Evaluating Sample Laboratory Report from Laboratory Manual

We've redefined the quality of writing based on the general writing factors, and how these factors relate to the rubric used to grade physics laboratory reports. The laboratory manual for the students includes, at the beginning, information about what is to be expected of their laboratory reports. There is also a sample report that further model what is expected. In this activity you will evaluate this sample laboratory report for its quality based on the grading rubric, all the while keeping in mind the qualities as described and defined by the general writing factors.

Individual Tasks:

1. *Individually* read through the sample laboratory report (the double-barred sections are descriptions and explanations on what is expected in each section of the report).

2. *Individually* evaluate the sample laboratory report – mark down any and all comments about the quality of the paper, both good and bad.

Whole Group Discussion:

Follow along with the overhead presentation as it points out certain segments that related to the writing factors. Participate in discussing various aspects of the quality of the sample laboratory report.

Time: 45 minutes.

SAMPLE COVER SHEET

PHYSICS ____ LABORATORY REPORT
LABORATORY I

Name and ID#: ______________________________________

Date performed: ___________ Day/Time section meets: ___________

Lab Partners' Names: __________________________________

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Problem # and Title: __________________________________

Lab Instructor Initials: _________

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 (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)	

* 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.

Appendix E: Sample Laboratory Report

There is no set length for a problem report but experience shows the good reports are typically 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

> 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.

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 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.

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

> 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**. That is all right. 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:

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

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

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

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

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

Faced with a choice in sign, our group chose the solution with the positive sign, deciding that a possible negative value for elapsed time does not correspond with our physical situation. From equation (2), we deduced that if v_o 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.

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:

$$x - x_o = v_o\Delta t + 0.5a\Delta t^2$$

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 that 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.

To ensure the ball's velocity was 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.

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.

During the time the ball was in the air, the horizontal velocity was 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).

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 came from deciding the time for the first data point when the ball is in the air and the last data point before it hit 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 matched 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.

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 the apparent independence of the 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

$$y - y_o = v_o\Delta t + 0.5a\Delta t^2$$

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

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

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

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

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.

The correct equation for the horizontal motion is

$$x - x_o = v_o \Delta t$$

The horizontal acceleration is always zero, but the horizontal distance that the ball covers before striking the ground does depend on initial velocity.

Alternative Analysis

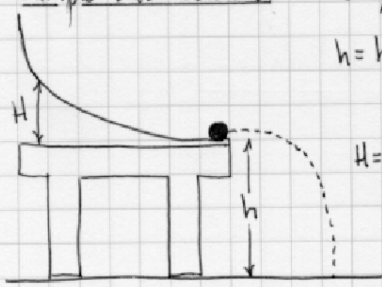
Since $y_o - y = h$ and $a = -g$ we can check to see if our measured time of flight gives us the height of the table. From our graph, we see that the data overlaps in a region of about 0.41 sec. With this as our time of flight, the height of the table is calculated to be 82.3 cm. Using a meter stick, 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.

APPENDIX E: SAMPLE LAB REPORT

The following are pages photocopied from my lab journal:

Sample Lab Journal July 13th, 1998



h = height of table

H = ball's 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.

Exploration: Larger H results in larger horizontal $\vec{v}$.

E - 6

Table 1

Fast Ball, $H \simeq 35cm$, $v_o = 2.51\ m/s$

Trial	Frames with ball in air	Deviation from ave.
1	13	0.25
2	13	0.25
3	12	0.75
4	13	0.25
Average	12.75	0.4

Time of flight:
$12.75\text{ frames} \times \frac{1}{30}\frac{\text{sec}}{\text{frame}} =$

0.42 sec

Uncertainty:
$\pm 0.4\text{ frames} \times \frac{1}{30}\frac{\text{sec}}{\text{frame}} =$

± 0.014 sec

Slow Ball, $H \simeq 10cm$, $v_o = 1.3\ m/s$

1	12	0.5
2	13	0.5
3	13	0.5
4	12	0.5
Average	12.5	0.5

Time of flight:
$12.5\text{ frames} \times \frac{1}{30}\frac{\text{sec}}{\text{frame}} =$

0.41 sec

Uncertainty
$\pm 0.5 \times \frac{1}{30}\frac{\text{sec}}{\text{frame}} =$

± 0.018 sec

Table 2

Medium Ball, $H \simeq 20$, $v_o = 1.8\ m/s$

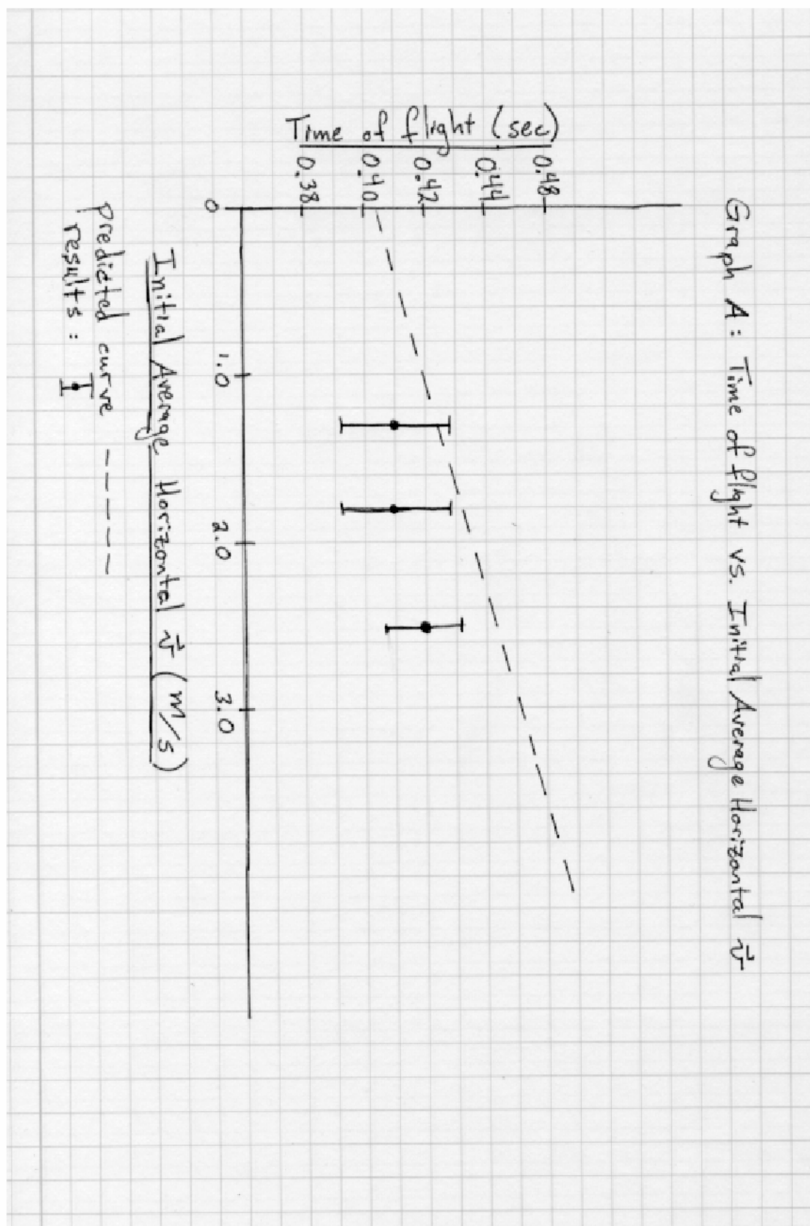
Trial	# frames	Deviation
1	12	0.5
2	12	0.5
3	13	0.5
4	13	0.5
Average	12.5	0.5

Time of flight:
$12.5\text{ frames} \times \frac{1}{30}\frac{\text{sec}}{\text{frames}} =$

