From Motion diagrams to Position and Velocity Graphs

Name:

Group Members:

Date:

TA's Name:

Apparatus: Aluminum track and a support, cart, plastic ruler, tape timer, and pencil

Objectives:
1) To be familiar with using motion diagrams.
2) To be familiar with displacement, time interval, instantaneous velocity, average velocity and average acceleration.
3) To extract information from kinematic graphs.

Part A: Creating a Motion Diagram

The apparatus can be used to produce motion diagrams for a cart accelerating down an incline plane (aluminum track). Your TA will demonstrate or assist you in using the tape timer. Use the tape timer set at 10 Hz to produce a motion diagram for the cart moving down the incline plane. In your tape, indicate the direction of motion using an arrow. There must be at least 15 to 20 dots in your tape that can be used as data.

Part B: Measurement and Analysis of Motion Diagrams

1. Establish a coordinate system for the motion diagram and locate the position of each dot. You may read the position to 1mm accuracy. Create a table with time and position data in an Excel spread sheet. Your first data point should be a couple of time intervals after the cart started to move. Your last data point should be before anyone touched the cart to stop it.

2. Using your data, calculate the average velocity of the cart for the entire run. Don't forget about units. Show your calculation.

$\boldsymbol{v_{avg}}$ = ______________________________

3. Make a prediction about where the instantaneous velocity is equal to the average velocity for the whole motion. Will it be at the middle position between the first and last point on the tape or is it at the midpoint of the time? Explain why you predicted this.

4. Calculate displacement and average velocity for the first time interval and show your calculation here.

	Calculation	**Result (with units)**
Δx		
v_{avg}		

5. Use Excel to calculate the displacement and average velocity for each time interval. Use the formula entry to perform the calculation. You can use the Fill Down function to extend the formula to the whole column. C***opy the table and paste it into a Word document.*** Ask your TA for help or view the Excel help video for assistance: http://www.physics.gsu.edu/doluweera/excl-2/excl-2.html

6. Since the time intervals are short, the velocity is not changing very much during each time interval. Therefore, it's reasonable to conclude that the average velocity for each time interval is very close to the instantaneous velocity at that time. Locate the time and position where the instantaneous velocity approximately equals the average velocity for the entire run that you calculated in Question 2. Is it at the middle position between the first and last point on the tape or is it at the midpoint of the time?

7. Does your result in Question 6 match with your prediction in Question 3? Don't change your prediction, instead explain why you got the result you did in Question 6.

8. Using your data for the velocity at the beginning and the end of your motion diagram, calculate the average acceleration of the cart for the entire run. Remember units. Show your calculation.

$\boldsymbol{a_{avg}}$ = ______________________________

Part C: Analysis of Motion Using Position and Velocity Graphs

Now we will use the data we have collected to represent the motion of the cart using graphs of position and velocity.

9. Use your data table for position and time to create a position vs. time graph in Excel. ***Label the axes appropriately (that means units also) and then copy the graph and paste it into your Word document.*** Describe the shape of the plot you found. That is to say, is the position versus time graph a straight line, curved up, curved down, etc.?

10. Why is the **position versus time** graph shaped that way it is? That is to say, how does the shape of the plot describe the motion you observed? In other words, what feature of the graph describes the motion you observed?

11. As mentioned earlier, since the time intervals are short, the velocity is not changing very much during each time interval. So we will use the average velocity for each interval as the instantaneous velocity during that interval. Create the velocity vs. time graph using your data table. ***Label the axes appropriately (that means units also) and then copy the graph and paste it into your Word document.*** Describe the shape of the plot you found, that is, is the velocity versus time graph a straight line, curved up, curved down, etc.

12. Why is the **velocity versus time** graph shaped that way it is? That is to say, how does the shape of the plot relate to the motion you observed? In other words, what feature of the graph describes the motion you observed?

13. What does the shape (straight line or curved up or down) of the **velocity vs. time** graph tell you about the acceleration of the motion you observed? That is, does the shape tell you that the acceleration is constant, increasing or decreasing? Explain.

14. How can you find the acceleration for the entire motion **from your graph**?

15. Use your velocity vs. time graph to determine the acceleration of the whole motion. Compare it with the average acceleration calculated in Question 8.

Acceleration from the velocity. vs. time graph	
Average acceleration calculated in Question 8 directly from the data	

If they are different, what are the possible reasons?

Instructions on how to submit the graphs:

1. Open a Word document and type the names of all present group members.
2. Copy and paste your data table to the Word document.
3. Copy and paste your "position vs. time" graph to the Word document. The graph must contain name of the graph, axes names with units to earn full credits.
4. Copy and paste your "velocity vs. time" graph to the Word document. The graph must contain name of the graph, axes names with units to earn full credits.
5. Pay attention to formatting of the Word document so that you don't waste paper.
6. Print the Word document (once for each person) and staple it to this lab to hand in to your TA. Also keep a copy for yourself (on flash drive or e-mail it to yourself).