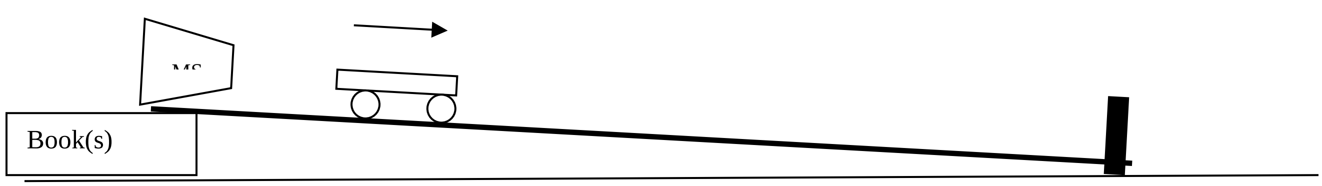
Concepts of One Dimensional Kinematics Activity

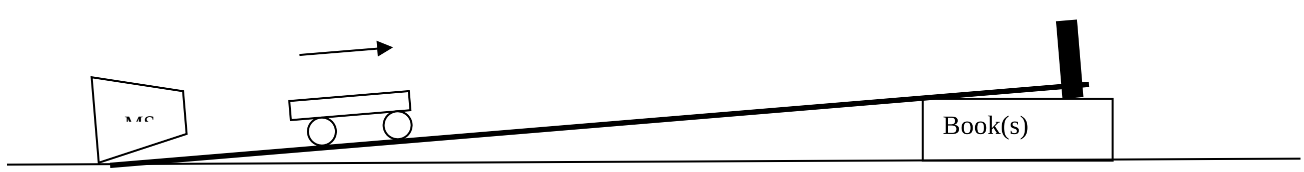
Purpose

During the activity, students will become familiar with identifying how the position, the velocity, and the acceleration of an object will vary with respect to time under conditions of constant acceleration. The condition of constant acceleration includes the condition of zero acceleration. Under conditions of constant acceleration, the following kinematic equations govern the motion of an object:

In each equation, the variables are defined as: v_0 – initial velocity v_f– final velocity x_0 – initial position x_f – final position a – acceleration t -- time	$v_f = v_0 + at$
	$x_f = x_0 + \frac{1}{2}(v_0 + v_f)t$
	$x_f = x_0 + v_0 t + \frac{1}{2}at^2$
	$v_f^2 = v_0^2 + 2a(x_f - x_0)$

A cart will be allowed to move on a frictionless track. In addition to ignoring friction, air resistance can also be ignored. While the cart is in motion for the three situations below, a motion sensor (MS) will continuously determine the cart's position, velocity, and acceleration. The computer will use the data from the MS and plot graphs of Position vs Time, Velocity vs Time, and Acceleration vs Time. However, prior to collecting data for each situation, each group should discuss the situation and predict and sketch how each graph should appear.





Part I

Record your predictions on the provided sheet for a cart on a level track.

To compare you prediction to experiment, follow the instructions below to set-up the track, the Motion Sensor (MS), and the PASCO Capstone software.

Use a level to ensure that the track is level. If an adjustment is necessary, a leveling foot is located on the end of the track opposite the motion sensor.

Physically connect the motion sensor to the PASCO Interface by plugging the yellow jack into port #1 and the black jack into port #2.

Log on to the computer and choose the COSAM pool. Double click the 'phy-lab' icon on the desk top, and open the PASCO Capstone program. Under File, select Open Experiment, choose the file folder named "capstone-activities", and then select the "Concepts of 1-D Kinematics Activity" file. After the file opens, the computer should be prepared to collect data. To collect data, click the ***Record*** button. In order to stop collecting data, click the ***Stop*** button. To delete a data run, select the "delete last run" button near the bottom-middle of the screen.

Start the cart close to the Motion Sensor (MS), and give the cart a slight push. The push should be sufficiently hard to keep the cart at a constant velocity, but it should not be so hard that the cart smashes into the backstop at the end of the track. After the cart has been pushed and it is in motion, start collecting data when the cart is approximately 12 cm (~5 inches) away from the MS. The MS will not work properly when an object is too close to it. Stop collecting data prior to the cart coming in contact with the backstop. The TA will visit the station to observe the data, and inform the group on how to fit the data. After the TA has observed the data, print the plots, and delete the data runs.