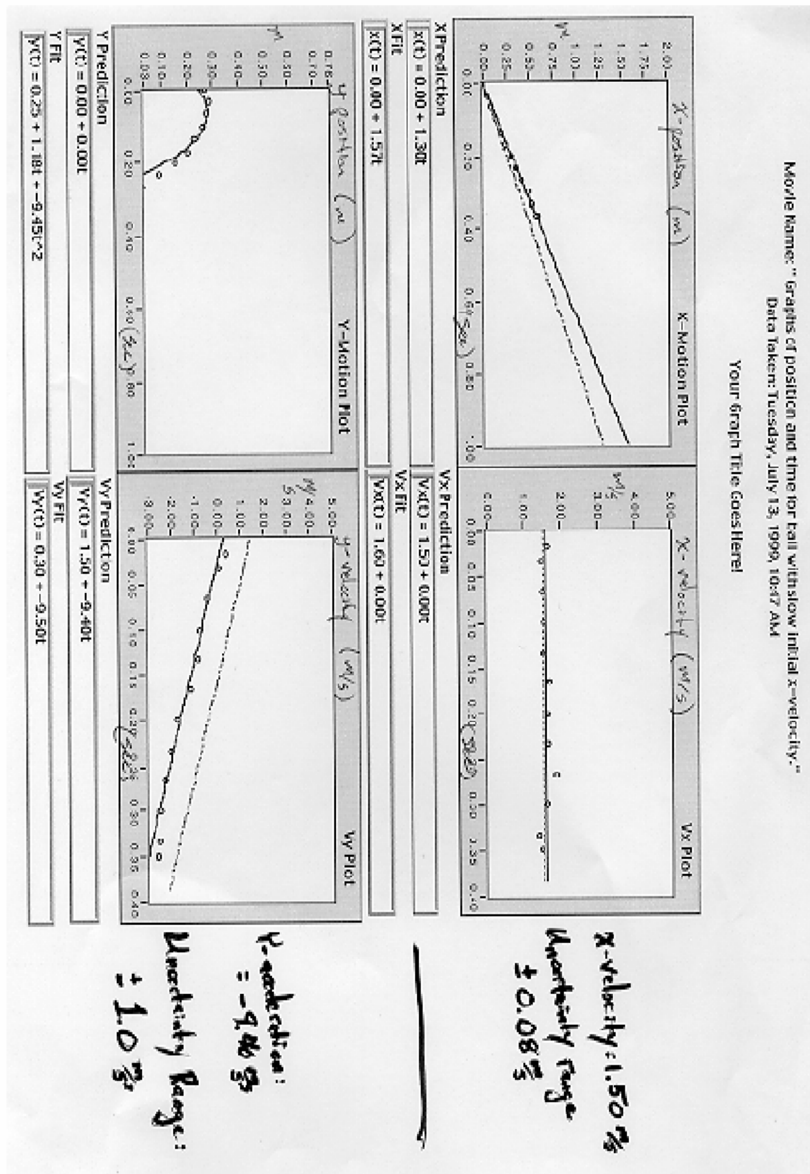
0.41 sec

Uncertainty: $\pm 0.5 \times \frac{1}{30}\frac{\text{sec}}{\text{frame}} =$

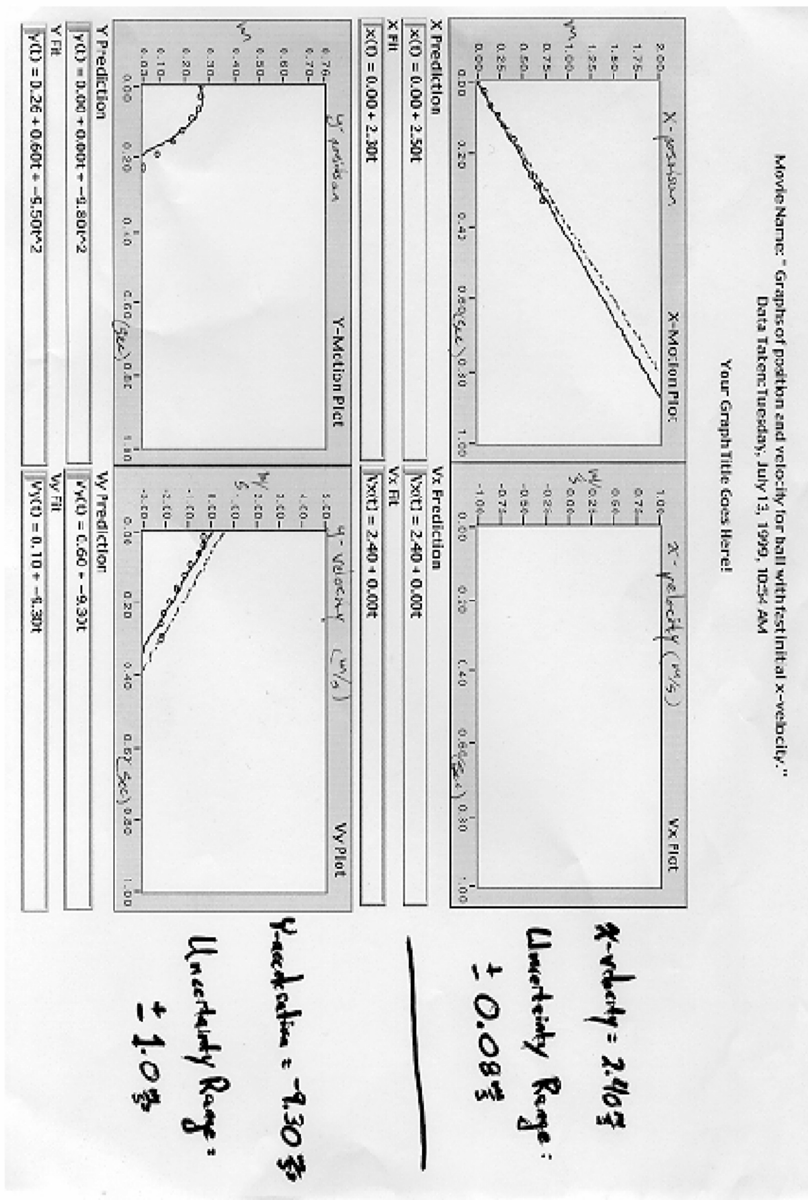
±0.018 sec


Graph A: Time of flight vs. Initial Average Horizontal $\vec{v}$
Time of flight (sec)
0.38
0.40
0.42
0.44
0.48
0
1.0
2.0
3.0
Initial Average Horizontal $\vec{v}$ (m/s)
Predicted curve
results:

APPENDIX E: SAMPLE LAB REPORT



APPENDIX E: SAMPLE LAB REPORT



How to Grade a Student Laboratory Report

We've redefined the quality of writing based on the general writing factors, and how these factors relate to the rubric used to grade physics laboratory reports. We've also evaluated the sample laboratory report from the laboratory manual. Now we will go through an example of how to grade a student laboratory report.

Individual Tasks:

3. *Individually* read through the example student laboratory report.

4. Follow closely as we go over the grading of the example student laboratory report.

5. Mark down any and all comments made during the presentation on the example student laboratory report.

Time: 30 minutes

Note: This activity is to show you how to grade student laboratory reports, so follow along closely.

SAMPLE COVER SHEET

PHYSICS ____ LABORATORY REPORT
LABORATORY I

Name and ID#: ____

Date performed: ____________ Day/Time section meets: ___________

Lab Partners' Names: ____________________________________

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Problem # and Title: ____________________________________

Lab Instructor Initials: _________

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 (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)	

* An "R" in the points column means to rewrite that section only and return it to your lab instructor within two days of the return of the report to you.

88\

Lab report of lab 2 problem #1

312

MASS AND THE ACCELERATION OF A FALLING BALL

The purpose of this lab is to determine if the acceleration of an object depend on its mass. We use a baseball and a plastic orange ball (1/3 mass of baseball). These two objects have different mass but almost the same size. They are use to be dropped so we can calculate the acceleration for each of them. A camcorder is used to record the different intervals of the balls. From the information received, we can determine the change of distance and the change of time of each interval. The software program "Lab View" guides us in our analysis of the change of velocity of each interval as it goes down the screen.

