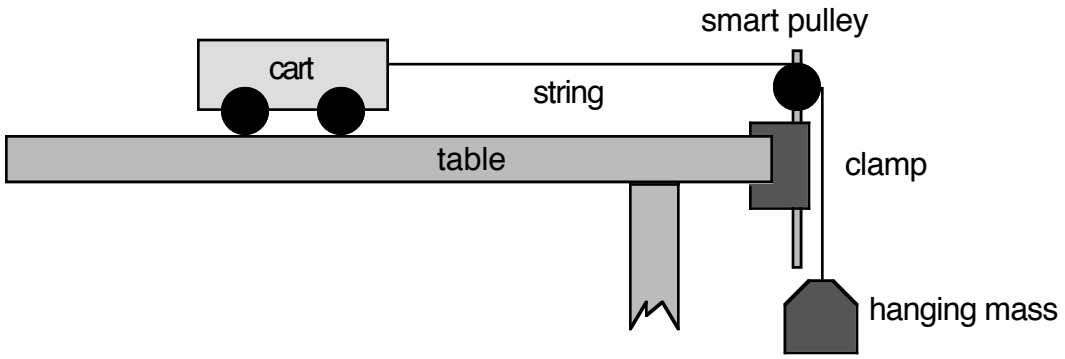
Lab: Kinematics AP Physics

Background
The relationship between an object's position, velocity, constant acceleration, and time can all be described by the *kinematic equations*. A computer-based data collection system allows us to measure position of a moving cart as a function of time and generate graphs of the car's motion.

Objectives
The objectives of this lab are to a) learn to operate the Lab Pro and Logger Pro tools, b) perform graphical analysis of motion data, and c) verify the kinematic equations.

Equipment

Lab table	Computer	LabPro Unit
LoggerPro software	Mass (50.0g)	Smart Pulley
cart	string	table clamp



Procedure
1. Set up cart/pulley system as shown, with Smart Pulley plugged into LabPro.
2. Start up LoggerPro software on computer.
3. Configure Logger Pro so that it recognizes the Smart Pulley as a "photogate timer" with a 10-spoke, inner groove" pulley.
4. Use LoggerPro to collect position-time data for your cart as it accelerates across the table. Be sure to catch the cart before it hits the Smart Pulley. Logger Pro will be displaying position-time, velocity-time, and acceleration-time graphs as the data is collect.
5. Examine the position-time graph, and then the velocity-time graph for the cart's motion. If both graphs have the appropriate shape, use the LoggerPro software to determine the slope of the velocity-time line.
6. Print two copies (one for each lab partner) of the data table and graphs, with both lab partners' names printed in the footer.

Other Stuff
Please refer to the *Checklist of Items to Be Completed for Each Experiment* for what to include in your lab notebook before you start answering the questions below!

ALSO, please note that that your $x_{initial}$ and $v_{initial}$ are almost certainly *not* 0 at time $t = 0$. Your data should allow you to determine what those initial values are for $x_{initial}$ and $v_{initial}$, so that you can use them in your calculations.

Questions
1. What is the velocity of the cart at time t=0.5 seconds? (You may choose a different time to analyze if your cart wasn't moving at t=0.5 s.)
   a. Determine $v_{0.5}$ using the velocity-time data or graph (with explanation).
   b. Determine $v_{0.5}$ using the distance-time data or graph (with explanation).

c. Determine $v_{0.5}$ using the equation $v_2 = v_1 + a\Delta t$, and any data from your data table or graphs. (Explain your method, and identify appropriate data points on graphs.)

d. Determine $v_{0.5}$ using the equation $v_2^2 = v_1^2 + 2a\Delta x$, and any data from your data table or graphs. (Explain your method, and identify appropriate data points on graphs).

2. How far did the hanging mass travel between t=0.25s and t=0.6 seconds? (You may choose a different time interval to analyze if your cart wasn't moving between 0.25 and 0.6 s.)

   a. Determine Δx using the distance-time data or graph (with explanation).

   b. Determine Δx using two data points from the velocity-time data or graph. (Explain your method, and identify appropriate data points on graphs.)

   c. Determine Δx using the equation $x_2 = x_1 + v_1 t + \frac{1}{2} a \Delta t^2$ and any data from your graphs. (Explain your method, and identify appropriate data points on graphs.)

3. Calculate percentage differences between your largest and smallest values in Question 1 and comment. Do the same thing for Question 2.

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Additional Notes

1. This lab handout has a specific description of a lab you have been assigned to perform: it provides you with a specific list of equipment that is to be used, a "cookbook"-style procedure (just follow the instructions), and a specific list of questions to be answered. Some of the labs we do in here will be of this format, but some will be a little more open-ended: you may not receive an equipment list, you may not be given a specific procedure, you may not be given a specific list of questions that must be answered. Nevertheless, in these open-ended labs, you'll be expected to describe the same things in your write-up:

- What are you trying to figure out?
- What equipment are you using?
- What data did you collect?
- How did you analyze the data?
- What conclusions did you come to?
- What sources of error were there in the lab?