Phys1111: Representations of Motion in One Dimension

Name:

Group Members:

Date:

TA’s Name:

Apparatus: Aluminum track and supports, PASCO Smart Cart, two cart stops (one for each end of track).

Objectives:
1) To be able to define acceleration and determine its sign.
2) To connect the signs of velocity and acceleration with speeding up and slowing down motions.
3) To understand the relationships between position and velocity vs. time graphs and acceleration.

Part A: Set-up and Coordinate System

When the cart is set into motion on an inclined aluminum track, it will move with a constant acceleration that depends on the angle of the track with the horizontal. By giving a small push to start it, the cart can be made to move either toward or away from the cart stop at top of the incline. In each case, the Smart Cart sensors will capture the motion of the cart and Capstone software will plot position vs. time, and velocity vs. time on the computer.

We will choose a coordinate system such that the top cart stop is at the origin and the positive direction is pointing away from the top cart stop toward the bottom of the incline. Also please note that Smart Cart has its own built in coordinate system as shown on the cart with x,y,z directions. Therefore you should align smart card coordinate system +x direction with the above selected coordinate system on the incline before doing the experiment and keep the orientation of the cart same throughout the experiment.

1. Given our coordinate system, as the cart moves up or down the track, describe when the position will be positive and when it will be negative?

2. Given our coordinate system, as the cart moves up or down the track, describe when the velocity will be positive and when it will be negative?

3. Given our coordinate system, as the cart moves up or down the track, describe when the acceleration will be positive and when it will be negative?
Part B: Equipment set-up and practice

Set up your cart and track as shown by your TA. Launch Capstone on your computer. Then start a new experiment and select “two displays.” Each Smart Cart has a number and make sure to select the correct Smart Cart by matching the Smart Cart number to connect the carts to the software. Select one display to be a graph and select position as the measurement. Select the other display to be a graph of velocity. Set the number of decimal places to 3 for each variable by choosing Data Summary on the left side menu bar and selecting the Properties for each measurement then selecting Numerical Format. After changing Number of Decimal Places to 3, click OK and proceed to the Properties for the next variable. See instructor if you need help with this.

Take some practice data while carefully moving the cart on the incline with cart +x direction pointed downward as explained above.
Part C: Graphs for Speeding Up

4. Use the inclined track to produce a motion where the cart is \textit{speeding up}. Draw a sketch and describe the set-up you needed to get that motion (for example, which way is track tilted, where does cart start and which direction is it moving).

5. Record position vs. time and velocity vs. time graphs using Capstone. Expand the scale of the position vs. time graph to see it well. Is the position positive or negative? ________________

6. Describe the shape of the position vs. time graph.

7. Also expand the velocity vs. time graph so that it’s easier to see. Is the velocity positive or negative? ________________

8. Describe the shape of the velocity vs. time graph.

9. In Capstone, highlight the velocity data for the part of the motion that corresponds to the cart speeding up. Use the fitting tool to determine the acceleration by finding the slope of the velocity vs. time data (just for the part of the motion where the cart is speeding up).

   \[ \text{Acceleration} = \text{___________} \]  \hspace{1cm} (Remember sign and units)

10. Is the acceleration positive or negative? ________________________________

11. Is the velocity vector up the incline or down? ________________

   Is the acceleration vector up the incline or down? ________________

   On your sketch in Question 4, draw the velocity and acceleration vectors and label them.

   \textit{Have your TA check your graphs for Speeding Up and initial below before you go on.}

   \textit{TA initials:}
Part D: Graphs for Slowing Down

12. Now use the inclined track to produce a motion where the cart is slowing down. Draw a sketch and describe the set-up you needed to get that motion.

13. Record position vs. time and velocity vs. time graphs using Capstone. Expand the scale of the position vs. time graph to see it well. Is the position positive or negative? ________________

14. Describe the shape of the position vs. time graph.

15. Also expand the velocity vs. time graph so that it’s easier to see. Is the velocity positive or negative? ________________

16. Describe the shape of the velocity vs. time graph.

17. In Capstone, highlight the velocity data for the part of the motion that corresponds to the cart slowing down. Use the fitting tool to determine the acceleration by finding the slope of the velocity vs. time data (just for the part of the motion where the cart is slowing down).

   Acceleration = ________________  (Remember sign and units)

18. Is the acceleration positive or negative? ________________________________

19. Is the velocity vector up the incline or down? ________________

   Is the acceleration vector up the incline or down? ________________

   On your sketch in Question 12, draw the velocity and acceleration vectors and label them.

   Have your TA check your graphs for Slowing Down and initial below before you go on.
   TA initials:
Part E: Comparing Speeding Up and Slowing Down

20. Compare the sign of the acceleration for these speeding up and slowing down cases. Is sign of the acceleration the same or different? ________________

Explain why that makes sense.

21. Does the sign of the acceleration alone tell you whether an object is speeding up or slowing down? Why or why not?

22. For speeding up, compare the direction of the velocity and acceleration vectors. Are they in the same or opposite directions? ____________________________

Do you think this will always be true? Why or why not?

23. For slowing down, compare the direction of the velocity and acceleration vectors. Are they in the same or opposite directions? ____________________________

Do you think this will always be true? Why or why not?
Part F: Graphs for motion with a Turning Point

24. Produce a motion where the cart *slows down to a stop, then speeds up in the opposite direction*. Record position vs. time and velocity vs. time graphs using the Capstone software. Describe the shape of the position vs. time graph identifying which point is the turning point.

25. Describe the shape of the velocity vs. time graph identifying which point is the turning point.

26. Is the acceleration positive, negative, or zero as the cart slows down? ________________
   Explain how you know that from your graphs.

27. Is the acceleration positive, negative, or zero as the cart speeds up? ________________
   Explain how you know that from your graphs.

28. Is the acceleration positive, negative, or zero at the turning point? ________________
   Explain how you know that from your graphs.

*Have your TA check your graphs for Turning Point and initial below before you turn in the lab.*

*TA initials:*