Position, Velocity, & Acceleration

Please Circle Your Lab Day: M T W R F

Name: ____________________________

Partner: ____________________________

Partner: ____________________________

Partner: ____________________________

- **Project 1**: How is the slope of the position vs. time graph related to velocity?
- **Project 2**: What do velocity vs. time graphs look like for a = *constant*?
- **Project 3**: How does mass affect the acceleration of a cart sliding down a ramp?
- **Project 4**: What is the acceleration of a ball thrown up in the air?

Project 1: How is the slope of the position vs. time graph related to velocity?

1. Level the track. Set the motion detector and the cart so that the motion detector can "see" the cart all the way down the track. Start the Logger Pro program. Make a trial run: push the cart away from the motion detector. Is the graph consistent with motion at constant velocity? If not, you might need to move objects that reflect sound pulses (near the line-of-sight from the detector to the cart).

____

____

____

____

2. Obtain **position vs. time** and **velocity vs. time** graphs for the cart moving at a *constant velocity*.

3. Click anywhere in the **position vs. time** graph. Use "Analyze", "Examine" and then, "Analyze", "Tangent" to examine the slope of the **position vs. time** graph. Click in the **velocity vs. time** graph and try the "Examine" option.

Q: How is the slope of the **position vs. time** related to the velocity of the cart? (Hint: compare the value of the slope of the **position vs. time** graph with the value of the velocity in the velocity vs. time graph at the same instant of time.)

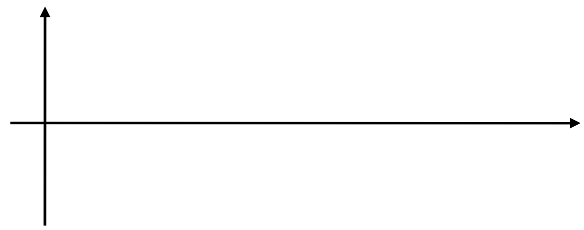
____

____

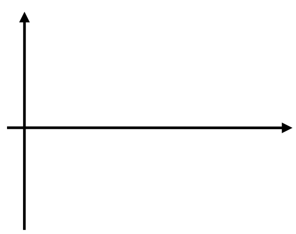
____

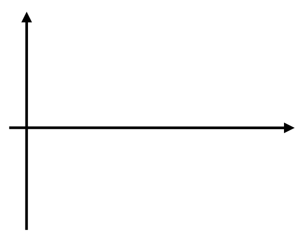
<u>Project 2</u>: What do velocity vs. time graphs look like for *a* = *constant*?

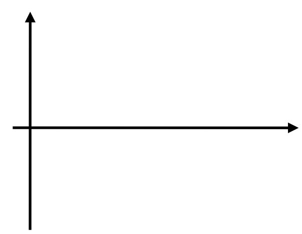
1. Put a book under the detector end of the track and ***sketch your prediction*** for the **velocity vs. time** graph for the cart released from rest at the high end of the track (with the motion <u>away</u> from the detector).



2. Click on Insert and add a graph. <u>Make sure the vertical axes are position, velocity and acceleration.</u> Resize your graphs so you can see all 3. If you need help, ask your instructor. Do the experiment by placing the cart at least 10 cm from the motion detector, start collecting data, and then release the cart. For each graph, zoom in on the relevant portion. Sketch the graphs (position, velocity, & acceleration) below and <u>label the axes</u>.







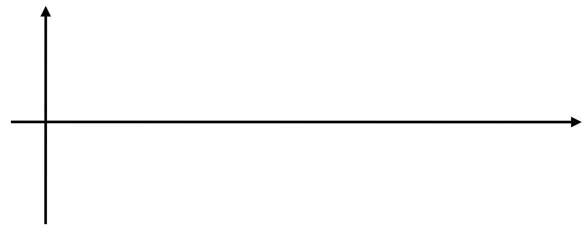
Q: Is the position vs. time graph a straight line or slightly curved? What does this mean?

Q: Does the velocity graph have a constant slope, or is it curved? What does this mean?