Part II

Record your predictions on the provided sheet for a cart going downhill.

Elevate the end of the track with the MS by 27 to 50 mm (1.5 to 2.0 inches) using books. Start the cart close to the Motion Sensor (MS), and release the cart. After the cart is approximately 12 cm away from the MS, start collection data, but stop collecting data prior to the cart hitting the backstop. Fit the data, and wait for the TA to observe the data. The TA will ask the group to determine the cart's acceleration as it went down the track and the cart's velocity as it reached the 1st photogate. After the TA has observed the data, print the plots, and delete the data runs.

Part III

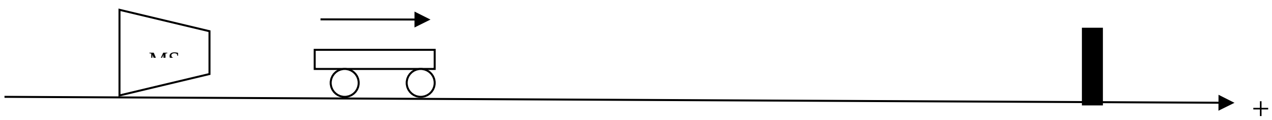
Record your predictions on the provided sheet for a cart traveling up and then down the ramp.

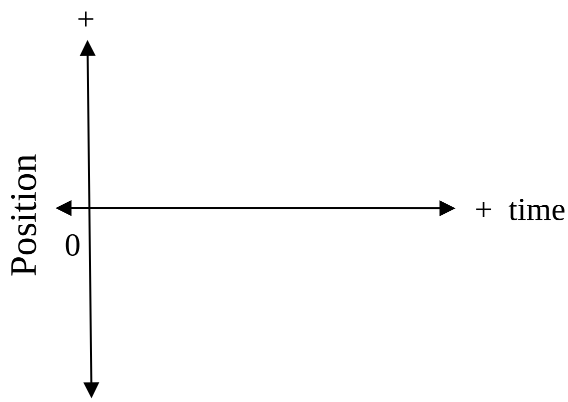
Elevate the end of the track opposite of the MS by 27 to 50 mm (1.5 to 2.0 inches) using books. Start the cart close to the Motion Sensor (MS), and give the cart a push up the ramp. The push should be sufficient to allow the cart to travel most of the way up the ramp, but the cart should not contact the backstop. Also, be aware that there are magnets on the cart and the backstop. Make sure the magnets on the cart are facing away from the backstop. It may take several practice runs to determine the proper amount of push to collect reasonable data. After the cart is approximately 12 cm away from the MS, start collection data, and stop collecting data when the cart is approximately 12cm away from the MS as it returns down the ramp. Fit the data, and wait for the TA to observe the data. After the TA has observed the data, print the plots.

After the plot has completed printing, delete the data runs and log off the computer.

Predictions for Part I – Level Track

A cart will be given a push and then allowed to travel along a perfectly level track without any further assistance. Assuming no friction or air resistance, predict the plots of Position vs Time, Velocity vs Time, and Acceleration vs Time and answer the questions.





Which of the four kinematic equations best describes the Position vs Time plot?

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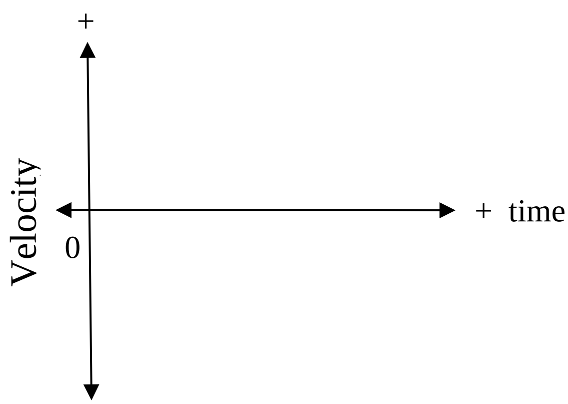
Is the plot Linear or Quadratic? ___________________



Will the velocity change with time or will it remain constant?

