students with writing assignments and writing process skills. Located in the English Department, 306B Lind Hall, hours are generally Monday through Thursday 9:00 a.m. to 4:00 p.m. and Friday 9:00 a.m. to 2:00 p.m. Check the Web site or call 612-625-1893 for updated hours of operation. Students can either make appointments or just walk in and can request help once or twice or request an ongoing weekly appointment. Instructor referrals are also accepted.

Online Writing Center

This online resource provides personalized online writing service for both undergraduate and graduate students, including consulting, interactive skills exercises, and specialized help for students in the sciences or technology. Since this service is online, students can submit their questions at any time and receive answers within several days. It is especially useful for students who cannot be on campus for face-to-face tutoring. This service is provided by the Rhetoric Department.

Center for Interdisciplinary Studies of Writing

The Center primarily encourages faculty research into writing across the curriculum. Though it does not have tutors for undergraduates, it does have a variety of useful writing handouts and resources. The Web site is especially designed to help students, faculty, and researchers enhance their writing. The site contains hundreds of useful links to other writing resources around the country and information on the University's writing-intensive courses. Click on "Resources for Undergraduates" for this information.

Composition Program

Composition is a program of the Department of English. Through its various courses, Composition teaches students to use language effectively and creatively, to construct compelling arguments, and to recognize that writing is empowering. Most Composition courses satisfy the Freshman Writing Requirement. Composition also gives students an introduction to life at the university, good study skills, the library and its resources, and the ways knowledge is created. The Composition Web has information, resources, and links for students, instructors, and visitors.

General College Writing Center

This is a walk-in center with undergraduate consultants who can work with students at any stage of the writing process. The center also accepts writing questions through email. Instructors may also refer students to the Center for one or two visits or for ongoing help. Located in the Academic Resource Center in 11 Appleby Hall, hours are 9:00 a.m. to 4:00 p.m. Monday through Thursday and 9:00 a.m. to 3:00 p.m. on Friday.

Minnesota English Center

The Minnesota English Center (MEC) provides noncredit composition and reading/composition classes for nonnative speakers of English who want to improve their English for academic, business, or personal reasons. The MEC also offers classes in other skills and provides referrals to qualified tutors who charge by the hour for short-term or long-term tutoring. For information on course offerings and fees, call 612-624-1503, e-mail mec@tc.umn.edu, or visit the MEC website, http://www1.umn.edu/mec

This site is currently under construction. Please direct questions to Ann Browning. Last updated: 1/24/02

Return to the CISW homepage
Return to the U of MN

CISW Home

News & Events
    Past Colloquia
    Past LRS Speakers

University Writing
Requirements

Teaching with Writing:
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    in the Disciplines

Support for instructors

Resources for
undergraduates

Graduate Minor in
Literacy & Rhetorical
Studies

Research opportunities
& archives

Minnesota Writing
Project

CISW people

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Search

UNIVERSITY OF MINNESOTA

One Stop | Directories | Search U of M
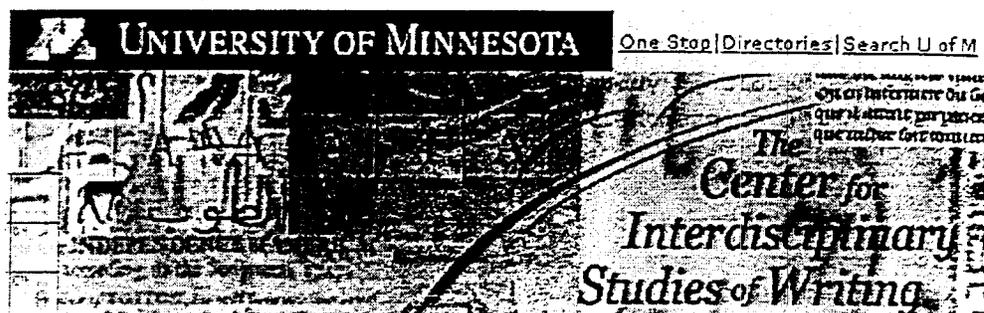
The Center for Interdisciplinary Studies of Writing

The Center was founded in 1989 with support from the University of Minnesota's Foundation and a gift from the Deluxe Corporation. Its mission is to improve the writing of undergraduates at the University of Minnesota.

The Center sponsors research on writing across the curriculum and in specific disciplines, development programs for faculty, resources for undergraduates, support for writing-intensive courses, a graduate minor with emphases on literacy and rhetorical studies, special events featuring writers and experts on writing for the entire University community, outreach to Minnesota schools through the Minnesota Writing Project, and a range of other services described within this Web site.

Writing-Intensive Resources for Scientific and Technical Disciplines

Courses

We provide support and resources for writing-intensive courses in COAFES.

Faculty

We assist and advise faculty of available pedagogical strategies for writing-intensive courses.

Students

We support student learning of written, oral, and visual communication in scientific and technical disciplines.

Contact

If you have questions about these resources, or the type of classroom support available, please feel free to contact us.

[Department of Rhetoric] [University of Minnesota]
[College of Agricultural, Food, and Environmental Sciences]

Content: Dr. Lee-Ann Kastman Breuch, Design: Jenni Swenson

EASI Web

Contest Winner

Bibliography of Sources for Instructors of Writing-Intensive Courses

Technical Communication Textbooks

These sources provide helpful instruction on a number of communication topics such as memos, letters, proposals, reports, resume and cover letters, rhetorical principles, and research in writing.

Lay, Mary, Billie J. Wahlstrom, Stephen Doheny-Farina, Ann Hill Duin, Sherry Burgus Little, Carolyn D. Rude, Cynthia L. Selfe, and Jack Selzer. Technical Communication. Irwin: Chicago, 1995.

Burnett, Rebecca E. Technical Communication. 4th edition. Wadsworth Publishing Company: Boston, 1997.

Pearsall, Thomas E. Elements of Technical Writing. Allyn and Bacon, 1996.

Anderson, Paul V. Technical Writing: A Reader-Centered Approach. New York: Harcourt Brace Jovanovich College Publishers. 1991. 2nd edition.

Barnum, Carol M., and Saul Carliner. Eds. Techniques for Technical Communicators. New York: Macmillan Publishing Company, 1993.

Articles about Writing in Various Disciplines

These articles address writing instruction in specific disciplines.

Chemistry

Driskill, Linda, Karen Lewis, Jennie Stearns, and Tracy Volz. "Students' Reasoning and Rhetorical Knowledge in First-Year Chemistry." Language and Learning Across the Disciplines 2.3 (April 1998): 2-24.

Klein, Bill, and Besty M. Aller. "Writing Across the Curriculum in College Chemistry: A Practical Bibliography." Language and Learning Across the Disciplines 2.3 (April 1998): 25-35.

Beall, Herbert, and John Trimbur. A Short Guide to Writing about Chemistry. New York: HarperCollins College Publishers, 1996.

Agriculture

Kastman, Lee-Ann M. and Susan L. Booker. "Writing Across the Disciplines in Agriculture." Language and Learning Across the Disciplines 2.3 (April 1998): 36-43.

Feldman, Ann Merle. "Chapter Nine: Nutrition." In Feldman, Ann Merle. Writing and Learning in the Disciplines. New York: Harper Collins College Publishers, 1996.

Engineering

Haines, Roger W. Roger Haines on Report Writing: A Guide for Engineers. Blue Ridge
     Summit, PA: TAB Professional and Reference Books, 1990.
Ellis, Richard. Communication for Engineers: Bridge that Gap. New York: Arnold; co-
     published by John Wiley & Sons, 1997.
Selber, Stuart A., and Bill Karis. "Composing Human-Computer Interfaces Across the
     Curriculum in Engineering Schools." In Electronic Communication Across the
     Curriculum. Eds. Donna Reiss, Dickie Selfe, and Art Young. NCTE: Urbana,
     IL: 1998.

Biology

Myers, Greg. Writing Biology: Text in the Social Construction of Scientific Knowledge.
     Madison, WI: University of Wisconsin Madison Press, 1990.
Pechenik, Jan A. A Short Guide to Writing about Biology. 3rd Edition. New York:
     Longman, 1997.
Langsam, Deborah M., and Kathleen Blake Yancey. "E-mailing Biology: Facing the
     Biochallenge." In Electronic Communication Across the Curriculum. Eds. Donna
     Reiss, Dickie Selfe, and Art Young. NCTE: Urbana, IL: 1998.

Other

Venable, Carol F., and Gretchen N. Vik. "Computer-Supported Collaboration in an
     Accounting Class." In Electronic Communication Across the Curriculum. Eds.
     Donna Reiss, Dickie Selfe, and Art Young. NCTE: Urbana, IL, 1998.
Chadwick, Scott A., and Jon Dorbolo. "InterQuest: Designing a Communication-
     Intensive Web-Based Course." In Electronic Communication Across the
     Curriculum. Eds. Donna Reiss, Dickie Selfe, and Art Young. NCTE: Urbana,
     IL: 1998.

General Texts about Writing in Scientific and Technical Disciplines

These books are helpful guides for undergraduate and graduate students. Many of these
books include detailed suggestions for writing and examples of documents such as
reports, lab reports, term papers, abstracts, references, titles, and figures.

Porush, David. A Short Guide to Writing About Science. New York: HarperCollins
     College Publishers. 1995.
Hult, Christine A. Researching and Writing in the Sciences and Technology. Boston:
     Allyn and Bacon, 1996.
Hult, Christine A. Researching and Writing Across the Curriculum. Boston: Allyn and
     Bacon, 1996.

Feldman, Ann Merle. Writing and Learning in the Disciplines. New York: Harper Collins College Publishers, 1996.

MacKenzie, Nancy R. Science and Technology Today: Readings for Writers. New York: St. Martin's Press, 1995.

Sources for Writing Teachers in Composition and Rhetoric

Intended for instructors, these texts provide helpful background information about factors for writing instruction such as rhetorical principles (audience, purpose, context), creating writing assignments, evaluating writing assignments, and designing writing-intensive courses.

Lindemann, Erika. A Rhetoric for Writing Teachers. 2nd edition. New York: Oxford University Press, 1987.

Flower, Linda. Problem-Solving Strategies for Writing. New York: Harcourt Brace Jovanovich, Inc. 1981.

Tate, Gary, and Edward P.J. Corbett. The Writing Teacher's Sourcebook. 2nd edition. New York: Oxford University Press, 1988.