Prediction

It is understand that any object regardless of its mass will be pull towards the earth at a constant acceleration of 9.8 m/s2. This is only true in a vacuum room. We predicted that the acceleration of an object would have a factor from its mass. The free-fall acceleration of an object will increase as the mass of the object increase. This change of acceleration is depending on the air acting on the ball. If the object has more mass then the object is able to reduce the pressure acting upon it but if the object is light, air will be a factor and it will not accelerate as fast.

Data and Results

We use a meter stick to ensure a vertical path for the ball to follow. The ball is being dropped from the top of the meter stick to the floor (bottom). We use the video camera to record a movie of the free-fall. The movie capture individual intervals of the fall, each time frame if capture every 1/30 sec. We then use the intervals to determine the change of distance over change of time.

The starting time for the baseball was 0.80sec and ended at 1.02 sec. The total time is 0.22 seconds to travel 100 cm. The average velocity is 454 cm/sec. The weight of this ball (baseball) is 140 grams and 7cm in diameter.

The starting time for the orange ball is at 0.6 seconds and ends at 0.9 seconds. The total time is 0.3 seconds over a distance of 100 cm. The average velocity of the free-fall is 333.33 m/s. The weight of the ball is 47.7 grams and a diameter of 6.5 cm.

From the data above, we can see that the velocity of the baseball is higher then the Orange ball.

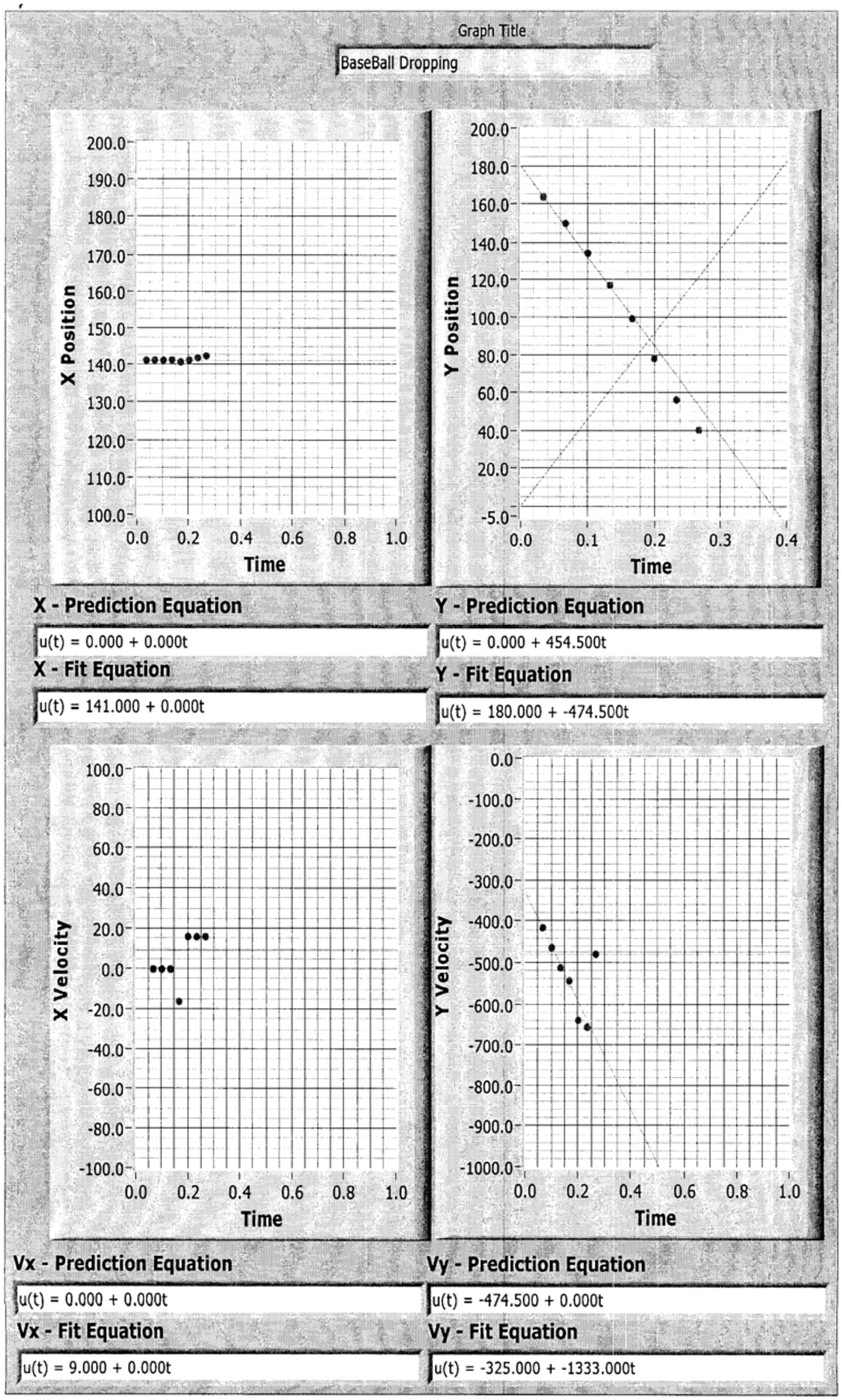
Baseball:
(Interval 2) 140cm/ 0.26sec = 538 m/s
(Interval 1) 125cm/ 0.24sec = 520 m/s
18.46 m/s / 0.02 sec = 923 cm/s = **9.23 m/s2**

Orange Ball:
(Interval 2) 330cm/ 0.22sec = 1500m/s
(Interval 1) 140cm/ 0.10sec = 1400m/s
100m/s / 0.12 sec = 833.33 cm/s = **8.33m/s2**

Difference of acceleration:
9.23 m/sec2 – 8.33 m/sec2 = 1.10 m/sec2

Conclusion

In conclusion, it took 0.08seconds longer for the orange ball to reach the ground then the baseball and baseball is acceleration 1.10 m/sec2 faster then the orange ball. We predict that if the balls were being evaluated in a vacuum room, the acceleration would be the same even if they have different mass.


Graph Title
BaseBall Dropping
X Position
Time
Y Position
Time
X - Prediction Equation
u(t) = 0.000 + 0.000t
X - Fit Equation
u(t) = 141.000 + 0.000t
Y - Prediction Equation
u(t) = 0.000 + 454.500t
Y - Fit Equation
u(t) = 180.000 + -474.500t
X Velocity
Time
Y Velocity
Time
Vx - Prediction Equation
u(t) = 0.000 + 0.000t
Vx - Fit Equation
u(t) = 9.000 + 0.000t
Vy - Prediction Equation
u(t) = -474.500 + 0.000t
Vy - Fit Equation
u(t) = -325.000 + -1333.000t

Grading Two Example Student Laboratory Reports

Now it's your chance to grade student laboratory reports. Please keep in mind the information from Activities **17** & **#18a** as you go through the following 2 student laboratory reports.

INDIVIDUAL TASKS:

1. *Individually* read through the 2 example student laboratory reports and grade them using the grading rubric for physics laboratory reports.

2. Mark down any and all comments on the example student laboratory reports as you grade them.

3. Assign points for each student laboratory report on the grading rubric.

GROUP DISCUSSION

TIME: 30 minutes

PRODUCT

Grading rubric; comments and feedback on each student laboratory report.

Activity 18b. Grading Two Example Lab Reports

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: _________

Grading Checklist	Points
LABORATORY JOURNAL:	
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DATA AND DATA TABLES (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)	

* 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.