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Explain: ____

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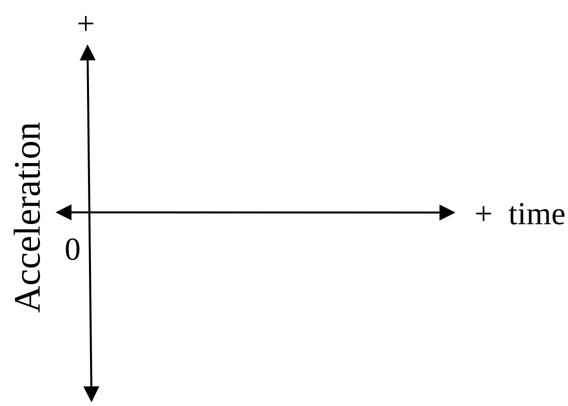

Can you predict a value for the acceleration? __________

If so, what is the value? ___________ Explain: ______

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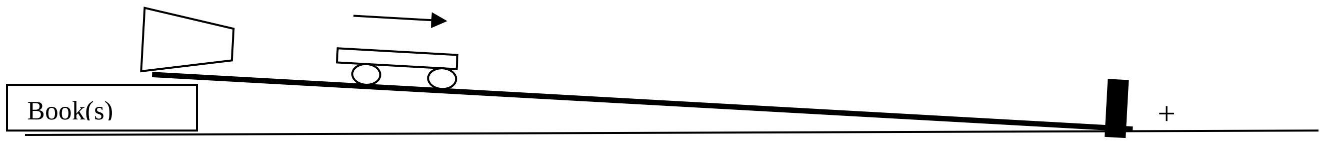
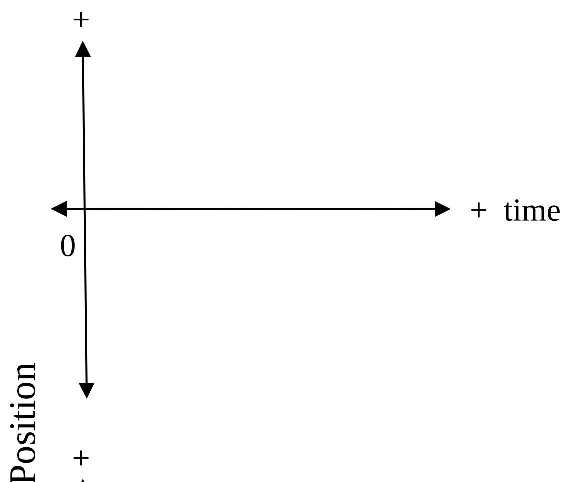
Predictions for Part II - Downhill

A cart will be allowed to travel downhill along a track. Assuming no friction or air resistance, predict the plots of Position vs Time, Velocity vs Time, and Acceleration vs Time and answer the questions.





Which of the four kinematic equations best describes the Position vs Time plot?

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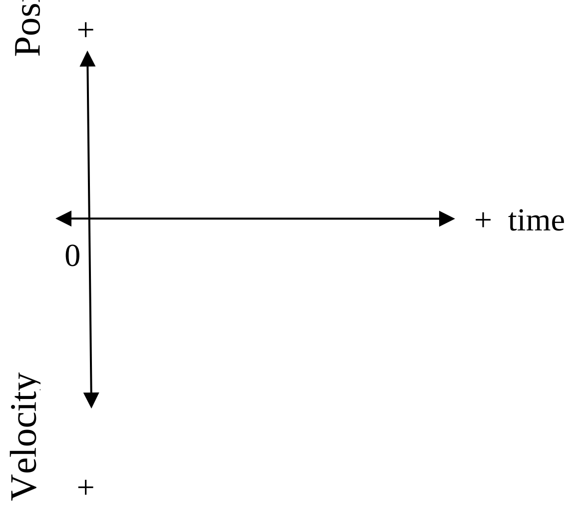
Is the plot Linear or Quadratic? ___________________



Which of the four kinematic equations best describes the Velocity vs Time plot?