Burnett, Rebecca E., and Lee-Ann M. Kastman. "Teaching Composition: Current Theories and Practices." In Handbook of Academic Learning. Academic Press, 1997/

Sources on Writing in Discipline-Specific Contexts

For more theoretical reading, these books provide essential background for understanding the roots of the writing-across-the-curriculum movement.

Bazerman, Charles. Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science. Madison, WI: University of Wisconsin Madison Press, 1988.

Kuhn, Thomas S. The Structure of Scientific Revolutions. 3rd edition. Chicago: University of Chicago Press, 1996.

Russell, David R. Writing in the Academic Disciplines, 1870-1990: A Curricular History. Carbondale, IL: Southern Illinois University Press, 1991.

Bazerman, Charles, and David R. Russell. Eds. Landmark Essays on Writing Across the Curriculum. Davis, CA: Hermagoras Press, 1994.

Recommended Handbooks

These handbooks provide instruction on grammar, mechanics, and language usage. If students in your class need guidance with basic language skills, one of these handbooks will be helpful.

Aaron, Jane E. The Little, Brown, Essential Handbook for Writers. New York: HarperCollins College Publishers, 1994.

Brusau, Charles T., Gerald J. Alred, Walter E. Oliu. Handbook of Technical Writing. 5th edition. New York: St. Martin's Press, 1997.

Hacker, Diana. A Writer's Reference. 3rd edition. Boston: Bedford Books, 1998.

Three Sample Lab Reports
from Different Students

Grading Grid

	Satisfactory	Adequate	Poor
Addresses Content accurately and thoroughly			
Write to the appropriate Context or situation of assignment			
Addresses Audience appropriately			
Indicates clear Purpose for writing			
Organizes writing well			
Includes adequate Support (documentation and illustrations)			
Applies an appealing Design			
Uses clear Expression			

Comments:

Grade: _____

Laboratory III-Frictional Force

Statement of the Problem

The problem for this lab was to determine the frictional force on the cart as it is accelerated by a hanging weight and then allowed to decelerate after the weight hits the ground. For our lab we used a cart, a string with a weight attached to it, a pulley, a ramp, a meter stick, a stopwatch, a digital video camera, and a computer to which the camera sent its information. We set the friction screw on the cart so that it slowed the cart down enough to give us good results in our video analysis. It took us a few tries to get the friction set just right. We then put a 10-gram weight on to the 50-gram hanging weight. We measured out the distance the cart would be traveling from where we released it. We also measured out the distance the cart would be traveling after the hanging weight lands on the ground. We set up a marker next to the meter stick where the hanging weight hits the ground. This way, when we analyzed our video later we would be able to do two analyses. The first analysis is from when we release the cart to when the hanging weight hits the ground. The second analysis is from where the weight hits the ground to where the cart stops.
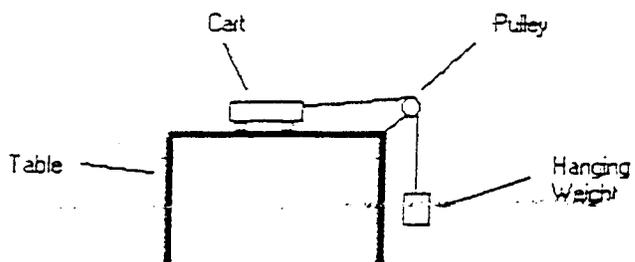
(Above is a picture of the lab setup)

After video taping the motion of the cart, we analyzed the video clip using the

LabVIEW program on the Macintosh computer to study the horizontal motion and the

velocity of the cart.

Prediction

Our group predicted the equation for the force of friction is

F=(friction coefficient)(mass of cart)(acceleration of the cart). We also predicted that the

cart would accelerate up until the point where the hanging weight hit the ground. After

the weight hit the ground, the cart would then decelerate because of the friction caused by

the screw. We also concluded that the graph horizontal position of the cart would be

parabolic due to the carts accelerating and then decelerating. We determined that the

equation for the position of the cart according to time is $X(t)=x(o)+v(o)t+(1/2)at^2$.

This equation gave us a parabolic curve, which is what we predicted it should be. The

equation for the horizontal velocity of the cart was $V(t)=v(o)+a(t)$. We concluded that

these equations would be the best and most accurate.

Data and Results

Using LabVIEW we were able to analyze the motion of the cart. In order to

gather data for the whole motion of the cart, we had to analyze the video in two parts.

The first part we analyzed was from the release of the cart to where the hanging weight

hit the ground. The second part we analyzed was from where the hanging weight hit the ground to where the cart stopped. We marked off a 52 cm section on the meter stick and used that to calibrate our videos. After doing this we began to collect the data from the movie. We did this by clicking on the end of the cart in the video. Each time we clicked on the end of the cart the computer advanced to the next frame and it plotted a point on the graphs at the bottom of the screen. We continued clicking on the cart until it got to the marker marking where the hanging weight hit the ground. After doing this, we found equations that fit the plotted points. We found that the equation for the position was $X(t)=x(o)+v(o)t+(1/2)at^2$. When we put numbers into this equation we were able to make the graph fit the plotted points. We did this same analysis for the two videos. The equation we found for the motion of the cart is $X(t)=0.51+1.15t-0.33t^2$. This equation gave us a parabolic curve, which is what we predicted. The equation we received for the horizontal velocity was $V(t)=1.05-.50t$. This equation gave us a line with a negative slope, meaning the velocity was constantly decreasing.

Conclusion

Our prediction for the equation for friction was wrong. We predicted that the equation for the force of friction would be F=(coefficient of friction)(mass of cart)(acceleration of cart). Our prediction of the graph of the position being parabolic was correct, however. What we did wrong for the frictional force equation was, we forgot to figure in the mass and the acceleration of the hanging weight. If we had done this we would have had the correct equation.

According to the results received from our graphs, the position was always positive, but it didn't increase at a constant rate. The velocity of the cart stayed constant throughout the motion of the cart. From the results we received in our lab we can now answer the original question given to us. The question was, "Is the frictional force on an object larger when that object speeds up than when it coasts?". Using the correct equation for the force of friction, we can tell that as an object speeds up, the frictional force gets larger. Therefore, an object with a greater acceleration will have a greater force of friction acting on it than an object with a lesser acceleration.

Movie Name:" k-dog2"

Data Taken: Wednesday, October 14, 1993, 6:15 PM

Your Graph Title Goes Here!

Position vs. Time

Velocity vs. Time

X-Motion Plot

Position

Time

Vx Plot
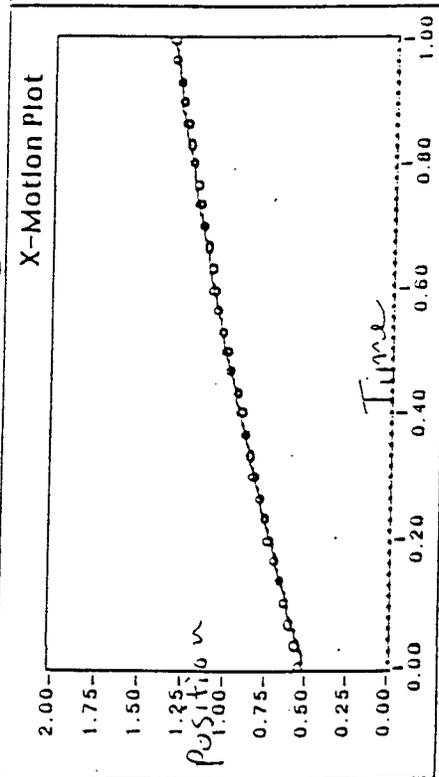
Velocity

Time

XPrediction

$x(t) = 0.00 + 0.00t$

XFit

$x(t) = 0.51 + 1.15t + -0.33t^2$

VxPrediction
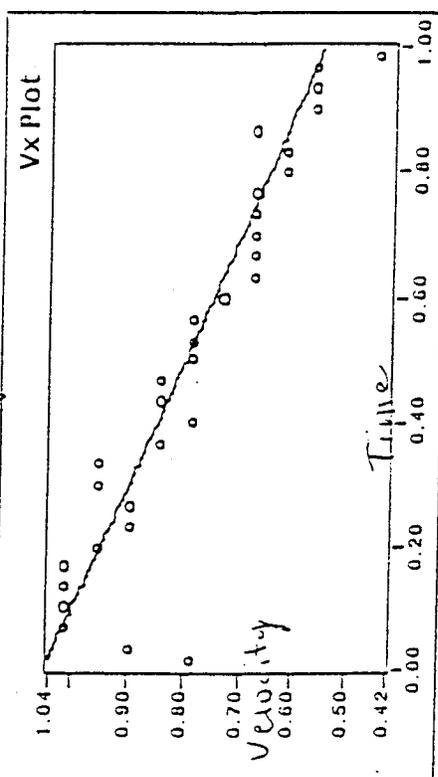
$Vx(t) = 0.00 + 0.00t$

VxFit

$Vx(t) = 1.05 + -0.50t$

Y-Motion Plot

Vy Plot

YPrediction

$y(t) = 0.00 + 0.00t$

YFit

$y(t) = 0.00 + 0.00t$

VyPrediction

$Vy(t) = 0.00 + 0.00t$

VyFit

$Vy(t) = 0.00 + 0.00t$

Grading Grid

	Satisfactory	Adequate	Poor
Addresses Content accurately and thoroughly			
Write to the appropriate Context or situation of assignment			
Addresses Audience appropriately			
Indicates clear Purpose for writing			
Organizes writing well			
Includes adequate Support (documentation and illustrations)			
Applies an appealing Design			
Uses clear Expression			

Comments:

Grade: _____

LAB #1, PROBLEM #3

STATEMENT OF THE PROBLEM

The problem was to determine the acceleration of an object moving up and down a ramp at all times during its motion. We pushed a cart up an air track from rest and observed its motion up the track and then on the way down after it reversed direction at the top of the inclined plane.

We made numerous movies of the cart moving up and down the track, but settled on just one video that accurately portrayed the velocity and acceleration of the cart throughout the cycle. We analyzed the movie through the use of the LabVIEW program provided to us by the physics department. Because the only motion we analyzed was in the x direction, the y portion of LabVIEW can be neglected.