Q: How would the velocity graph be different if the motion detector were placed at the other end of the track (please sketch, label the axes, and explain)?

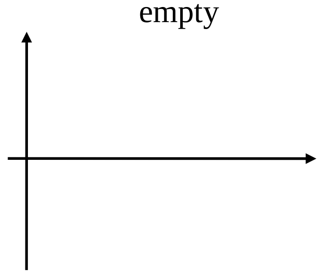
<u>Project 3</u>: How does mass affect the acceleration of a cart *rolling* down a ramp?

1. *<u>Predict/sketch</u>* what the **acceleration vs. time** graph will look like for a more massive cart rolling down the ramp (motion detector still at the top of the ramp). Use <u>a dashed line</u> to show the acceleration of the cart from the previous project, and <u>a solid line</u> to show your prediction for the acceleration of the more massive cart.

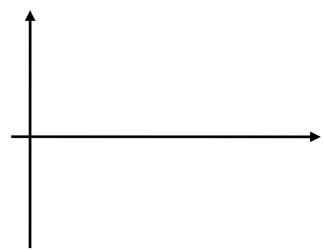


2. Resize the acceleration graph to fill the window (it can cover the other graphs). Do the experiment and sketch the graphs for an empty cart and a cart with one metal bar added (*500g*):

empty



loaded



3. Select a section ("region") of the graph by positioning the cursor at a beginning point on the curve, hold down the left mouse button, and drag it until the two vertical lines bracket your "region of interest", then release the mouse button.

   Now use "Analyze**", "**Statistics**"** to find the average (mean) acceleration in this region for the empty cart. Repeat for the loaded cart.

	magnitude units		magnitude units
acceleration of empty cart =	____ ______	acceleration of loaded cart =	_____ _____

How does the acceleration change when you add mass to the cart?

____

____

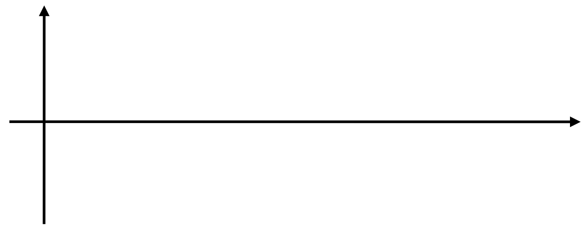
Calculate a percent difference ($\frac{|A-B|}{0.5\times(A+B)}\times 100\%$). Percent difference = ____________

Show your calculations:

If you get a large percent difference (about 20% or larger), then something was wrong with your measurements. Show your result to the instructor. Then carefully redo the experiments if instructed.

<u>Project 4</u>: What is the acceleration of a ball thrown up in the air?

1. Sketch your **<u>prediction</u>** of what the **acceleration vs. time** graph will look like for a cart given an initial push up the ramp if it is allowed to roll up and back down (motion detector still at the top).



   Explain why you drew the graph this way:

   ____

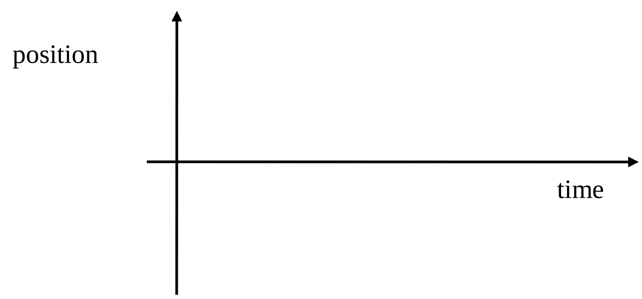
   ____

   ____

   ____

2. Do the experiment (you will need 3 graphs) and accurately sketch the graphs (position, velocity, & acceleration). Make sure the cart doesn't get too close to the detector.

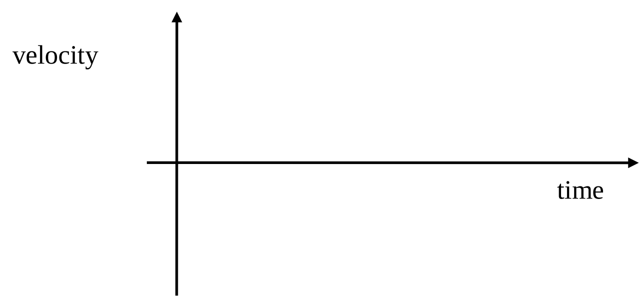
3. Label the point on each graph when the cart reached its highest point on the ramp.