Example #1

n

Lab Report 2 – Lab 3, Problem 1

Statement of the problem:

I am a volunteer in the city's children's summer program. One suggested activity is for the children to build and race model cars along a level surface. To ensure that each car has a fair start, my co-worker recommends a special launcher be built. The launcher uses a string attached to the car at one end and, after passing over a pulley, the other end of the string is tied to a block hanging straight down. The car starts from rest and the block is allowed to fall, launching the car along the track. After the block hits the ground, the string no longer exerts a force on the car and the car continues moving along the track. I want to know how the launch speed of the car depends on the parameters of the system that you can adjust. I decide to calculate how the launch velocity of the car depends on the mass of the car, the mass of the block, and the distance the block falls. My ultimate goal was to find the answer to the question – "What is the velocity of the car after being pulled for a known distance?"

Prediction:

I predicted that, using the equation $V=\sqrt{(2M_agh)/(M_a+M_c)}$

and with the data collected during setup, that the velocity at the time the block hit the floor would be 60.5cm/s. (Prediction graphs are attached.)

Procedure:

First, we gathered supplies. We used a cart, a flat track with a pulley attached, a mass hanger with a mass set to simulate the wooden block, string, and a video camera attached to a computer with video analysis software. We massed the cart and the block, and began to set up the experiment. We placed the cart on the track, and ran the string through the pulley. We hooked our mass onto the end of the string, and held it to a height that we measured and marked. We began recording video and let the mass go. We made 3 runs like this to obtain the best video. When we were satisfied we analyzed the video and came up with a good measurement of the cart's velocity. We printed our graphs and made conclusions based on our data.

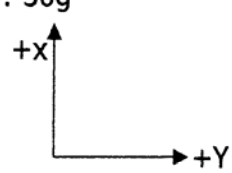
Data and Results:

Mass of Cart (Mc): 753.8g

Mass of Block (Ma): 50g

Height (H): 30cm

Coordinate Axis:



(Graphs of data analysis are attached)

Discussion:

The results from the lab were pretty close to the prediction made by plugging the masses of the cart and block and the height of the drop into the equation I wrote in my lab journal.

In the lab, there were a few sources of obvious error. The first major source was the method of getting data. The computer software is a bit inaccurate in measuring the velocity with the method of selecting points in the video frames. The camera we used has a curved lens, which distorts the video. This all leads to data that is off from the expected return. Another possible source of error is the equipment. The set-up we used was not entirely perfect in the fact that we were not taking friction into account, yet there was most likely friction in the cart's wheels. This would matter most during the time after the block has hit the ground, which is the situation we are modeling.

We could have made a few improvements. The main improvement would be to more accurately analyze the data within the computer software to compensate for any distortion in the video. We also could have made sure the cart was properly lubricated before performing the experiment.

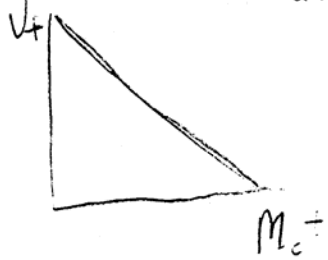
Conclusions:

In our lab, we discovered the velocity of the car after being pulled a known distance was around 55cm/s. This was close to our initial prediction, so we were satisfied with our results.

The launch velocity of the car does depend on its mass, as well as the mass of the block and the distance the block falls. This is due to the fact that they all affect the forces acting on the car. There are some instances where the mass would not really affect the launch velocity. If the distance dropped were very close to zero, the launch velocity would be near zero no matter what the mass of the block was.

If the same block falls the same distance, the force exerted by the block on the cart would not change, no matter the mass of the cart. The force of the block on the cart is always equal to the block's weight.

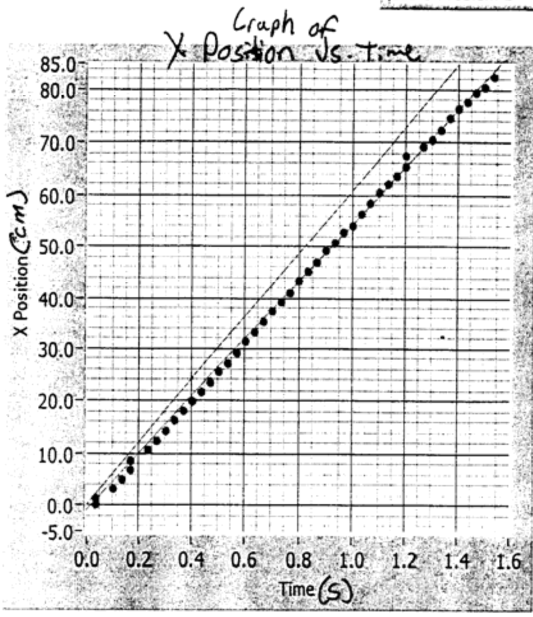
Prediction graphs

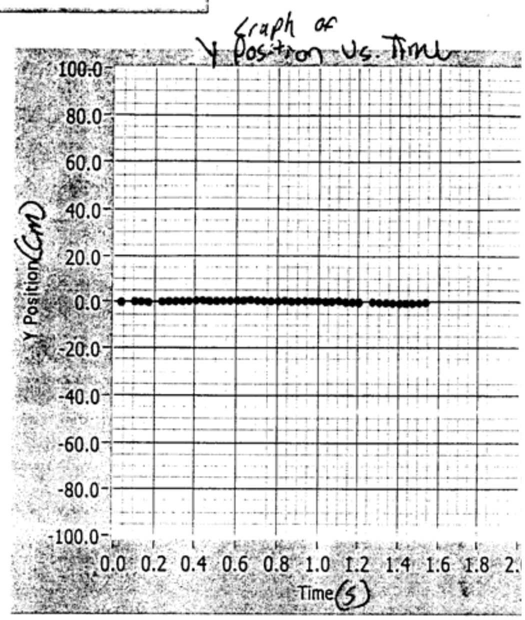


7

Graph Title

Lab 3 Problem 1





X - Prediction Equation

u(t) = 0.000 + 60.500t

X - Fit Equation

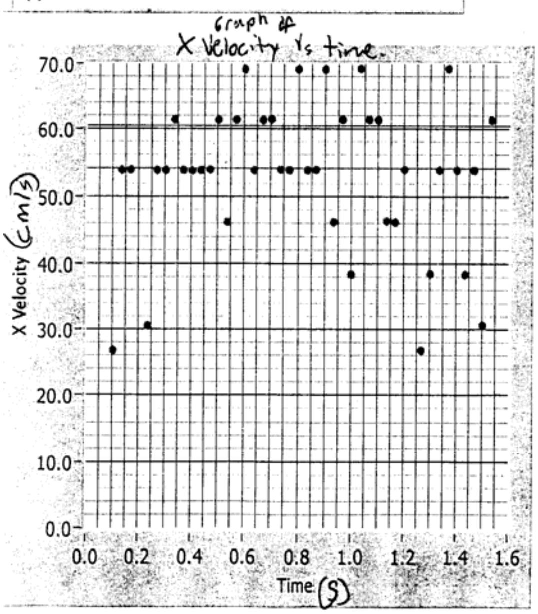
u(t) = -1.000 + 55.000t

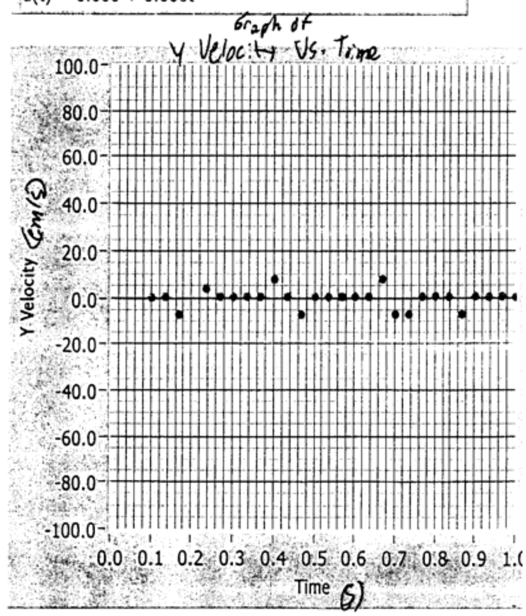
Y - Prediction Equation

u(t) = 0.000 + 0.000t

Y - Fit Equation

u(t) = 0.000 + 0.000t





Vx - Prediction Equation

u(t) = 60.500 + 0.000t

Vx - Fit Equation

u(t) = 54.000 + 0.000t

Vy - Prediction Equation

u(t) = 0.000 + 0.000t

Vy - Fit Equation

u(t) = 0.000 + 0.000t

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: _________

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 (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)	

* 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.