PREDICTION

We were asked to predict the graph produced for the acceleration-versus-time graph for a given initial velocity up the inclined plane. We thought the acceleration would be the same at the beginning of the run as near the end of the run. At the top of the inclined plane we thought the acceleration would slow and then go to O m/s^2. After the reversal in direction, we thought again that it would increase its acceleration all the way down the inclined plane. So we reasoned from this that the equation needed to interpret the data correctly would be the following:

$$Y = A + Bt + Ct^2$$

Because of the initial deceleration into a reversal of direction and the subsequent acceleration down the ramp, we hypothesized a parabolic shape. We had a problem coming up with the correct position of the shape however, and as a result our prediction graph is not even remotely close to the final data results. For the predictions that I made on the position-versus-time graph, you can look to the lab journal report included in the packet. For the group's LabVIEW prediction, take a look at the computer printout of the final results.

DATA AND RESULTS

We used a woodblock to set up the inclined plane. It lifted one end of the air track about 10.14cm in the air. The other end rested on the table creating an angle of 3.30 degrees with it. We set up a couple of markers along the track to help us determine the speed of the cart. We set one at 126 and one at 7.5 near the end of the track. The 7.5 indication mark is where the cart reversed direction. The 126 marker is where we started the timing of the cart. This information is included at the top of the lab journal entry.

The actual data collection consisted of several minutes of pushing the cart up the ramp to get the desired video for the analysis. Next we entered our movie into the LabVIEW program to be analyzed. We used the black plastic at either end of the cart to calibrate the distance of the movie measurements. A portion of the LabVIEW program was also dedicated to predicting the velocity-vs. -time graph. This can also be found on the copy of the lab journal entry.

UNCERTAINTIES

·   Much of the uncertainties lie in the method in which the initial speed and the average speed were calculated. We calculated the average velocity for the entire round trip, from the bottom to the top and back down to the bottom. We should have calculated the average speed up the ramp, and then an average speed going down the ramp. Although it is not possible to get the exact same trial twice, so the only way to determine this would be the through the video made. I believe that our reasoning for finding initial velocity was off as well. Which would have made our predictions off in the first couple of graphs.

CONCLUSIONS

From our analysis and the graphs produced from the analysis, we determined that the acceleration acting on the cart is equal throughout the entire trial is the same. So even though the cart is slowing on the way up and speeding up on the way down, the acceleration is the same.

Our prediction for the results of the position vs. time were right in assuming that it would be a parabola, however the positioning was incorrect. The final equation for our graph is

$$Y = .84t + .2t^2$$

On the other hand, our predictions for the graph of the velocity-time-time graph were dead on. The graph of our prediction and the final results can be found in the analysis sheet in the packet. The line's equation was

$$Y = .84t - .4t$$

Lab 1 Problem 3

D=Traveled 12b-7.5 = 78 ㎝   26.33 cm/s = .2633 M/s

T=It took 4.50 seconds

$$x = x_o + V_o t + \frac{1}{2} a t^2$$

3.30° Angle w/ the table

$V_o =$
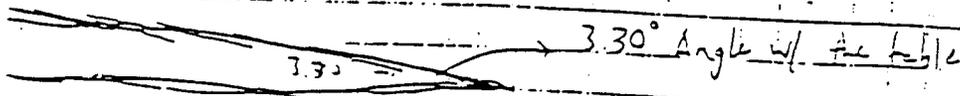
Our prediction of the Data

Pos
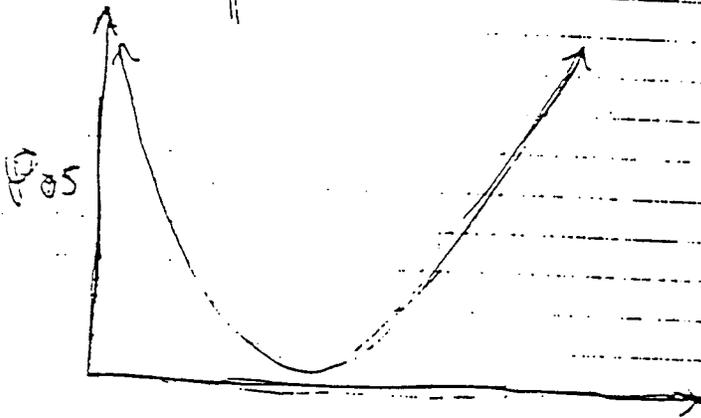
I interpreted this as a deceleration
and then the vertex
is the point where it turned around
and then the acc goes back
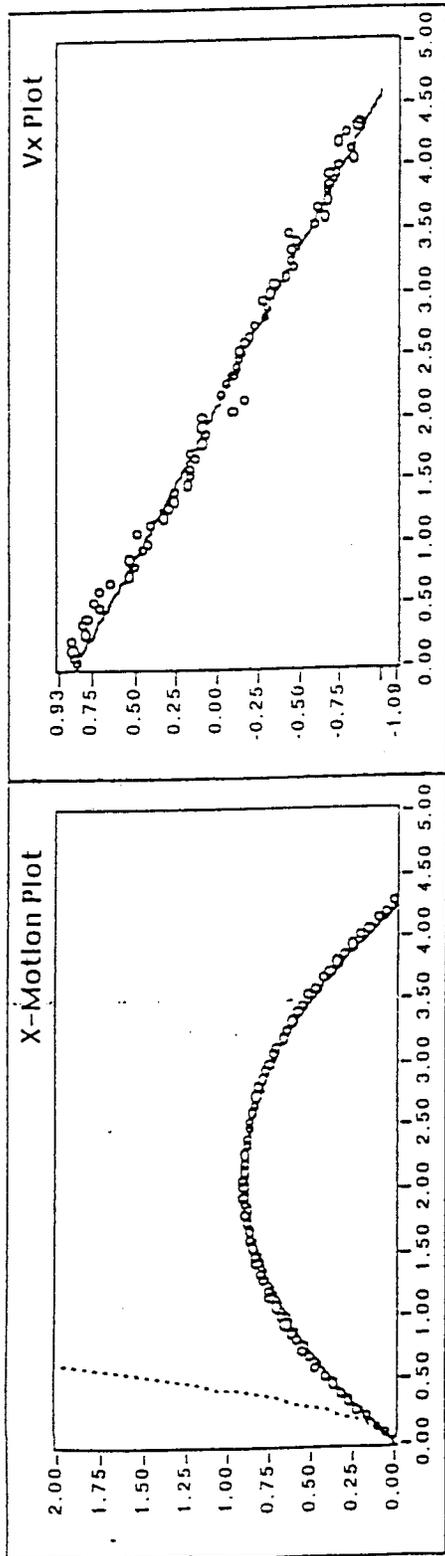up again.

Actual Graph of the Data

Pos

$$y = .841 t + .34 t^2$$

Vel
vs.
time
prdction

$V. 841 - .4t$

time   4 s

Fine
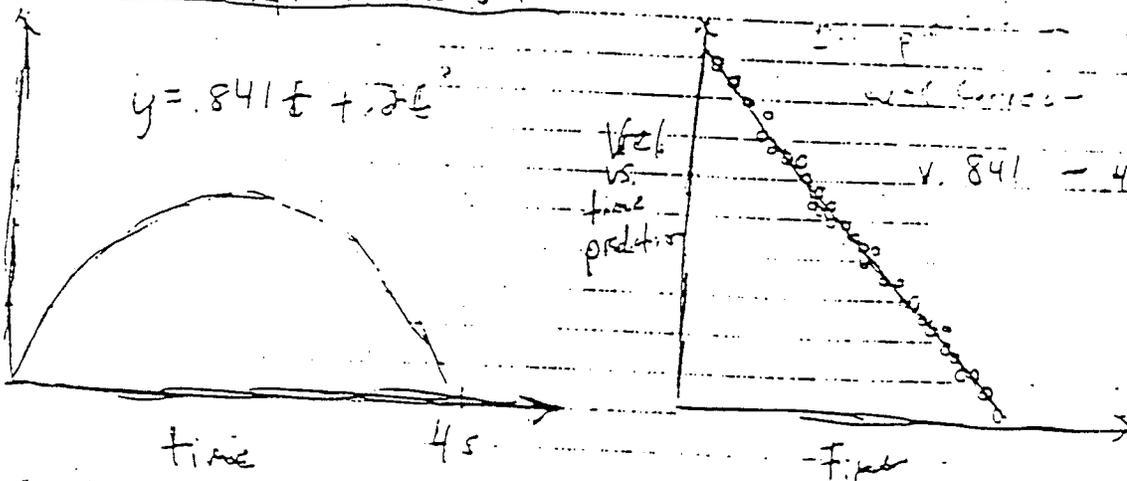
Analysis

$$f(t) = .84 t - .34 t^2$$

$$V = .84 - .4 t$$

The acceleration is constant. The Slope of the
V vs t. graph is constant.

Graph 1-3

X-Motion Plot

X Prediction
$x(t) = 0.00 + 0.45t + 4.50t^2$

X Fit
$x(t) = 0.00 + 0.04t + -0.20t^2$

Vx Plot

Vx Prediction
$Vx(t) = 0.84 + -0.40t$

Vx Fit
$Vx(t) = 0.84 + -0.40t$

Y-Motion Plot

Y Prediction
$y(t) = 0.00 + 0.00t$

Y Fit
$y(t) = 0.00 + 0.00t$

Vy Plot

Vy Prediction
$Vy(t) = 0.00 + 0.00t$

Vy Fit
$Vy(t) = 0.00 + 0.00t$

Grading Grid

	Satisfactory	Adequate	Poor
Addresses Content accurately and thoroughly			
Write to the appropriate Context or situation of assignment			
Addresses Audience appropriately			
Indicates clear Purpose for writing			
Organizes writing well			
Includes adequate Support (documentation and illustrations)			
Applies an appealing Design			
Uses clear Expression			

Comments:

Grade: _____

PROBLEM #3

FRICTIONAL FORCE

STATEMENT OF PROBLEM

The problem was to study the behavior of frictional force on a cart. Is the frictional force larger when the cart is gaining speed do to an applied force than when it coasts and slows down because of friction? We used the following equipment in our experiment: meter stick, stopwatch, video camera, computer with video analysis software, track, cart and weights. The experimental setup is illustrated in appendix one.

PREDICTION

In order to help answer the problem we needed to find the value of the frictional force when the force was applied and when there was no applied force. We calculated the frictional force in terms of the mass of Object A, the mass of the cart and the acceleration of the cart. These are known or measurable values.

For the situation where the cart was being pulled by Object A the equation was derived using "Newton's Second Law of Motion."