Q: What is the velocity of the cart when it reaches its highest point on the ramp?

____

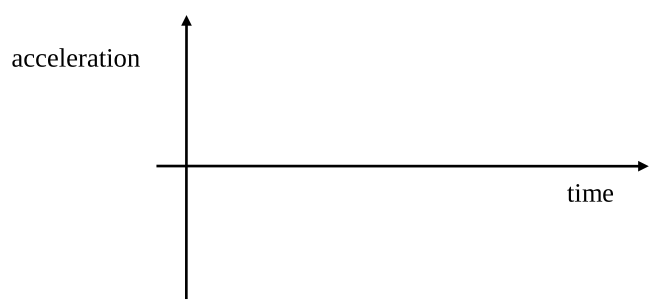
____



Q: How does the acceleration vary in time as the cart slows down and speeds up?

____

____

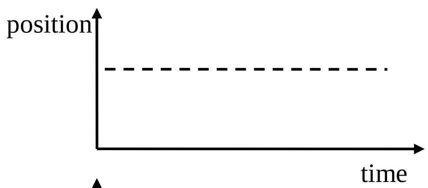


HOMEWORK

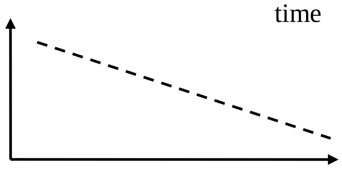
H1. Describe the motion displayed in each position vs. time graph. Refer to moving towards or away from detector, at constant speed, or speeding up or slowing down.

Graph	Description

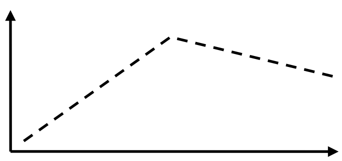
A.



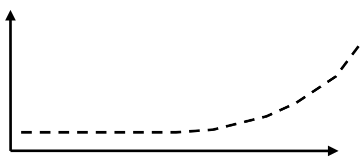
B.



C.



D.



H2. Sketch a **position vs. time** graph for each of the following: a) velocity = 0.0, b) velocity = constant, c) velocity increasing at a constant rate (acceleration = constant). Start at the origin of each graph.

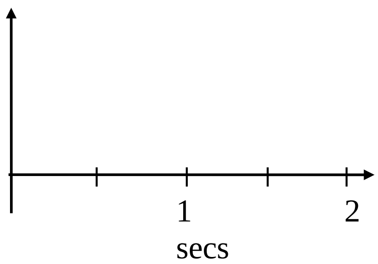
(a)

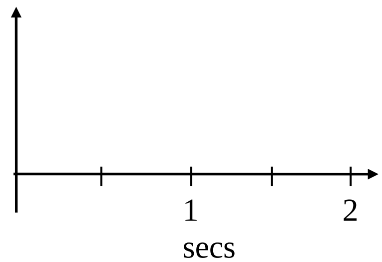
(b)

(c)

Position, Velocity, & Acceleration

H3. Suppose you are in a car moving at (initially) 1 m/s. Sketch velocity vs. time graphs that correspond to 1) acceleration = 0.0 m/s^2, and 2) acceleration = 2.0 m/s^2. Label the axes (name and scale) showing values for 2 seconds.





H4. What would happen to the <u>acceleration</u> of the cart if the ramp were made steeper? Explain why you believe your answer is correct.

Q: What would be the <u>numerical value of the acceleration</u> of the cart if the ramp were infinitely steep (i.e., straight up and down)? Explain why you believe your answer is correct.

H5. Make sketches of **position, velocity, & acceleration vs. time** graphs for a ball being thrown straight up in the air and coming back down. Label each curve where the ball reaches its maximum height. Explain why you believe your graphs and labels are correct.