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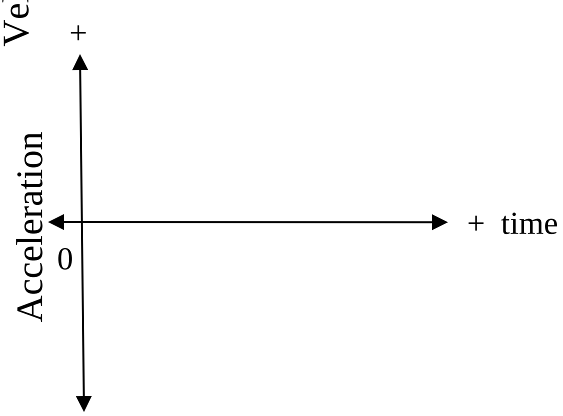
Is the plot Linear or Quadratic? ___________________

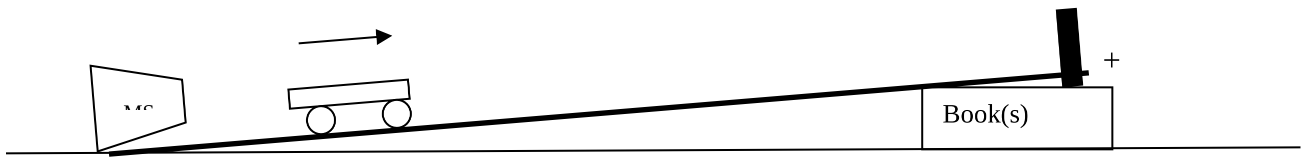


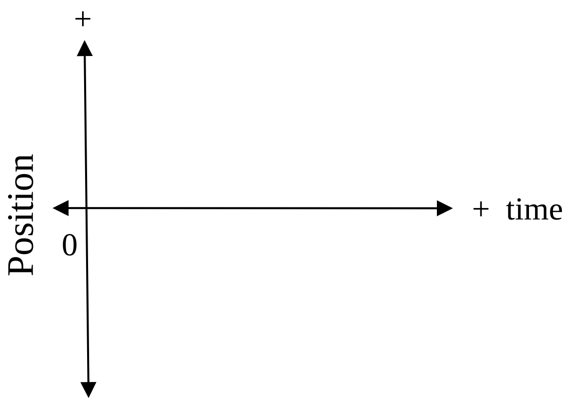
Will the Acceleration vs Time plot start above or below the Time axis? ________________________

Will the plot of the Acceleration vs Time ever cross the Time axis? ________________________

Predictions for Part III – Up and Down a Ramp

A cart will be allowed to travel up and then down a ramp. The cart will be given a strong push to initiate the motion, but it will not be contacted after the initial push. Assuming no friction or air resistance, predict the plots of Position vs Time, Velocity vs Time, and Acceleration vs Time and answer the questions.





Which of the four kinematic equations best describes the Position vs Time plot?

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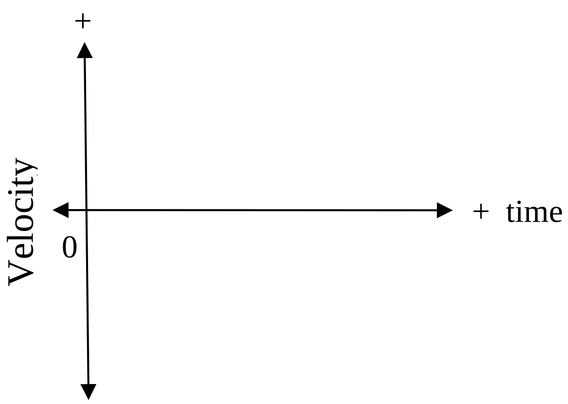
Is the plot Linear or Quadratic? ___________________



Which of the four kinematic equations best describes the Velocity vs Time plot?

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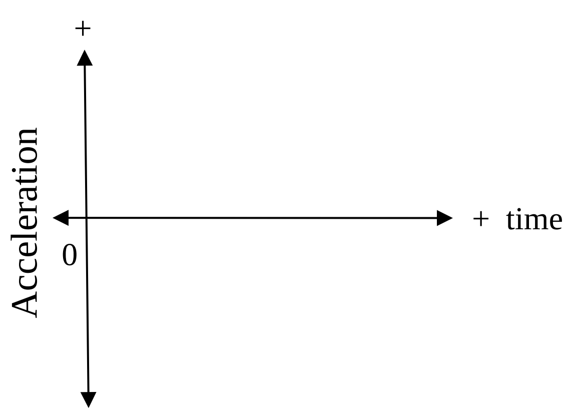
Is the plot Linear or Quadratic? ___________________



Will the Acceleration vs Time plot start above or below the Time axis? ________________________

Will the plot of the Acceleration vs Time ever cross the Time axis? ________________________

Will the value of the Acceleration ever be zero? _______

Explain: ____

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