Sum of the forces on Object A:

$$\Sigma F_A = m_A a$$
$$m_A a = W_A - T$$
$$m_A a = m_A g - T$$

Sum of the forces on the cart:

$$\Sigma F_C = m_C a$$
$$m_C a = T - f_k$$

The force of tension in both of the above equations has the same magnitude. Thus, the two equations can be combined using substitution for T.

$$f_k = m_A g - a(m_A + m_C) \qquad (1)$$

This is the equation for the force of friction in the first situation.

For the second situation where no force is being applied and the cart was slowing down do to friction the following equation was derived using "Newton's Second Law of Notion."

$$\Sigma F_C = m_C a$$
$$f_k = m_C a \qquad (2)$$

From these equations our group decided that there should be no difference in the value of the frictional from situation one to situation two. Kinetic frictional does not act like static friction. When the

force applied on the object increases the kinetic friction does not increase with it, it stays fairly constant as long as the object is still kinetic.

DATA AND RESULTS

To minimize the time of the lab we did not make two different videos for the two situations. Instead we marked the spot on the track that corresponded to Object A hitting the ground. This way the analysis could be done in two parts on the same video. We also found the spot on the track that corresponded to when Object A was hanging from its designated height of 0.50 meters (50 cm). This way we had a repeatable experiment given the designated starting point. The meter stick was laid horizontally to measure the horizontal distance of the second situation. We also timed the entire motion of the cart to help us make our predictions.

We made four runs to determine a good time for the entire trip of the cart. The timed trip is 1.66 seconds with an uncertainty of $\pm$ 0.04 seconds. To find the value of the frictional force we needed to know the mass of Object A, the mass of the cart and the acceleration of the cart in both of the situations. For the mass of object we took a 50 g mass and added 50 g weight to it making a total of 100 g. We weighed the mass of the cart on the triple beam balance and obtained a mass of 509.2 g because the precision of the balance is unknown and we got a consistent result for the mass when we weighed it again we assigned no uncertainty to this measurement. To determine the acceleration of the cart we needed to analyze our video and obtain graphs of the carts motion. The graphs of the results from the video analysis are displayed in appendix two.

Using kinematics and the equations from our video analysis the acceleration in both situations can be found easily.

Position formula: $\qquad x = x_0 - v_0 t + 0.5 a t^2$

Results for situation one:

$$x(t) = 0 + 0.3t + 0.49t^2$$

From the model of the position formula we found the acceleration for situation one to be 0.98 m/s^2.

Results for situation two:

$$x(t) = 0.51 + 1.15t - 0.329t^2$$

Using the position formula as the model the acceleration for situation two is 0.658 m/s^2.

If we take equations 1 and 2 and plug all our measurements into their respective spots the values of the kinetic frictional force can be obtained for both situations. For situation one let m_A be the mass of Object A (in kilograms), let m_C be the mass of the cart (in kilograms), let a be the acceleration of the cart (in m/s^2) and let g be the acceleration due to gravity. When the measurements are plugged in, kinetic frictional force for situation one is computed to be 0.383 newtons. For situation two let m_C be the mass

of the cart and let a be the acceleration of the cart. In situation two the value for kinetic frictional force came out to be 0.335 newtons.

The calculated values for the kinetic frictional force are only within tenths of each other. The reason for this is probably due to the quality of our video and the fact that we put the two situations on just one video. If the video wasn't at the exact point where Object A hit the ground our acceleration results could have been slightly different. Other than that the results should speak for themselves.

CONCLUSION

According to our results the predictions that we made were correct. The frictional force is not greater when a force is applied and the cart speeds up than when no force is applied and the cart slows down due to gravity. Unlike static friction, kinetic friction does not change in magnitude depending on the force applied.

There were no major problems in the process of our experiment. The only improvements that can be made are in the analysis of our video. Uncertainty to exactly where the cart was relative to the falling Object A created confusion on where to stop analysis of situation one and where to begin situation two. This experiment involved a lot more calculations and was challenging. Overall we feel we did an excellent job in performing this lab.

EXPERIMENTAL SETUP

STRING

CART

$M_c = 509.2 g$

TRACK

$M_A = 100 g$

A

50 cm

PAD

TIME(S)	DEVIATION
1 1.61	0.05
2 1.71	0.05
3 1.64	0.02
4 1.69	0.03
AVE 1.66.5	0.04

1.66 sec

1.66 sec ± 0.04 sec

SITUATION ONE:

$a \downarrow$ A   T

$\sum F_A = W_A - T$

N

T   CART f_k

W_c

$\sum F_c = T - f_k$

SITUATION TWO:

A N_A

W_A

$\sum F_A = W_A - N_A = 0$

N_c

CART f_k

W_c

$\sum F_A = f_k$
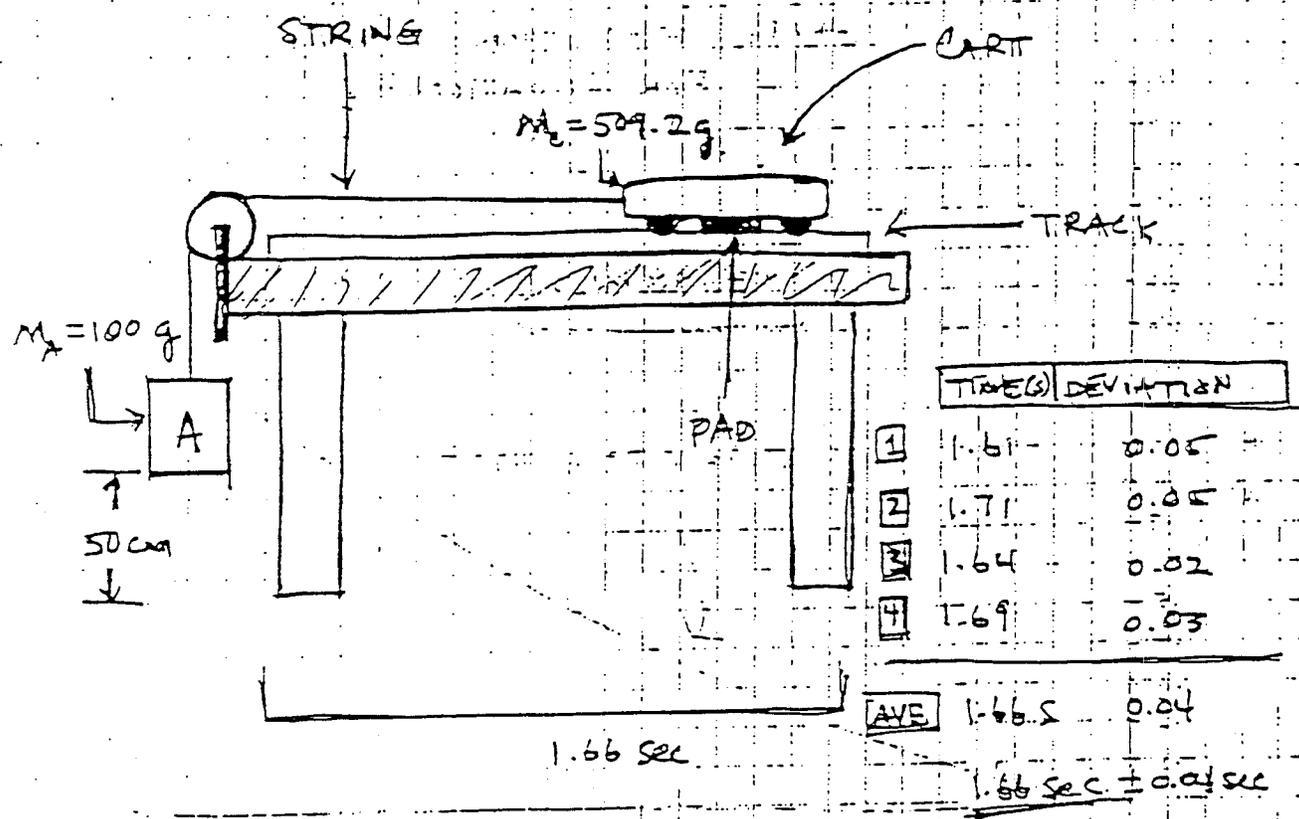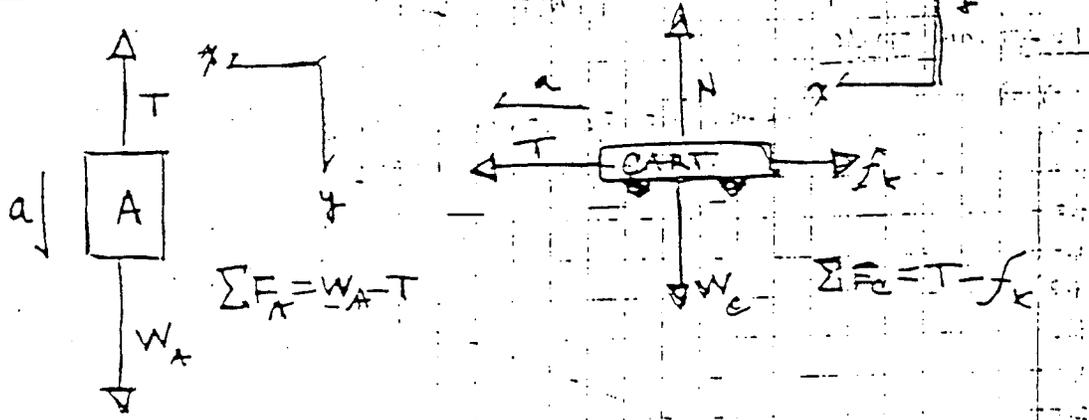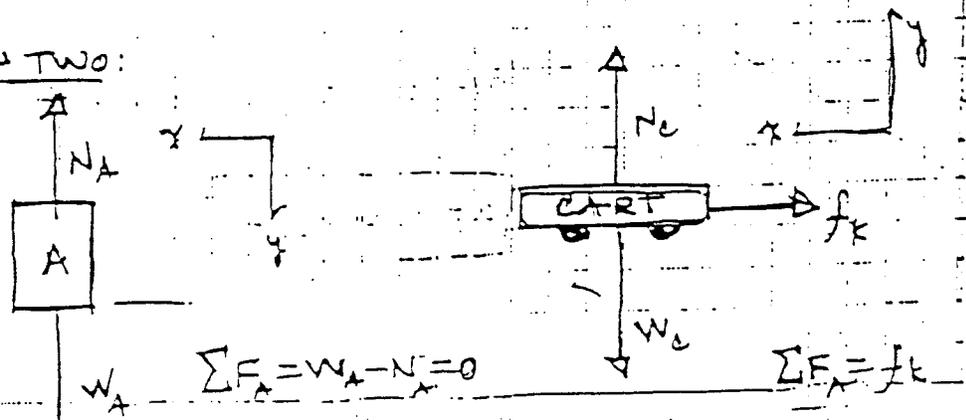
SITUATION ONE

