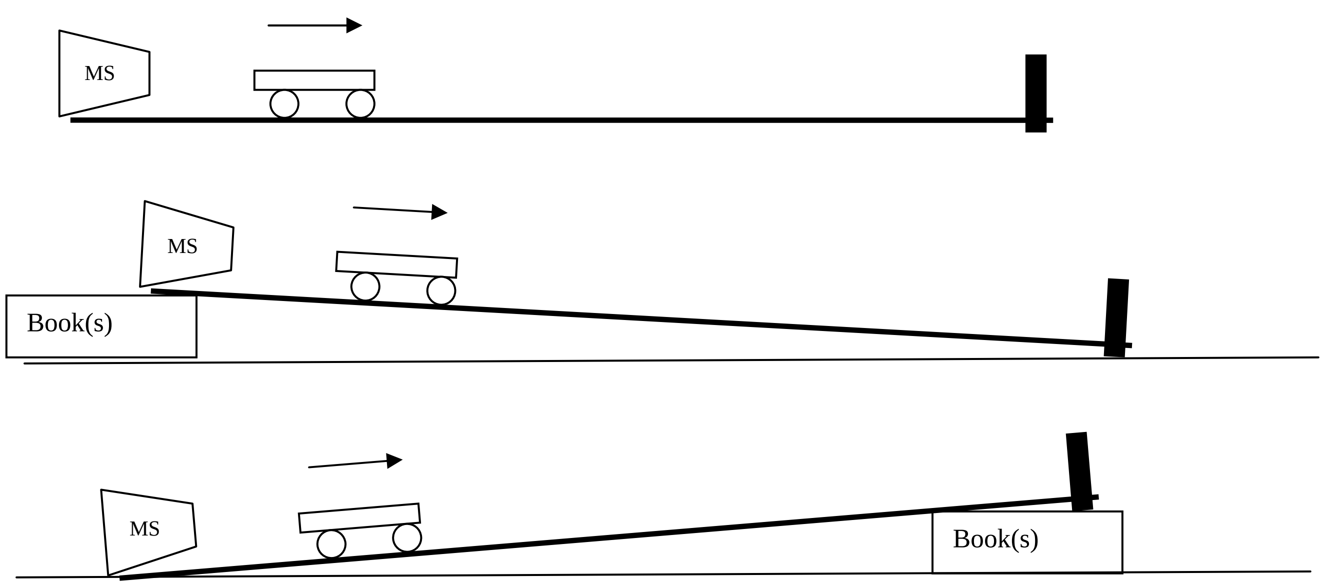
Concepts of One Dimensional Kinematics Activity

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_f – final velocity v_0 – initial velocity x_f – final position x_0 – initial 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, wind 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 you 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 Data Studio software.

Using a bubble level, ensure that your 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.

Open the Lab Doc Folder located on the desktop, and select the “Concepts of 1-D Kinematics” icon. The computer should now be prepared to collect data. When you are ready to collect data, you will need to push the start button. In order to stop collecting date, push the stop button. If you would like to delete a data run, select the “experiment” tab, and choose “delete last run” or “delete all runs”.

Start the cart next to the Motion Sensor (MS), and give the cart a slight push. The push should be sufficiently hard to make the cart reach the end of the track, 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 12cm (~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.

If you are satisfied with the data that you have collected, print your plots and compare the computer generated plots with your predictions. After your graph has completed printing, delete you data runs.

Part II

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

Elevate the end of the track with the MS by 27 to 50mm (1.5 to 2.0 inches) using books. Start the cart next 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.

If you are satisfied with the data that you have collected, print your plots and compare the computer generated plots with your predictions. After your graph has completed printing, delete you data runs.

Part III

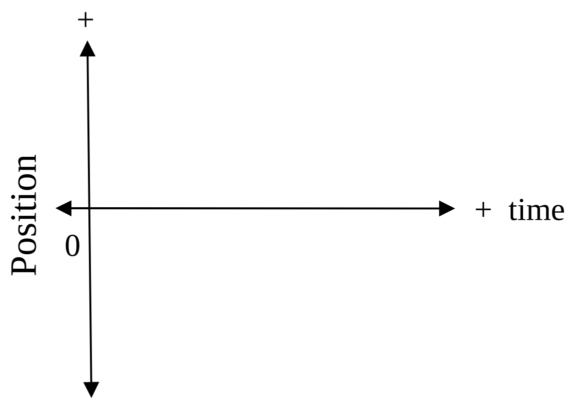
Record you predictions on the provided sheet for a cart traveling up and then down the ramp.

