Lab 2 Warm up: **Name ________________________ Number _____**

Suppose that a person starts at the 1-meter mark in front of the motion detector, walks slowly and steadily (with uniform motion away) from the motion detector for 3 seconds, stops for 1 seconds, and then walks quickly and steadily towards the motion detector.

a) Make a sketch to show the graph of position vs. time. Label axis. Group discuss.

position

time

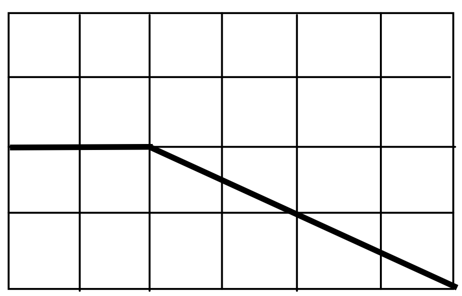
b) Do the experiment and make any corrections on the original graph.

Investigation 1.1

It is very important to make your predictions before you conduct the experiment. After your predictions, write down the description of the actual motion that makes the graph. Note: Distance units are left out on purpose. Describe, in general terms, the motion.

A)

Position



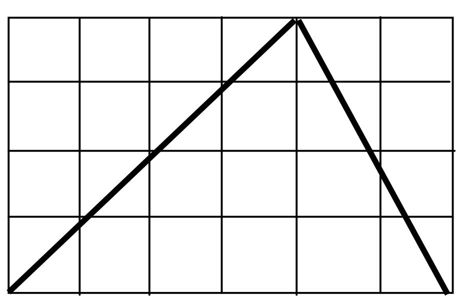
Time (s)

i) Prediction

ii) Description of actual motion

B)

Position



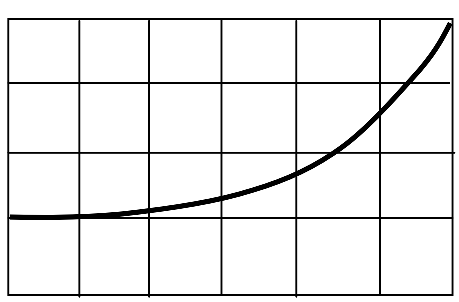
Time (s)

i) Prediction

ii) Description of actual motion

C)

Position



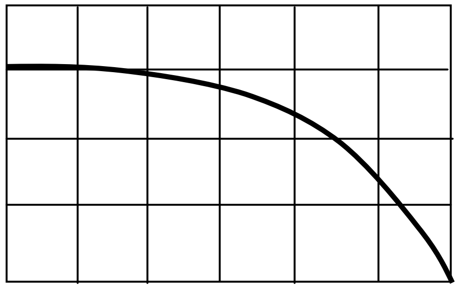
Time (s)

i) Prediction

ii) Description of actual motion

D)

Position



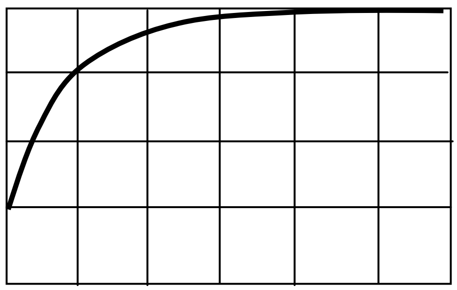
i) Prediction

ii) Description of actual motion

Time (s)

E)

Position



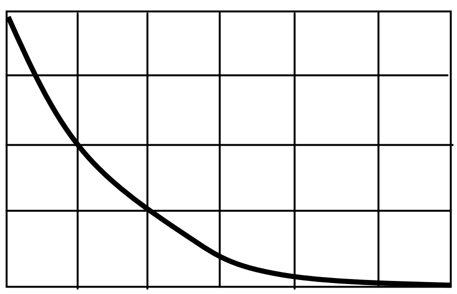
i) Prediction

ii) Description of actual motion

Time (s)

F)

Position



i) Prediction

ii) Description of actual motion

Time (s)

Group Assignment 2 – Constant Acceleration Your goal is to determine the equation for an object undergoing constant acceleration of a cart down a single aluminum track. 2a through 2h are questions that will be *algebraic* in nature. No values will be placed into these variables until you get to the Experiment part of 2.

__ intitial here "I understand that the final answers will be boxed in a-h below."

2a) You will be releasing the car and starting the timer from *rest*. This means all values of $\mathbf{v_o}$ should be set to what? ________ .

2b) Use the 1st kinematic equation and solve (showing all steps) for acceleration algebraically.

2c) An object is undergoing constant acceleration. Come up with the equation for *average velocity* during that motion and the only variables being $\mathbf{v_o}$ and $\mathbf{v_f}$.

2d) If an object covers distance **d** in time **t**, determine the objects *average velocity*.

You should have 2 equations (from 2c and 2d) for *average velocity*.