GRAPH OF POSITION OF CART
FOR SITUATION #1

$x(t)$

$a = .98 \, m/s^2$

$x(t) = 0.3t + .49t^2$

TIME (sec)
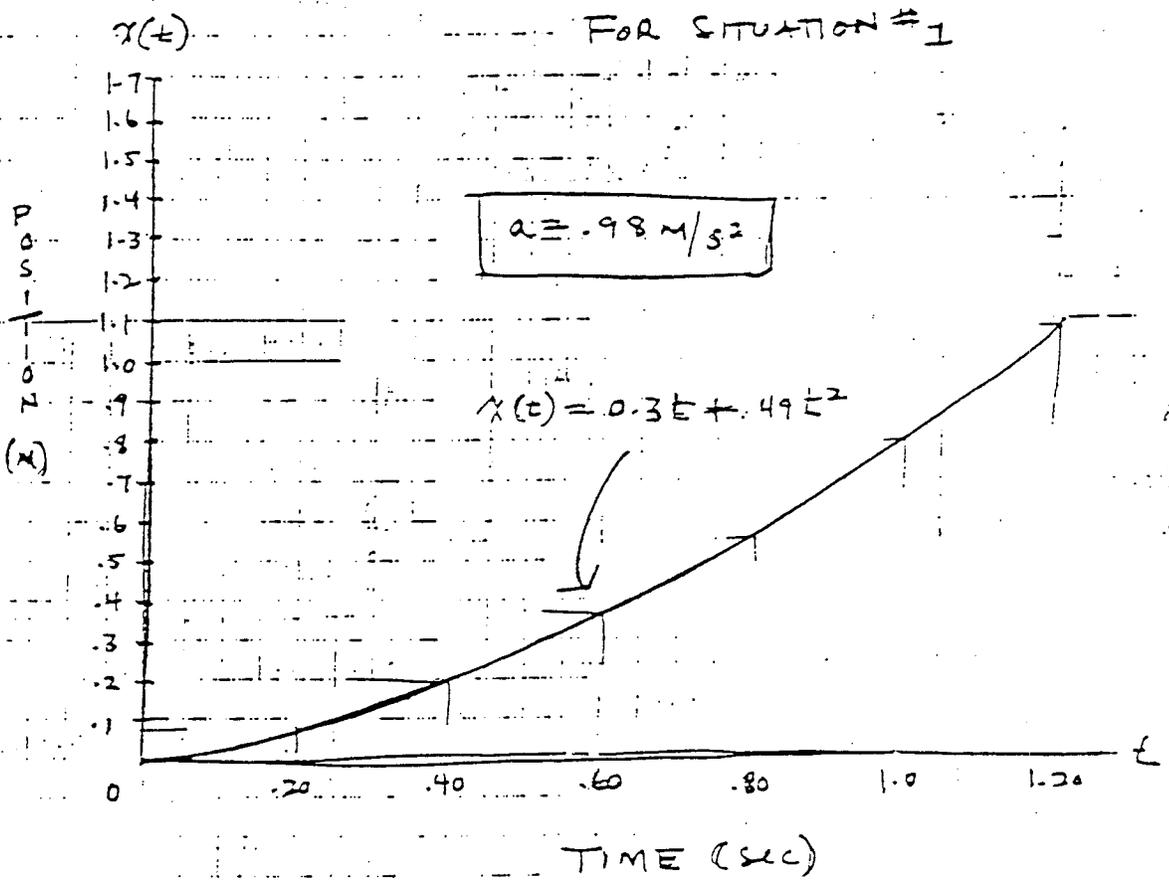
SITUATION TWO

GRAPH OF POSITION OF CART
FOR SITUATION #2

$x(t)$

$x(t) = 0.5 + 1.15t - 0.33t^2$

$a = 0.66 \, m/s^2$

TIME (sec)
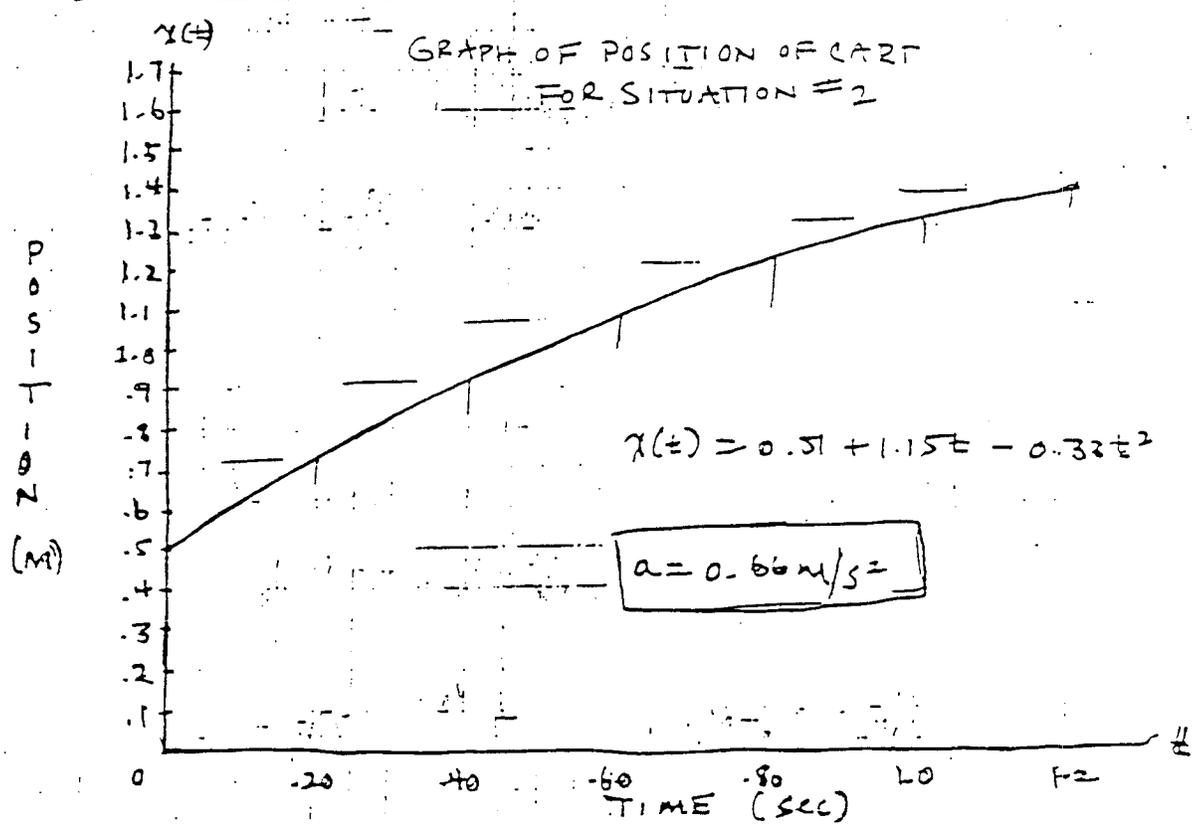
Three Sample Lab Reports Showing Progression from the Same Student

Grading Grid

	Satisfactory	Adequate	Poor
Addresses Content accurately and thoroughly			
Write to the appropriate Context or situation of assignment			
Addresses Audience appropriately			
Indicates clear Purpose for writing			
Organizes writing well			
Includes adequate Support (documentation and illustrations)			
Applies an appealing Design			
Uses clear Expression			

Comments:

Grade: _____

STATEMENT OF PROBLEM, We were asked to determine if the acceleration of an objet going up an incline would be the same, greater, or less than the acceleration of that same object going down the incline. We were also asked to construct a graph of acceleration versus time. This graph was supposed to include the whole motion of the object, taking in consideration the acceleration of the object at its highest point. Our group took a metal cart, stopwatch, and a meter stick. We rolled the cart up the incline and then let it come down the same incline as to simulate the roller coaster track. We recorded this with lab view and made sure that the cart never left the picture of the movie so we could get accurate data.

PREDICTION, I believe that our whole group came to the conclusion that the cart would have a greater acceleration going down the track than it would going up that same track. We talked it over with ourselves and still had that same idea. Our group also compared our graphs (witch were all a little different) and thought that the acceleration would be greater going down than going up. Our group all agreed that the acceleration would be zero at its highest point. Our group decided that V-V0/T would be a good way to measure the acceleration and compare each side of the ramp. After some consideration and a little help from you we decided to use the equation Xo + VoT + ½(At squared. Then in the LabView, we chose the equation that represented this form A +Bt C (t) squared. We needed these equations to represent X as a position of time.

DATA AND RESULTS, We took our cart, gave it a push up the inclined track, and recorded its motion going up the track and coming back down on one continuos recording. We were careful

to make sure that the cart did not go off the screen. While we recorded this on Lab View we measured the time that it took. As you can see from looking at our graph of the actual position Vs time we somehow did not have an accurate time and we understated our acceleration. My original prediction graph does not look like my actual graph that the lab view produced. I now realize that the graph of a object going up and down the same incline is a upside down parabola because the acceleration is always negative. Furthermore the acceleration of the object is always constant; witch is the reason the equation representing our cart is the form of a parabola.

UNCERTAINTY, I would say that most of the uncertainty in this experiment would be from the error in the time as well as the exactness of the measurement of length. Also, there may be some uncertainty in the recording of the motion if a few frames are skipped or could not record all the information on the screen.

CONCLUSIONS, The conclusion that I came to, is that the cart has the same acceleration going either way up or down the track because they are both on the same angle. My personal prediction was that the acceleration would be greater going down the track. Maybe this would be so if the angle going down were steeper? In addition, my original equation to represent the graph I drew was wrong. The right equation is $Xo + Vo + \frac{1}{2}(a)(t)squared$. The equation I had was $A = V-Vo/t$. In addition, we underestimated our acceleration as you can see in the graph from LabView witch is attached. The reason that this is wrong is that I thought the acceleration would be different. The reason why we underestimated our acceleration is because we had inaccurate time recorded. This is where the level of uncertainty comes into play. I also observed that the acceleration is zero at the time where it switches from going up the track to down the track. This is what we predicted to happen. Our group did not have time to make an acceleration Vs time graph. However, the graph is a constant slope from left to right because the acceleration is always negative and this is why the graph is an upside down parabola. This lab has helped me

understand the idea of acceleration on an incline and decline. I also learned that the acceleration is always negative (in this respect) witch is a little hard to comprehend at first but it was nice to observe this in lab.