Example #2

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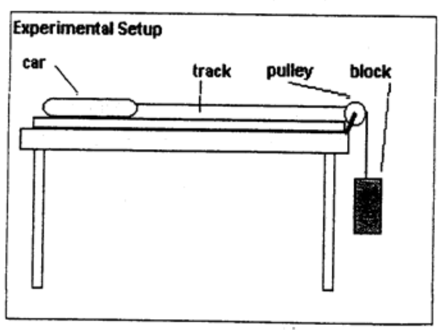
Lab III Problem 1: Force and Motion

1. Statement of the Problem -- According to the lab manual, my group members and I were asked to test the velocity of a toy car launched down a track. The car is attached to a string at the end of the track, which goes over a pulley and is then attached to a block. When the block is released, the string pulls the car down the track. After the block hits the ground, the car is no longer pulled but keeps going. We were asked to find how the cars speed after the block hits the ground depends on the mass of the car, the mass of the block, and the distance the block falls before hitting the ground. The question we answered in this lab is:

What is the velocity of the car after being pulled a known distance?

We used a toy car with a string attached to it, a block, a pulley, and a track to conduct our experiment. We recorded the motion of the car and the block using a video analysis application written in LabVIEW™, then analyzed the video to find the position, velocity and acceleration of the car while it was being pulled by the falling block and after the black reached the ground.

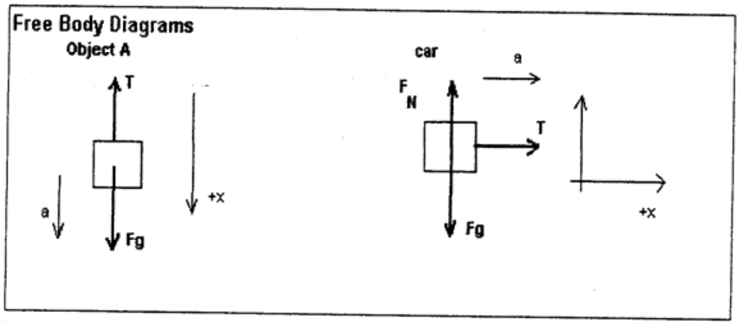
The block (called object A) has a significantly shorter distance to fall than the car has to travel along its track. In this experiment, we ignored the friction between the car and the track and between the pulley and the string. We also ignored the mass of the string.



2. Prediction --

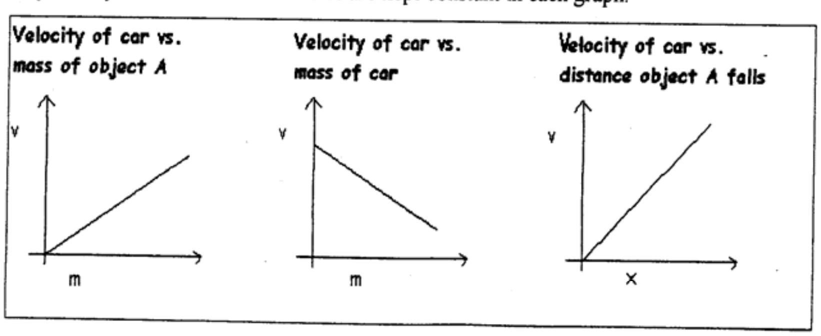
The first question asked me to calculate the cart's velocity after the block had hit the ground. I predicted that $\mathbf{v_c} = \mathbf{\sqrt{2xg[m_a/(m_c + m_a)]}}$. I solved the first kinematics equation, $\mathbf{x_c = x_{0c} + v_{0c}t + 1/2at^2}$ **for t**, assuming that x_0 =O, v_0 =0 and $a_c = a_A$, and that the magnitude of the car's displacement was the same as the magnitude of the block's, (since the string did not stretch), yielding $\mathbf{t = 2x/a}$. Since v= at, $\mathbf{v = a\sqrt{(2x/a)}}$ and v^2 =2ax. Solving for a gives $\mathbf{a = v^2/2x}$.

Variables	
x	position
xo	initial position
v	velocity
vo	initial velocity
a	acceleration
t	time
m	mass of object A
m	mass of car
F	Force
g	gravity
N	Normal Force
T	tension force



Since the objects are attached to the same string, the tension forces acting upon them are equal to each other. The sum of the forces acting on Object A in the x direction is $\mathbf{\Sigma F_A = Fg - T}$. The sum of the forces acting on the car in the x direction is $\mathbf{\Sigma F_c = T}$. Since F= ma, $\mathbf{M_A a = M_A g - T}$ and $\mathbf{M_c a = T}$. Using $\mathbf{a = v^2/2x}$, $\mathbf{M_A(v^2/2x) = M_A g - T}$, and $\mathbf{M_c(v^2/2x) = T}$. Combining these equations gives $\mathbf{M_A(v^2/2x) = M_A g - M_c(v^2/2x)}$, and solving for v gives $\mathbf{v_c = \sqrt{2xg[m_a/(m_c + m_a)]}}$.

The next three prediction problems asked us to draw a graph of the car's velocity vs. time as a function of the mass of object A, mass of the car, and distance object A falls, respectively. The other two variables are kept constant in each graph.



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The velocity would increase as the mass of object A or the distance object A falls increased, and would decrease as the mass of the car increased. The velocity would increase at a greater rate with the increase in distance than it would with the increase in mass of object A. Another way this could be said is that the graph of velocity vs. distance would have a greater slope than the graph of velocity vs. mass of object A.

3. Procedure – We set up the experiment according to the experimental setup picture above. The mass of the car we used was 252 g, and the mass of object A was 50 g. The distance form object A to the ground was 0.41m and the total distance the car was able to travel was 1m. There was 0.59m for the car to travel after object A hit the ground. We placed the camera about 1.5m away from the table holding the track so that the entire length of the track could be seen as well as object A. We recorded the car's motion and then analyze it in LabVIEW™. We divided the motion of the car into two parts -- motion before object A hit the ground and motion after object A hit the ground -- and analyzed each part separately. We predicted the equations for the position vs. time graphs, plotted data points of both the horizontal and vertical motion of the graphs, and then found the best-fit equations for them. We did the same for the car's velocities.

4. Data and Results – SEE ATTACHED GRAPHS

We predicted that there would be no motion, and hence no velocity, in the y direction for any of the graphs, and our prediction was correct.

Before object A hit the ground --When we predicted the equation for the x position vs. time of the car before object A hit the ground, we didn't really know what we were doing. We should have used the equation $x = x_0 + v_0t + 1/2at^2$ to make our prediction. The values for x_0 and v_0t would both have been equal to zero and we could have predicted the acceleration using $a = v^2/2x$: $(\sqrt{2xg[m_a/(m_c + m_a)]})^2/2x = [m_a/(m_c + m_a)]g = a$. This would have given us an acceleration of 1.49 m/s*s, and a predicted equation of $x = 0 + 0(t) + 0.75\text{m/s*s}(t^2)$. The value of 0.897 m/s*s in the best-fit equation is reasonably close to this. Since the slope of a velocity vs. time graph is equal to the acceleration and since 0.897 m/s*s was equal to ½ a, we predicted that the slope of the acceleration vs. time graph would be equal to 1.80 m/s*s, and our prediction fit the actual value of 1.70 m/s*s well.

After object A hit the ground—We predicted that the car would have zero acceleration during this portion of its motion and that its velocity would be equal to its final velocity, just as object A hit the ground. Again, we used the equation $x = x_0 + v_0t +$

$1/2at^2$ to describe the predicted motion, with x_0 and a both equal to zero. We predicted the velocity to be $v = \sqrt{2xg[m_a/(m_c + m_a)]}$, or 1.167m/s. This prediction was very close to the actual value. We predicted that for the velocity vs. time graph, the velocity would stay constant at 0.167m/s, and our prediction was very close to the actual best-fit line equation.