2e) Set them equal to each other:

2f) What is the final velocity of the cart in terms of only *time* and *distance* traveled? (solve for v_f from the equation you placed in 2e)

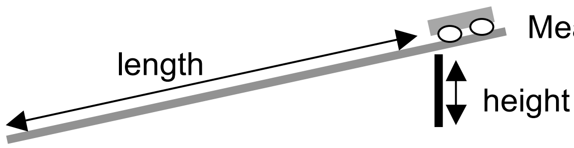
2g) Now plug in your result from 2f into your equation from 2b. This should give you the acceleration of a cart down an aluminum track (undergoing *constant* acceleration) in terms of the measured distance and the recorded time.

2h) Verify the correct units for acceleration from your equation in 2g.

The Experiment: (this is your lab. The previous was deriving the equations needed) *The objective of this lab is to see how steepness of an incline plane affects the acceleration of a cart as it is released from rest. You will be measuring the acceleration of a cart down the incline plane from four different heights. You will then see if the relationship to height lifted and acceleration is linear.*

Set up: Arrange the aluminum track so that is forms a ramp on which you can roll metal cart. Use one wood block lying on its side. We will be assuming that the cart will always undergo constant acceleration. Clean your track to aid in this assumption!

Now run the experiment 3 times using multiple (3) stop watches for each drop. Be sure to always keep the distance down the ramp and height the same. The height is *amount lifted* by the block from the table. The length is from the front of the car to the stopping point. The time for all lab members will be the time for the complete trip (from $\mathbf{v_o}$ to $\mathbf{v_f}$). It may help to place a boo at the end so everyone can hear the cart hit the end of the track.



Measure the length ______ and height _______

drop 1: T1 _____ T2 _____ T3 _____

drop 3: T1 _____ T2 _____ T3 _____

drop 3: T1 _____ T2 _____ T3 _____

Place all 9 data points in a *single column* in excel and determine the *average time* and *standard deviation*. Use the average time to calculate the experimental value of final velocity (equation 2g). Show work. **Do Not** go on to other heights until you have shown your instructor your calculated final velocity (using average time) for the *first height*.

1) Height: ______ ave. time _____ stdv _____ Final Velocity _________

Now repeat the experiment at **3 more** heights (and 3 runs for each of the 3 heights, 9 time trials). You may place the data directly into excel. Please email yourself a copy of the raw data for any analysis you will do later. *Show work for v_f in all three below:*

T1 ____ T2 ____ T3 ____ T4 ____ T5 ____ T6 ____ T7 ____ T8 ____ T9 ____

2) Height: ______ ave. time _____ stdv _____ Final Velocity _________

T1 ____ T2 ____ T3 ____ T4 ____ T5 ____ T6 ____ T7 ____ T8 ____ T9 ____

3) Height: ______ ave. time _____ stdv _____ Final Velocity _________

T1 ____ T2 ____ T3 ____ T4 ____ T5 ____ T6 ____ T7 ____ T8 ____ T9 ____

4) Height: ______ ave. time _____ stdv _____ Final Velocity _________

Group Assignment 3 – Based on your data, use equation *2b* to determine the acceleration of the cart down the ramp in all 4 heights. *Show work to right. Keep units in all steps of your work.*

a1 = ______

a2 = ______

a3 = ______

a4 = ______

The Big Picture: Is there a *linear* relationship to the height of the track and the acceleration? To test this, using Excel, plot the independent variable on the x-axis and the dependent on the y-axis. Of the two, which is the independent variable, and why? (you lose points if you don't answer "why")

How confident would you be in stating that the two values have a linear correlation?

Goup Assignement 4 – Did theory agree with experiment?
Theoretically, the acceleration down an incline is given by: $a = g \cdot \sin(\theta)$
g = 9.8 m/s^2 θ *= angle between track and table.*
Did your values fall within the accepted values? (a good way to see how close "theory" and "experiment" are to each other is to do a % comparison. Take the absolute value of the difference, and divide it by the theoretical value. Then multiply by 100% to get a %)

Group Assignment 5 – motion sensor verification. Set up a motion sensor for one of your 4 heights (sensor at top of ramp facing down). Use the *Logger Pro* velocity vs. time graph. Determine the slope of the velocity line using the analysis button and select "linear fit" . Compare the motion sensor acceleration to your value and the theoretical values. Discuss results.

Conclusion: Answer these questions, then write a general conclusion for lab 2. Please type this all up and attach to your lab along with your excel printouts. Make sure it is easy to follow which data set goes with which trial, height, etc.
Some questions you must answer before your conclusion (types up please):

1. What assumption must be made in order to use the kinematic equations?
2. Is there any reason why you think this assumption is invalid?
3. What did you learn about this lab?
4. Did you walk away with a better understanding of how an object behaves when undergoing a constant acceleration?
5. How can this lab be improved for next year?