ALTERNATIVE ANALYSIS, one way to get the acceleration of the object from our graph of x as a position of time is to take the derivative of the equation as follows.

$X1 = Xo + Vot + (a/2) t$ squared witch is $X = Vo + 2(a/2)t$

This gives you the area under the graph or in these terms the acceleration. This comes out to be roughly 30 cm/s. This is a good alternative analysis because this corresponds with the graph.

Start
time

end
time
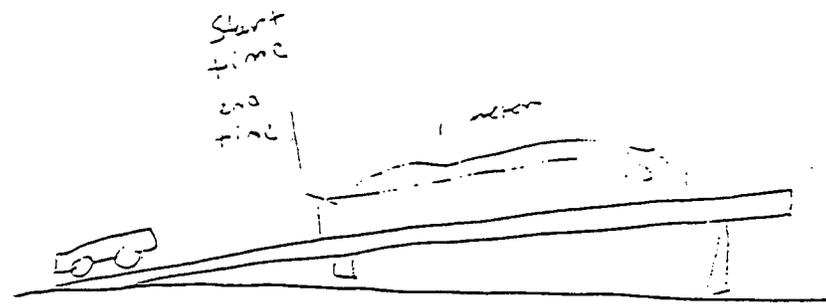
meter

Equipment : metal cart, Ramp on an incline, meter
stick, video camera, computer, stopwatch

Purpose: Determine if the acceleration is faster, slower
or the same each way down the ramp

method: One person pushes the cart on a ramp,
records the motion on the computer, cart.
The third person records the time

Explanation: The acceleration is constant.

My Initial graph that I predicted
before coming to CLASS LOOKS Like The
Shown.

graph 1)

a

t
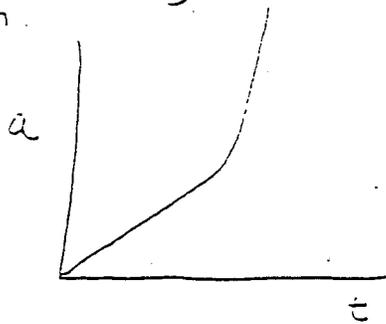
Then we talked it over with each o.
In Class and came to the conclusion th
the cart will accelerate faster going down —

graph 2)

a

t
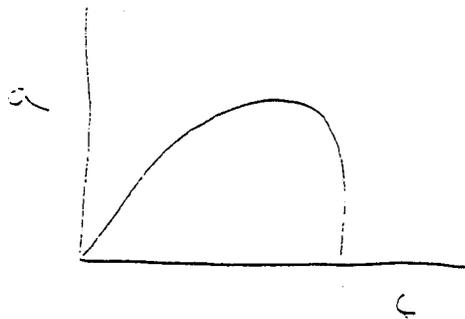
This graph is More Like the True graph
we were on the right track.

Then the next prediction for the graph.
mode was on the computer. That graph
is on the next page.
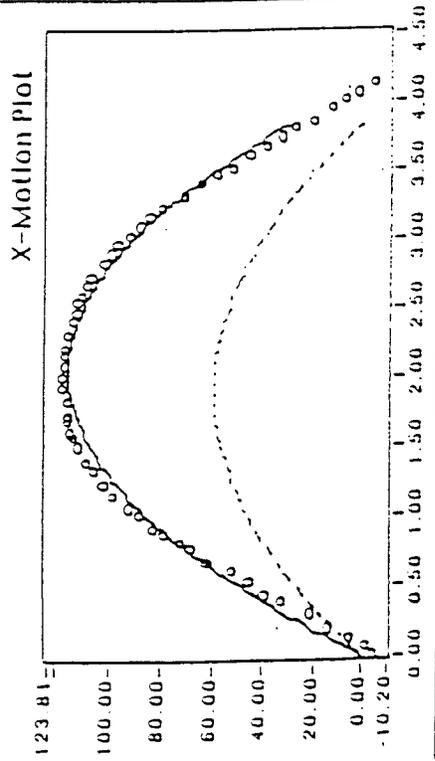
Movie Name: "Movie 2"

Data Taken: Wednesday, September 23, 1998, 6:18 PM

Your Graph Title Goes Here!

X-Motion Plot

X Prediction

$x(t) = 0.00 + 62.00t + -16.20t^2$

X Fit

$x(t) = 0.00 + 112.00t + -27.20t^2$

Vx Plot

Vx Prediction

$Vx(t) = 0.00 + 0.00t$

Vx Fit

$Vx(t) = 0.00 + 0.00t$

Y-Motion Plot

Y Prediction

$y(t) = 0.00 + 0.00t$

Y Fit

$y(t) = 0.00 + 0.00t$

Vy Plot
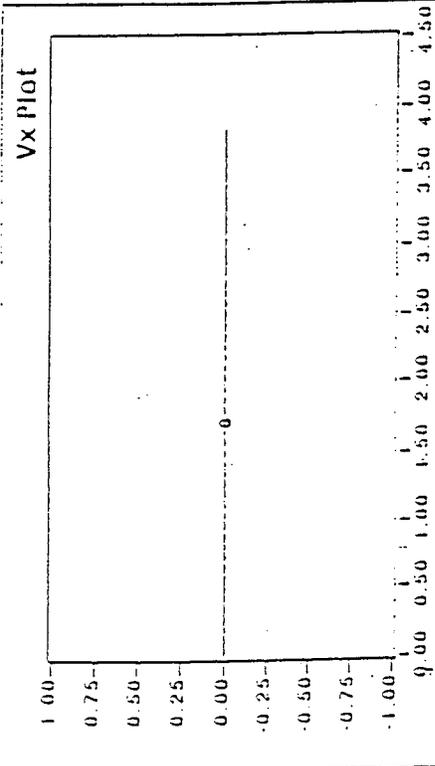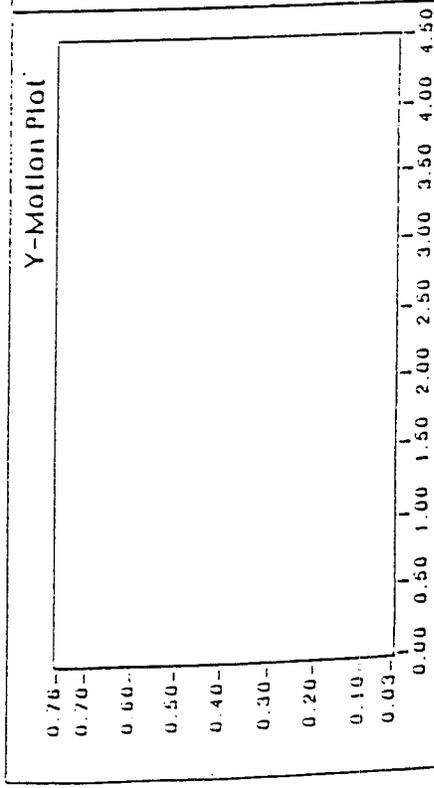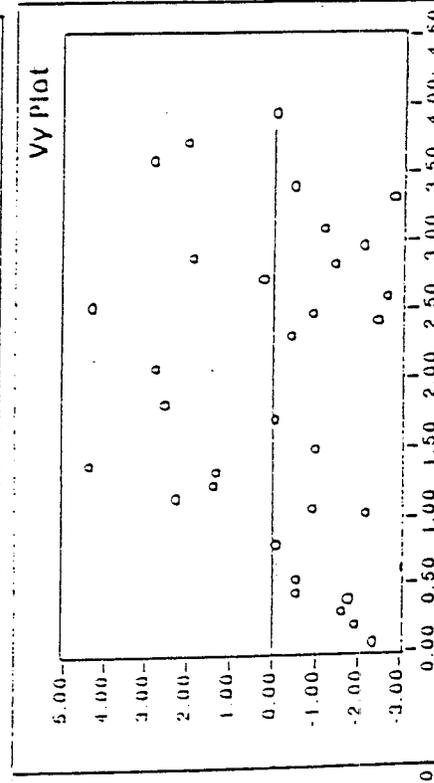
Vy Prediction

$Vy(t) = 0.00 + 0.00t$

Vy Fit

$Vy(t) = 0.00 + 0.00t$

Statement of Problem

We were asked to determine if the frictional force on an object is larger when the object speeds up or when the object is coasting. Our setup was a cart on a track, which was attached to a mass that was hanging over the side of the table by a string. We were given a cart that had a weight of 505 grams and we could change the weight of the hanging mass. We were asked to determine the acceleration of the cart and with that information we could figure out the frictional force excerpted on the cart. While we recorded this motion of the cart with Lab View we also timed the cart to see how long it took to come to a rest from when we drooped the mass which struck the floor.

PREDICTION

Our group Predicted that the frictional force of an object decreases with an increase in acceleration. This indicated to us that because the hanging block and cart are attached the acceleration would be greater if the mass of the hanging block increases. So, we predicted with an increase in the mass of the hanging block the friction will decrease. Our group also came to the prediction that the cart will have a negative acceleration after the hanging mass hits the floor. Because the cart is negatively accelerating the cart is slowing down very fast and the frictional force is greater after the hanging mass hits the floor. My personal prediction was the same except I thought that the acceleration would be zero after the hanging mass hits the floor.

DATA AND RESULTS

. Our group took a cart which was attached to a hanging mass by a string we dropped the mass and the cart began to accelerate positively until the mass hit the floor. Once the mass hit the floor the cart began to accelerate negatively which then the cart comes to a stop. The entire time of the motion is 2.5 seconds and the cart traveled about 167 centimeters. We recorded this motion of the cart with Lab View and then we analyzed our data. We used the equation $A + BT + CT^2$ to represent our data that would produce the graphs using the Lab View software. Our graph of the position Vs time graph is a positively sloping line starting from the origin and moving to the upper right part of the page. This graph resembles the first quadrant of a $y=x^2$ graph. This indicates that the acceleration of the cart is positive before the hanging mass hits the ground. The position Vs time graph for the cart after the hanging mass hits the ground resembles half of an upside down parabola, which indicates the acceleration, is negative after the hanging mass hits the ground. Both of these graphs are attached to this report so you can view them. Our group did not have enough time to finish the lab; therefore, we did not get an equation for the graph after the hanging mass hits the floor.