5. Discussion--

Results- The acceleration of the car in the experiment is dependant on the block falling. Before the block hits the ground, the car accelerates because of the falling block. The acceleration of the block and the car is the same because the same tension force acts them upon. Their accelerations are equal to $[m_a/(m_c + m_a)]g$, where m_a is the mass of object a (the block), m_c is the mass of the car, and g is the acceleration due to gravity, 9.8m/s*s. The velocity of the car and of object a at the time when object a hits the ground is equal to $\sqrt{2xg[m_a/(m_c + m_a)]}$.

After the block hit the ground there would no longer be any tension in the string and the sum of the forces on the car would be equal, (since T=0 and $F_g = -F_N$). Because F=ma, the car would have no acceleration. Its velocity would continue to be equal to $\sqrt{2xg[m_a/(m_c + m_a)]}$.

Error- Error resulted from our collection of data points again. It is difficult to click on exactly the same point of the car each time and to click on the same y value along the track each time as well. This results in distortion of the position measurements and velocities calculated. There is not much that can be done about this, except that we should try to be very precise in future collection of data points. Also, the camera could have caused a slight distortion of the collected data values. In this experiment, we neglected the friction between the car and the track and between the pulley and the string. This made the calculations a lot easier, but it caused our predicted value for the acceleration of the car and the block to be different than the actual value.

Improvements- It would be optimal to do many trials of this experiment, using different values for m_c, m_a and x, to check that the equations really fit, but time is an issue. With more precise data collection, we could have eliminated some of the movement and velocity seen along the y-axis.

6. Conclusions-- Using physics principles and equations, we predicted that the velocity of car pulled a known distance by a falling object would be equal to $\sqrt{2xg[m_a/(m_c + m_a)]}$, where x is equal to the distance the object falls, g is equal to gravity (9.8m/s*s), m_a is the mass of the object falling and m_c is equal to the mass of the car being pulled. Since the tension forces on each object are the same, they have the same acceleration and this can be predicted using Newton's second law and kinematics equations. The results of our experiment confirmed this.

In each case but one, the predicted values for the components of the equations of the graphs were the same or close to the actual ones. When we predicted the value for acceleration of the car before the block hit the ground, we didn't figure any friction into the calculations. We based all of our future predictions off of the actual values we got for this graph's equation and they all matched the actual values well.

The launch velocity of the car does depend on the mass of the car, the mass of the block and the distance the block falls, according to $v = \sqrt{2xg[m_a/(m_c + m_a)]}$. For values of m_a that are much larger than m_c, m_c does not affect v very much, since $[m_a/(m_c + m_a)]$ becomes very close to 1.

The tension force upon the car and the block is dependent on the masses of both objects. Changing the mass of either one will change the tension force exerted on both. The tension force on the block is equal to its weight if the block has no net acceleration; in other words, when $T = F_g$. This would happen if the mass of the block was zero, and since it could never have zero mass, it would never happen in a frictionless system. It may come close to zero though, and would reach zero in a system with friction. We could test this experimentally by using a car with a very large mass and using blocks of decreasing masses. The acceleration of the car should go toward zero as the mass of the blocks decrease.

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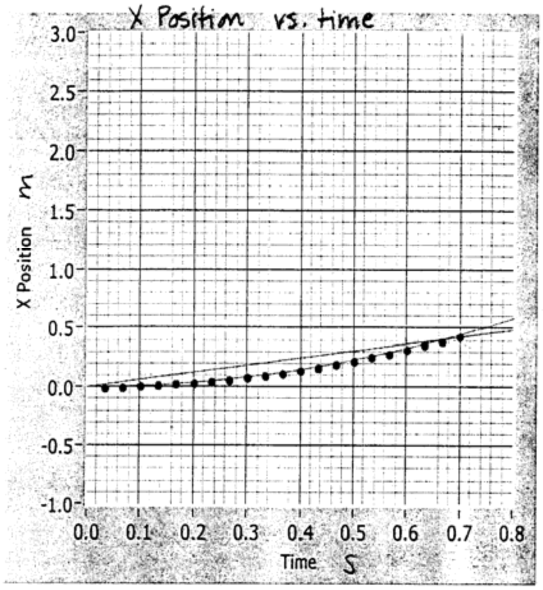
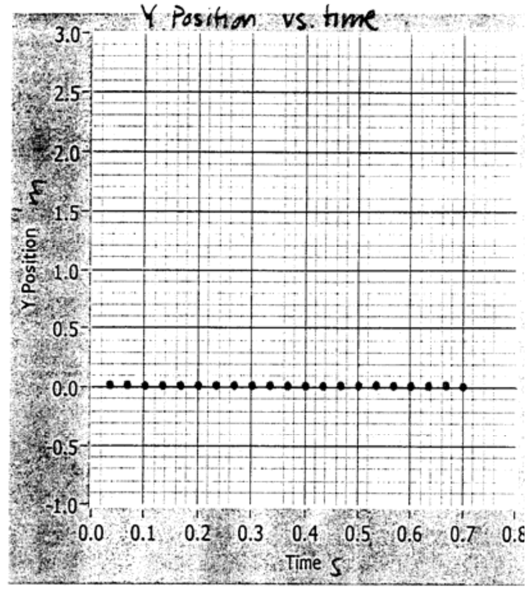
Graph Title