Elevate the end of the track opposite of the MS by 27 to 50mm (1.5 to 2.0 inches) using books. Start the cart next 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.

If you are satisfied with the data that you have collected, print your plots and compare the computer generated plots with your predictions. After your graph has completed printing, delete you 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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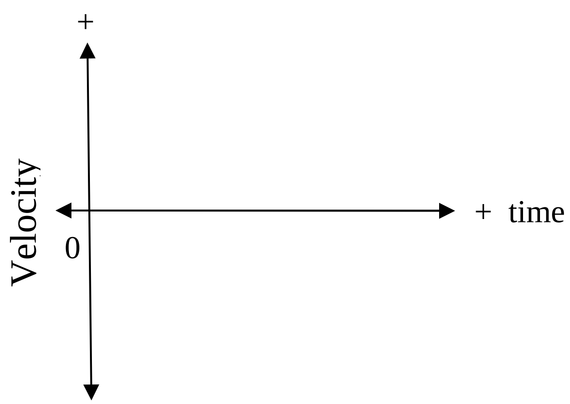
Is the plot Linear or Quadratic? ____________________



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

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Explain: ____

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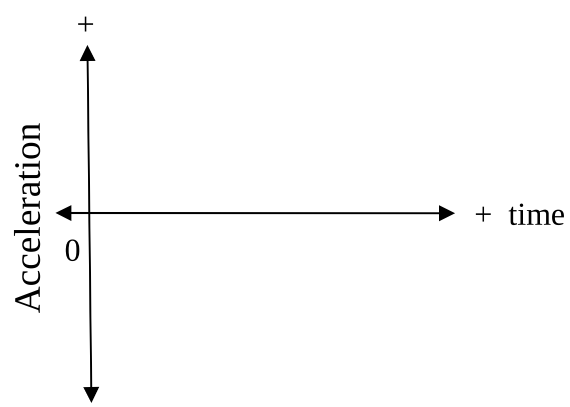

Can you predict a value for the acceleration? __________

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

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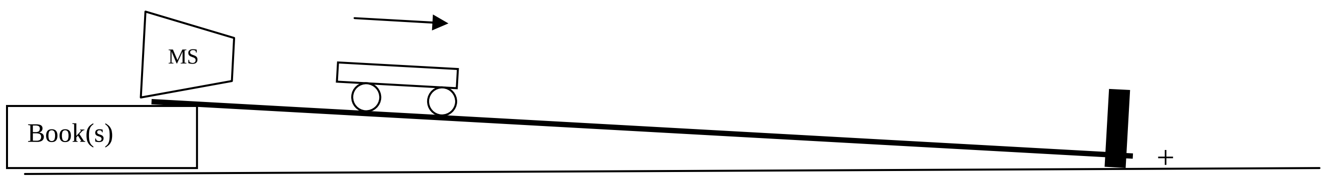
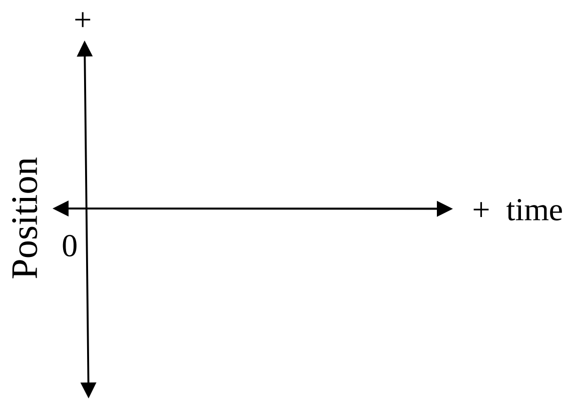
Predictions for Part II - Downhill

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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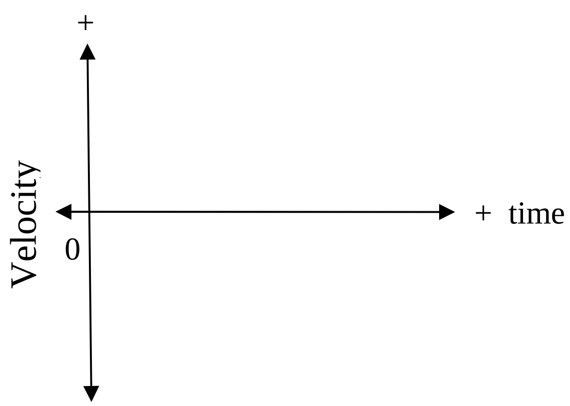
Is the plot Linear or Quadratic? ____________________