Instead of getting the acceleration from Lab View we had to figure it out on our own using the derivative of the position Vs time graph to get the velocity and the using the change in velocity to get the acceleration. I concluded that the acceleration was -1.0 m/s^2. Now that I have the acceleration I can figure out the frictional force on the cart before and after the hanging mass hits the floor. I used $f = Mag - (Mg + Ma)(a)$ to get the frictional force of the cart before the hanging mass hits the floor. I also used $-f = Ma$ to get the frictional force after the hanging mass hits the floor, which is much simpler

because there is no tension in the rope. The cart weighed 505 grams and the hanging mass was 100 grams and the acceleration was −1.0 m/s^2. With this information substituted into the equations above we get the frictional force of the cart is -.53 after the hanging mass hits the ground and 1.5 before it hits the ground.

UNCERTAINTY

There is always uncertainty in every experiment and in this experiment, I would have to say there is three main factors. One main uncertainty is the exactness of the measurement, we measured 167 cm and that could be of by + or − 1 cm. Also, there has to be uncertainty in the recording of the carts motion. If the recording is choppy than there will only be a few data points, which in return throws off our graph. Last, there is the measurement of time we estimated 2.5 seconds for the motion of the cart. This estimate is good up to + or - .1 seconds. All of these uncertainties defiantly make a difference in the outcome. Also, there is a special uncertainty for our group because we had to calculate the acceleration by the slope of the graph where we could have got the acceleration from the Lab View results.

CONCLUSION

The conclusion that I have come to is that the frictional force of an object increases when the object is accelerating and that the frictional force is less for an object that is simply coasting. This conclusion is different than my personal prediction and our group prediction. Our group predicted exactly opposite of what is concluded here. This makes me wonder if my results are wrong or if this conclusion is valid. The only way I

can see that this is true is because the more force in one direction than there has to be an

opposing force in the opposite direction. Therefore, the more acceleration the more

frictional force there is in the opposite direction. I am curious to know if this conclusion
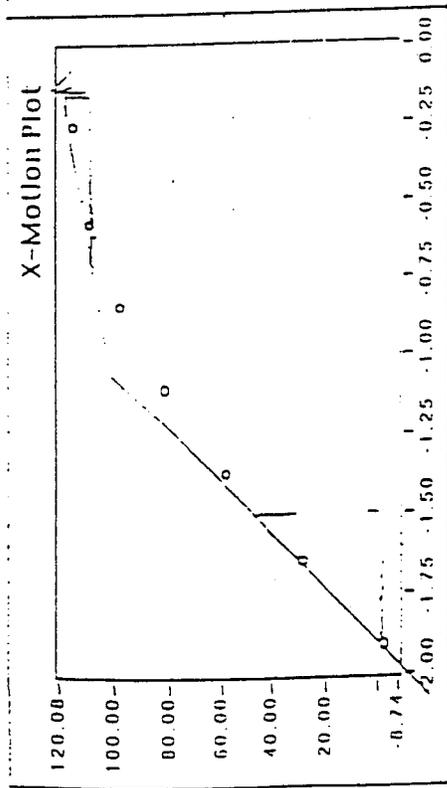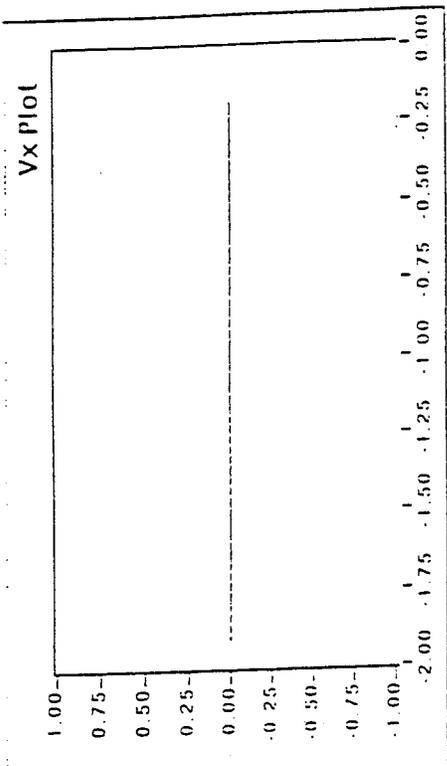
is correct.

$$V = \frac{\Delta x}{\Delta t}$$

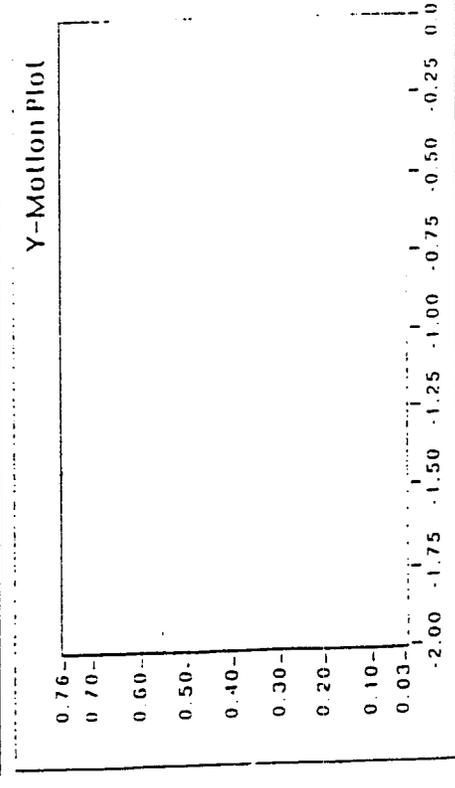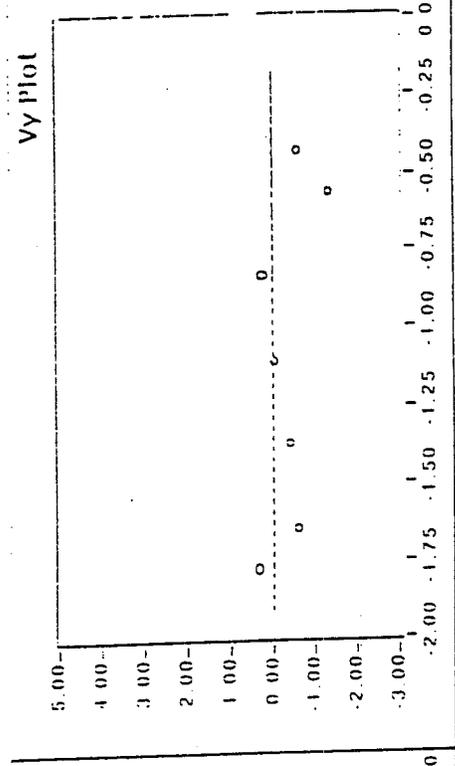$$c = \frac{\Delta c}{\Delta t}$$

Movie Name: "lab 3.3"

Data Taken: Wednesday, October 14, 1998, 5:30 PM

Your Graph Title Goes Here!

X-Motion Plot

Vx Plot

XPrediction
|x(t) = 0.00 + 120.00t + -35.00t^2

XFit
|x(t) = 0.00 + 120.00t + -35.00t^2

VxPrediction
|Vx(t) = 0.00 + 0.00t

VxFit
|Vx(t) = 0.00 + 0.00t

Y-Motion Plot

Vy Plot

YPrediction
|y(t) = 0.00 + 0.00t

YFit
y(t) = 0.00 + 0.00t

VyPrediction
|Vy(t) = 0.00 + 0.001

VyFit
Vy(t) = 0.00 + 0.001

Your Graph Title Goes Here!

Vx Plot

X-Motion Plot

Vy Plot

Y-Motion Plot

XPrediction
$x(t) = 0.00 + 0.00t + 490.00t^2$

XFit
$x(t) = -15.00 + 0.00t + 25.00t^2$
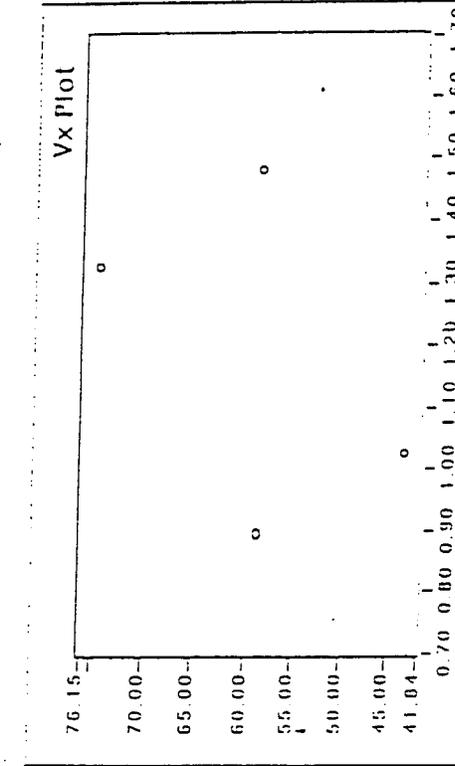
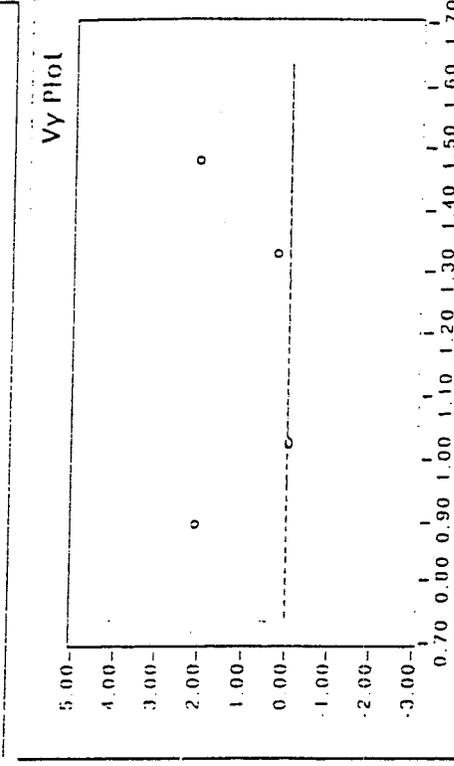VxPrediction
$Vx(t) = 0.00 + 0.00t$