Lab III Problem 1: Before [A] hit the ground





X - Prediction Equation

u(t) = 0.000 + 0.600t

X - Fit Equation

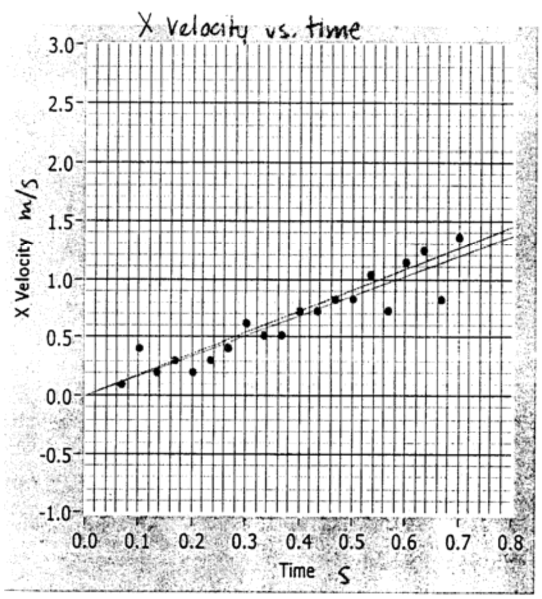
u(t) = 0.000 + 0.000 t + 0.897 t^2

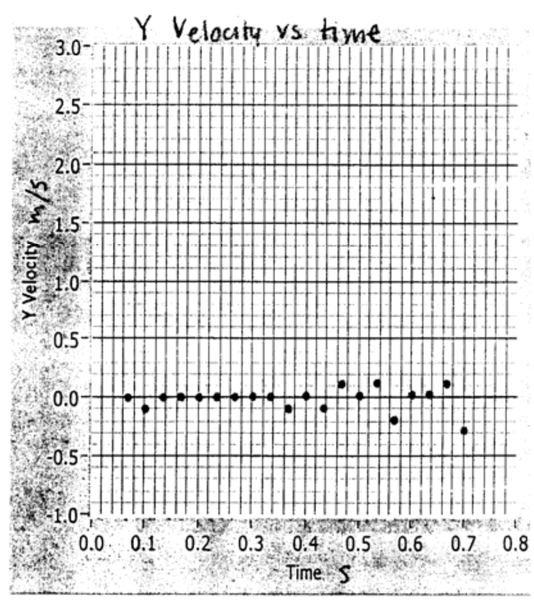
Y - Prediction Equation

u(t) = 0.000 + 0.000t

Y - Fit Equation

u(t) = 0.000 + 0.000t





Vx - Prediction Equation

u(t) = 0.000 + 1.800t

Vx - Fit Equation

u(t) = 0.000 + 1.700t

Vy - Prediction Equation

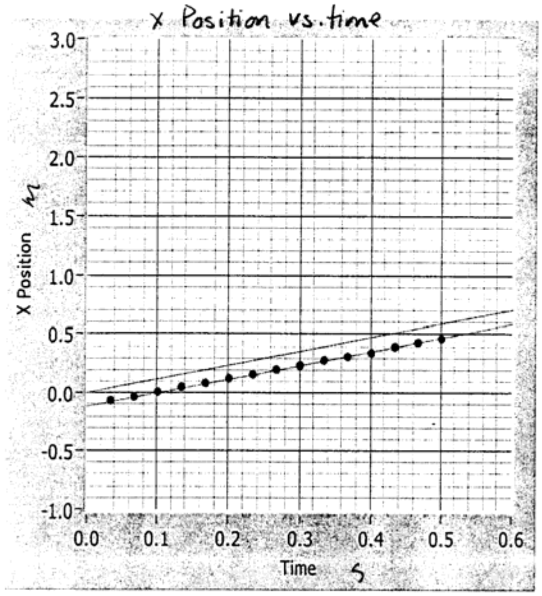
u(t) = 0.000 + 0.000t

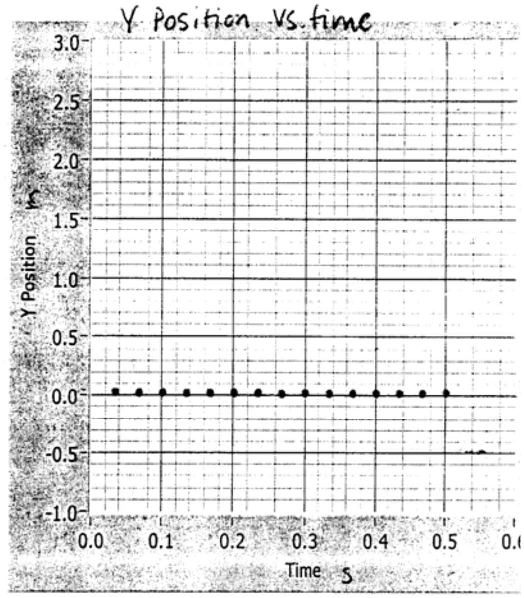
Vy - Fit Equation

u(t) = 0.000 + 0.000t

Graph Title

Lab III Problem 1: After [A] hit the ground





X - Prediction Equation

u(t) = 0.000 + 1.167t

X - Fit Equation

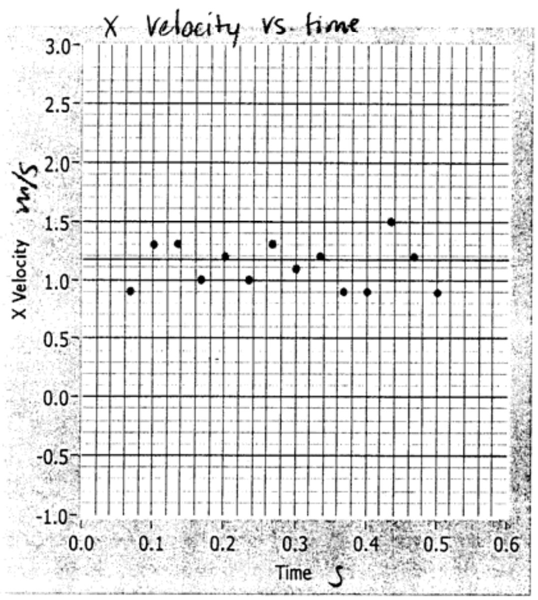
u(t) = -0.120 + 1.167t

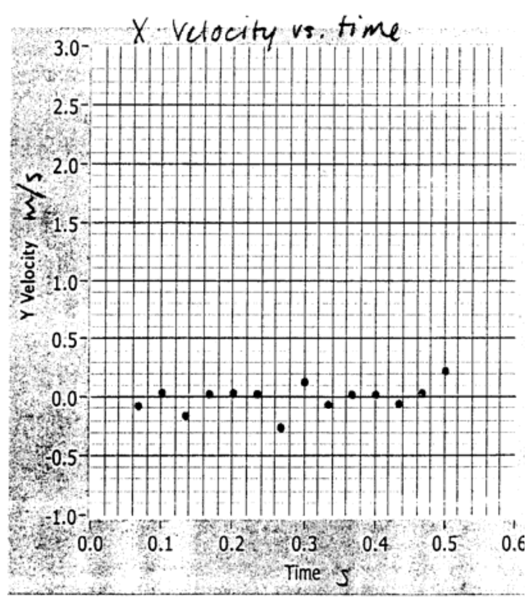
Y - Prediction Equation

u(t) = 0.000 + 0.000t

Y - Fit Equation

u(t) = 0.000 + 0.000t





Vx - Prediction Equation

u(t) = 1.167 + 0.000t

Vx - Fit Equation

u(t) = 1.170 + 0.000t

Vy - Prediction Equation

u(t) = 0.000 + 0.000t

Vy - Fit Equation

u(t) = 0.000 + 0.000t

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. Student 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/

Classroom Climate

A positive Classroom Climate can play an important role in determining academic misconduct and sexual harassment.

In your groups:

1. **Recall examples of positive/negative classroom climates.**
2. **Brainstorm factors that contributed to the positive/negative classroom climate**

Scholastic Dishonesty is ...

Directions: Circle **T** if the statement accurately completes the above sentence; Circle **F** if the statement does not accurately complete the above sentence.

T / F 1. The act of passing off someone else's work as your own.

T / F 2. Extensive assistance from other people on an assignment without recognition.

T / F 3. Using sections of someone else's homework assignment.

T / F 4. Looking at another student's examination during a testing situation.

T / F 5. Conferring with fellow students during an examination period.

T / F 6. Allowing another student to copy from your examination.

T / F 7. Using notes stored on a calculator during a closed-book examination.

T / F 8. Using another person's idea without acknowledging that person.

T / F 9. Allowing another student to copy sections of your paper.

T / F 10. Signing another student's name on an attendance sheet.

T / F 11. Permitting another student to sign your name on an attendance sheet.

T / F 12. Collaborating with a fellow student on a take home exam.

T / F 13. Copying an answer to a problem line-for-line from a textbook or solution manual without identifying where it came from.

T / F 14. An act that can result in expulsion from the University.

Adapted with permission from the Teaching Enrichment Program at the University of Minnesota.

Case Studies: Diversity and Gender Issues

GROUP TASK

This exercise uses "critical incidents" derived from encounters among and between teachers and students at the University of Minnesota. The critical incidents are, as the name implies, incidents or situations that are of importance in understanding the behavior, values, and cultural differences of those described in the incident. Case Studies #1 through #6 deal with incidents you might encounter as a graduate teaching assistant. Case Studies #7 and #8 describe encounters between people from the U.S. and international scholars. Case Studies #9 through #11 deal with incidents with fellow graduate students.

The incidents are open-ended, with no absolute right answer to be guessed or learned. In our discussion of the incidents, several explanations, alternatives, or solutions could be proposed depending on the personality, style, or culture of the individuals.

Discuss the four critical incidents assigned to your group. Use the guidelines listed under each critical incident to begin the discussion. There is no need to limit your discussion to just the questions provided.

GROUP ROLES

Skeptic: Ask what other possibilities there are, keep the group from superficial analysis by not allowing the group to agree too quickly; ask questions that lead to a deeper analysis; agree when satisfied that the group has explored all possibilities.

Manager: Suggest a plan for discussing each incident and answering the questions; make sure everyone participates and stays on task; watch the time.

Checker/Recorder: Ask others to explain their reasoning process so it is clear to all that their suggestions can be discussed; paraphrase, write down, and edit your group's response to each incident.