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

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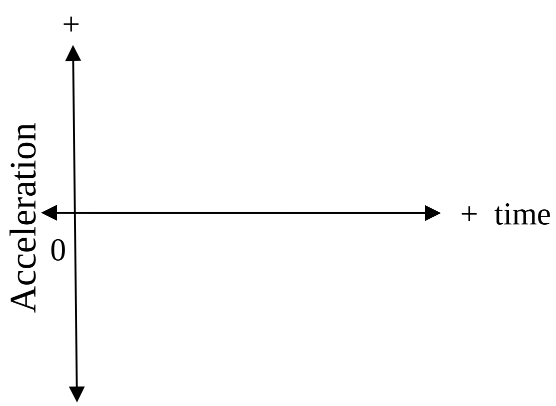
Is the plot Linear or Quadratic? ____________________

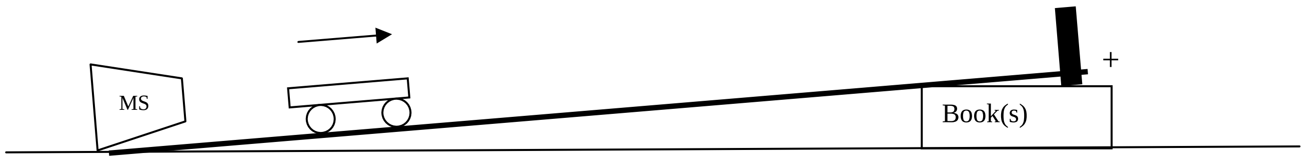


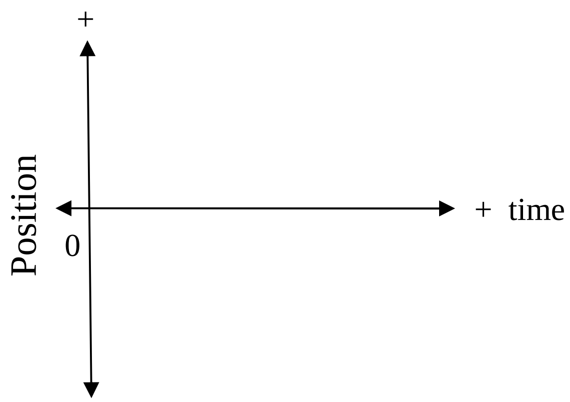
Will the Acceleration vs Time plot start above or below the Time axis? _________________________

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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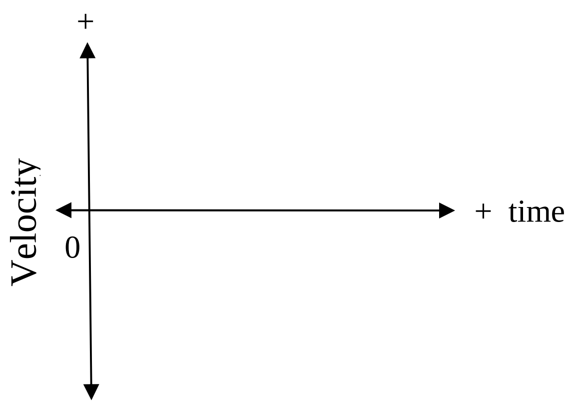
Is the plot Linear or Quadratic? ___________________



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

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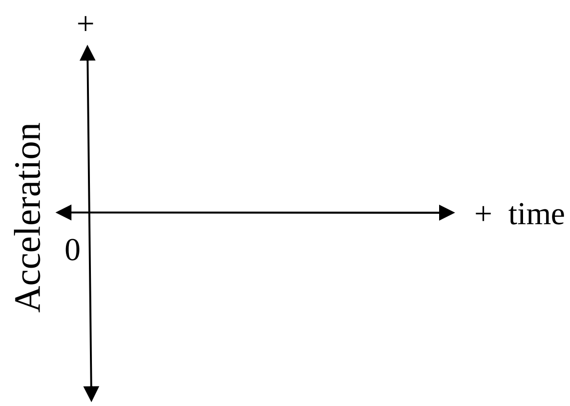
Is the plot Linear or Quadratic? ___________________



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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