VxFit
$Vx(t) = 0.00 + 0.00t$
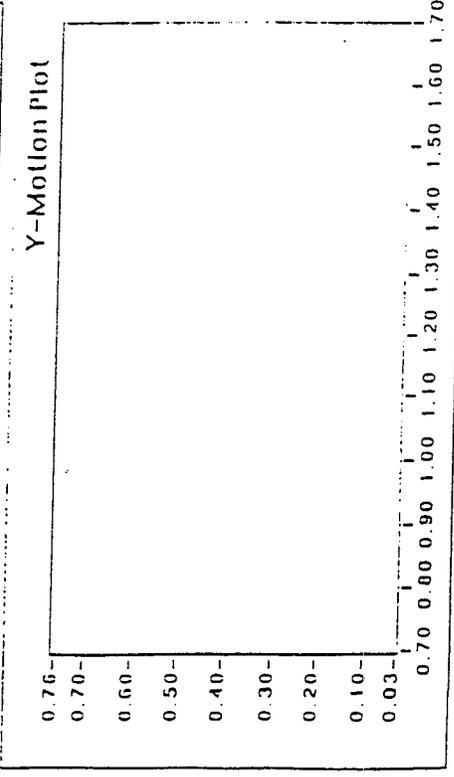
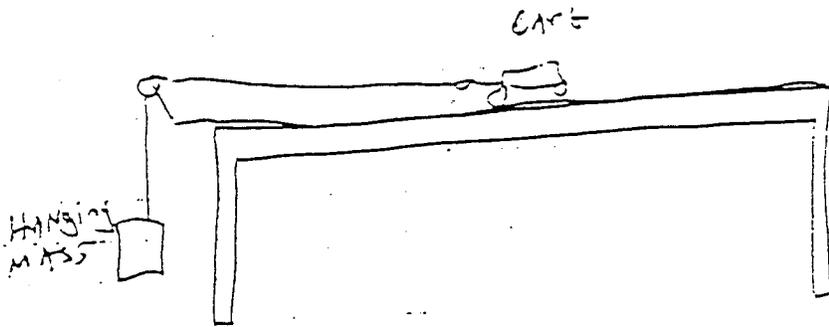YPrediction
$y(t) = 0.00 + 0.00t$

YFit
$y(t) = 0.00 + 0.00t$

VyPrediction
$Vy(t) = 0.00 + 0.00t$

VyFit
$Vy(t) = 0.00 + 0.00t$

LAB III
prob 3

cart

HANging
MASS

Equipment. Video camera, Stopwatch, metal cart,
        Hanging mass

Purpose, Determine if the frictional Force is
        more when an object speeds up or when
        it is coasting

method, We Dropped the hanging mass and recorded
        the carts motion. This gives us the
        acceleration and then we can determine the
        frictional force.

My prediction, Frictional Force will be less
            when an object accelerates

$$f = mag - (ma + ms)a$$

$$f = ma$$
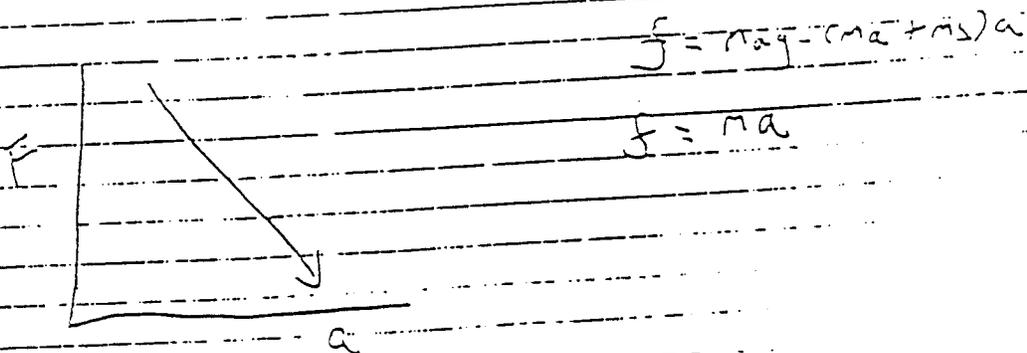
Statement of Problem

We were asked to find the linear velocity of an object rotating at a constant angular speed. Then we were asked to relate that to the distance from the axis of rotation and determine how that changes with respect to the axis. Our group took a stopwatch, a meter stick, and video analysis equipment and conducted our experiment. We gave the beam a push, which was free to rotate around its center, and recorded its motion with Lab View. While our group recorded its motion we also timed the revolution it underwent as well.

Prediction

There is one main prediction that needs to be discussed and that will be done now. We were asked to determine how the linear velocity of a point changes when the point is further from the axis of rotation at a constant angular velocity. Our group predicted that the linear velocity is predicted using this equation,

$$V=RW$$

Where $W = $ (Rev) (2pie)/ (time) and R = the radius

There is a specific way to obtain the equation V=RW and that will be discussed now. First, you need to separate the point on the beam as an x and y component. The x component is RcosWT, the y component is RsinWT, when you have these components you can take the derivative to obtain the x and y components of the velocity. Once you have these components of the velocity you can square both of them and add them

together under the radical to give you the equation V=RW. Also let it be known that if you took the derivative of the velocity components then you get the acceleration components. Then using the same procedure for the linear velocity you can get the acceleration, A=RW^2. IF there is any part of this reasoning that is unclear you can see the documents from my lab book attached to the end of this report.

Data and Results

Our group took a metal beam that rotated around its central axis and gave it a initial push to set itself into motion. While the beam was in motion we timed how long it took to make five revolutions. When we timed our beam, we determined it made five revolutions around its central axis in 7.85 seconds. With this information we could determine the angular velocity W. The way we determined this was done two ways, first we quickly calculated the value for W using

(rev)(2pie)/ (time) this gave us W equaling 4.04 rad/s.

Second, we calculated W using Lab View and the equation.

A+ Bsin (C+Dt) where A is the shift in the origin of the circle. B is the radius, C is theda, and D is the angular velocity W.

Once we knew what the angular velocity was, we could use W in the equation V= RW and determine our original question asked. How does the linear velocity of a point on the

beam that is rotating change with respect to its radius with a constant angular velocity. To show this relationship I've included a table for easy viewing.

Linear Velocity	Radius	Angular Velocity
.202 m/s	.05m	4.04rad/s
.404m/s	.1m	4.04rad/s
.606m/s	.15m	4.04rad/s

It is clearly shown that with a constant angular velocity, the linear velocity increases when the radius of that point increases. If needed, you can also see the attached lab pages at the end of this report for further description.

Uncertainty

With every experiment, there is always an uncertainty that can take place and this will be discussed now. The main uncertainty that I think affected this experiment is the timing of the rotation of the beam. Mainly, because it is difficult to make an exact time measurement of the moment when the beam crosses the reference line for the fifth time. This is what we did to calculate W, and if your time is off then the value for W is slightly wrong which in return creates an error in the linear velocity.

Conclusion

I will now recap my results and conclude what was observed for this lab. First we took a metal beam that rotated around its axis and recorded its motion with Lab View.

While the beam was rotating we timed how long it took to make five revolutions. We did this to determine the angular velocity W. We also determined this using an alternate method with Lab View. Once we knew the angular velocity W we plugged that value into the equation V=RW where R is the radius. Our group and I concluded that the linear velocity V increases when the radius increases of a point on the rotating beam with a constant angular velocity. We can also say that the linear acceleration increases as the radius increases because A= RW^2. There is also a graph attached to the end of this report showing these relationships for easy understanding. I think this lab was an overall good way for me to see these relationships physically.
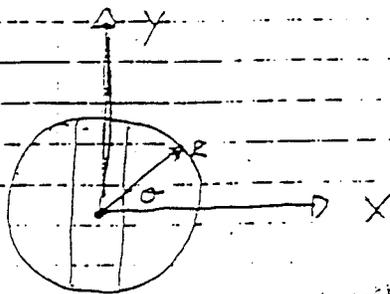
Rotation   TRANSLATIONAL

θ Angular position x

$\dfrac{d\theta}{dt}$ Angular velocity w $\dfrac{dx}{dt} = v$

position vector

X component $r\cos\theta = r\cos wt$

$\left. \begin{array}{c} \\ \\ \end{array} \right\}$ x, y components position

Y component $r\sin\theta = r\sin wt$

angular displacement

$\theta = wt$

X component $-rw\sin wt$ derivative of position
velocity   just velocity.

Y component $= rw\cos wt$
velocity

finding $\sqrt{(-rw\sin wt)^2 + (rw\cos wt)^2}$
speed

$= \sqrt{r^2w^2(\cos^2 wt + \sin^2 wt)}$

$= \sqrt{r^2w^2}$

speed $= rw$

$V = rw$

When A=0 $\bar{W} = \dfrac{rev \times 2\pi}{time}$

when we had $\dfrac{5 \; rev \times 2\pi}{7.85 \; seconds}$ = 4.04 RAD/s
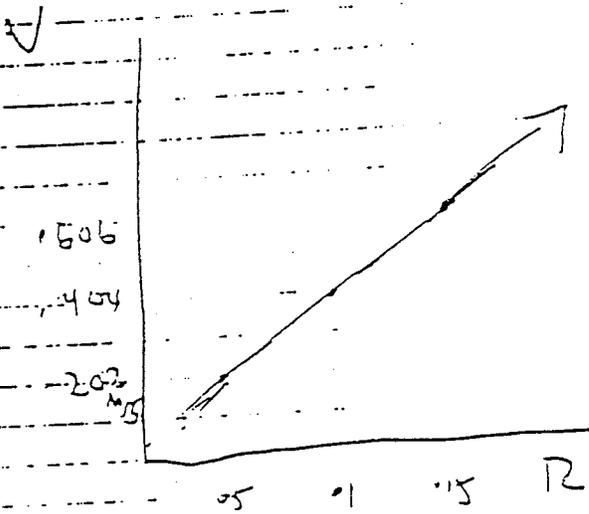
Linear relationship

Top view
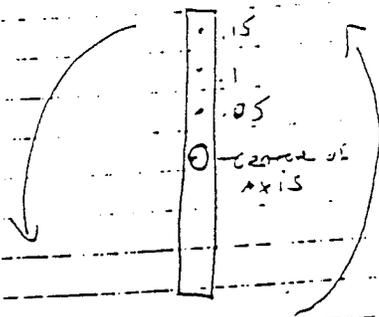
L velocity = r·w

(.05)(4.04) = .202 m/s

(.10)(4.04) = .404 m/s

(.15)(4.04) = .606 m/s

r   w   LV

Supplies
1) meter stick
2) Stop watch
3) top view