TIME: 25 minutes

The *Checker/Recorder* will be asked to make the opening comments about **one** of the assigned case studies when we return to the larger group.

GROUP PRODUCT

Answer Sheets for assigned Case Studies.

Name : ________________________________

Case Study #1*

One of your physics students is a highly achieving undergraduate who is very bright, personable, and attractive. You enjoy working with this student, but are not otherwise interested in a relationship. Unexpectedly, the student leaves you a note, professing an interest in establishing a close relationship, along with a bouquet of flowers.

*Adapted from University-wide sexual harassment training

1. What are your responsibilities in this situation?
2. How can you maintain the kind of teaching relationship you want?

NOTES:

Name : ____

Case Study #2*

One day, as you are waiting for students to come in and settle down for your discussion session, you notice that one of the students enters wearing a T-shirt which is emblazoned with a sexually obscene and violent slogan. The student sits down as the bell rings for the class to begin. Just as you are about to begin your opening game, another student states loudly that he cannot sit in the class and attempt to learn if that T-shirt is allowed to stay there. The two students then engage in a shouting match.

*Taken from University-wide sexual harassment training

1. What are your responsibilities in this situation?
2. What are some possible solutions?

NOTES:

Name : ____

Case Study #3

You are discussing with your class the physics of sound, specifically why longer musical instruments make deeper sounds. To provide a quick demonstration, you have one male student and then one female student stand up and say "oooh." After the session, the female student goes to the professor and says that she felt singled out since she is the only woman in the class. Further, she was upset and embarrassed since saying "oooh" loudly in a room full of men seemed to her to be too sexual a thing to do.

1. What could you have done to prevent the situation?
2. What could you do to resolve the situation?
3. What could your professor have done to prevent the situation?
4. What could the professor do to resolve the situation?

NOTES:

Case Study #4

Jose, a student in your section, is in a wheelchair. His brother Pedro is in the same section, and is very protective of Jose. (Pedro registered for all the same classes as Jose on purpose so that he can help him out.) The brothers want to be in the same group, but you want to have diverse groups so that students can get to know one another. However, because of Jose's disability you give in to the brothers and put them in a group with two other people. When there is a group test problem, the brothers surprise you by speaking Spanish to one another. You ask them to speak English so that everyone in the group can understand. They tell you that they don't think they read English as well as other people in the class and are just talking to each other in Spanish to be sure that they understand the quiz problem.

1. What could you have done to prevent the situation?
2. What can you do to resolve the situation?

NOTES:

Name : ____

Case Study #5

You are a relaxed TA, often chatting and laughing with students in your section before you start class. One day before lab, you discover that you share an interest in racquetball with one of your students and you make an appointment to play. Soon you are meeting every Wednesday at lunch for a racquetball game with this student and becoming friends. The other students in your section know about this and are upset about it. You think it's no big deal, since it's not as though you are romantically involved with your student.

1. What are your responsibilities in this situation?
2. What can you do to resolve the situation?

NOTES:

Name : ________________________________

Case Study #6

Early in the spring semester, one of your fellow team members stops by your lab section and starts chatting and visiting with one of your students during the lab. It is soon obvious that the two are in a relationship. After lab, you find out that this student was in the TA's lab last term.

1. What are your responsibilities in this situation?
2. What can you do to resolve the situation?

NOTES:

Name : ____

Case Study #7*

Abdelkader, Mohammed and Naji, students from the same country, are close to completing their first semester at the University. When they first met at the new student orientation program and discovered they were all in the same engineering department, they arranged their schedules so they could take most of their classes together. Every day before their physics class they met to study each other's notes and to discuss the assigned reading and homework they had done the night before.

Their physics professor noticed that the three students made nearly the same errors in the first exam of the semester. At the time, he assumed it was because they were from the same educational background. However, when he noticed that all three students had exactly the same problems incorrect on their second test, he decided they had to be cheating. The professor called the students into his office and explained that this type of behavior was unacceptable. He told them that he was going to call the foreign-student advisor to see what action could be taken because of their cheating.

*Adapted from Florence A. Funk's "Intercultural Critical Incidents"

1. What happened? (Describe the situation.)
2. Why? (Give causes/interpretation of the situation.)
3. Alternatives/Solutions:
   a. What could have been done to prevent the situation?
   b. What can be done to resolve the situation?

NOTES:

Name : ________________________________

Case Study #8*

Chong, a new international student at the University of Minnesota, arrived on campus two weeks before classes began so he could find housing, register for classes and become familiar with the St. Paul-Minneapolis area. During this two week period everything went well. He found an apartment to share with a U.S. student from his department, was able to register for all the classes he needed, and made the acquaintance of a few other students. Once classes began Chong discovered that he was thrilled with the discussion that took place between the students and professors in his classes, he enjoyed the company of his roommate's friends and he enjoyed the easy access to movies, shopping, and fast food establishments.

About three weeks into the term, Chong began to find the endless classroom discussions a waste of time. He was frustrated with the ridiculous antics of his roommate's friends and it seemed that everything he needed cost too much. He found that he was now seeking the company of his countrymen and that their discussions most often centered on how "screwed-up" everything was in the States. He ate lunch in a local ethnic restaurant and avoided contact with students from the U.S. unless it was required to fulfill classroom assignments.

*Taken from Florence A. Funk's "Intercultural Critical Incidents"

1. What happened? (Describe the situation.)
2. Why? (Give causes/interpretation of the situation.)
3. Alternatives/Solutions:
   a. What could have been done to prevent the situation?
   b. What can be done to resolve the situation?

NOTES:

Name : ____

Case Study #9

Boris is a first year physics graduate student from Russia. Although he speaks English with a heavy accent, he is fluent and is given his own discussion and lab sections to teach. After a few weeks he becomes puzzled by his students' behavior. Even though he can tell from their test scores that they are confused about physics, they never ask questions or come to his office hours. They come to class late and have to be asked two or three times before they will respond when he asks them to go to the board. Boris comes to you and asks what he should do.

1. What happened? (Describe the situation.)
2. Why? (Give causes/interpretation of the situation.)
3. Alternatives/Solutions:
   a. What could have been done to prevent the situation?
   b. What can you do to help resolve the situation?

NOTES:

Name : ______________________________

Case Study #10

Mary was having some difficulty in one of her 5000-level physics classes.
She had trouble with the homework assignments and then scored below the median on the first two exams. About halfway through the term, Mary went to see the professor to ask him for help. He told Mary that she should really be ashamed at her performance in the class and that she would probably fail. He refused to help her and told her that she should drop out of school, since it was unlikely that she would ever be a physicist. After meeting with him, the student was so upset that she went to the top of a tall building and considered killing herself.

1. What happened? (Describe the situation.)
2. Why? (Give causes/interpretation of the situation.)
3. Alternatives/Solutions:
    a. What could Mary have done to prevent the situation?
    b. What can Mary do to resolve the situation?
    c. What could the professor have done to prevent the situation?
    d. What could you (as one of Mary's classmates) do to prevent or resolve the situation?

NOTES:

Name : ____

Case Study #11

In one of her sections Susan had a male student, Joe, who was very self-assured. During her office hours, he often sat very close to her and put his arm around the back of her chair. One day in lab, as Susan helped a group at the next table, Joe reached behind him and stroked her leg. She said, "Don't do that," and asked to speak to him after class. When the other students had gone, Susan said, "I don't know what you thought you were doing when you touched my leg in class." Joe said that it had been an accident, and Susan ended the conversation. Immediately after that, she went to see the lecturer for Joe's class and told him the whole story. The professor laughed.

1. What happened? (Describe the situation.)
2. Why? (Give causes/interpretation of the situation.)
3. Alternatives/Solutions
   a. What could the TA (Susan) have done to prevent the situation?
   b. What could Susan do to resolve the situation?
   c. What could the professor have done to prevent the situation?
   d. What could the professor do to resolve the situation?

Name : ____