Representations of Motion in One Dimension:

Speeding up and slowing down with constant acceleration

Name:

Group Members:

Date:

TA's Name:

Apparatus: Aluminum track and supports, cart, motion sensor, and PASCO interface

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 motion sensor. In each case, the motion sensor 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 motion sensor is at the origin and the positive direction is pointing away from the motion sensor since this is the default choice in Capstone.

1. Given our coordinate system, when will the position be positive?

2. Given our coordinate system, when will the position be negative?

3. Given our coordinate system, when will the velocity be positive?

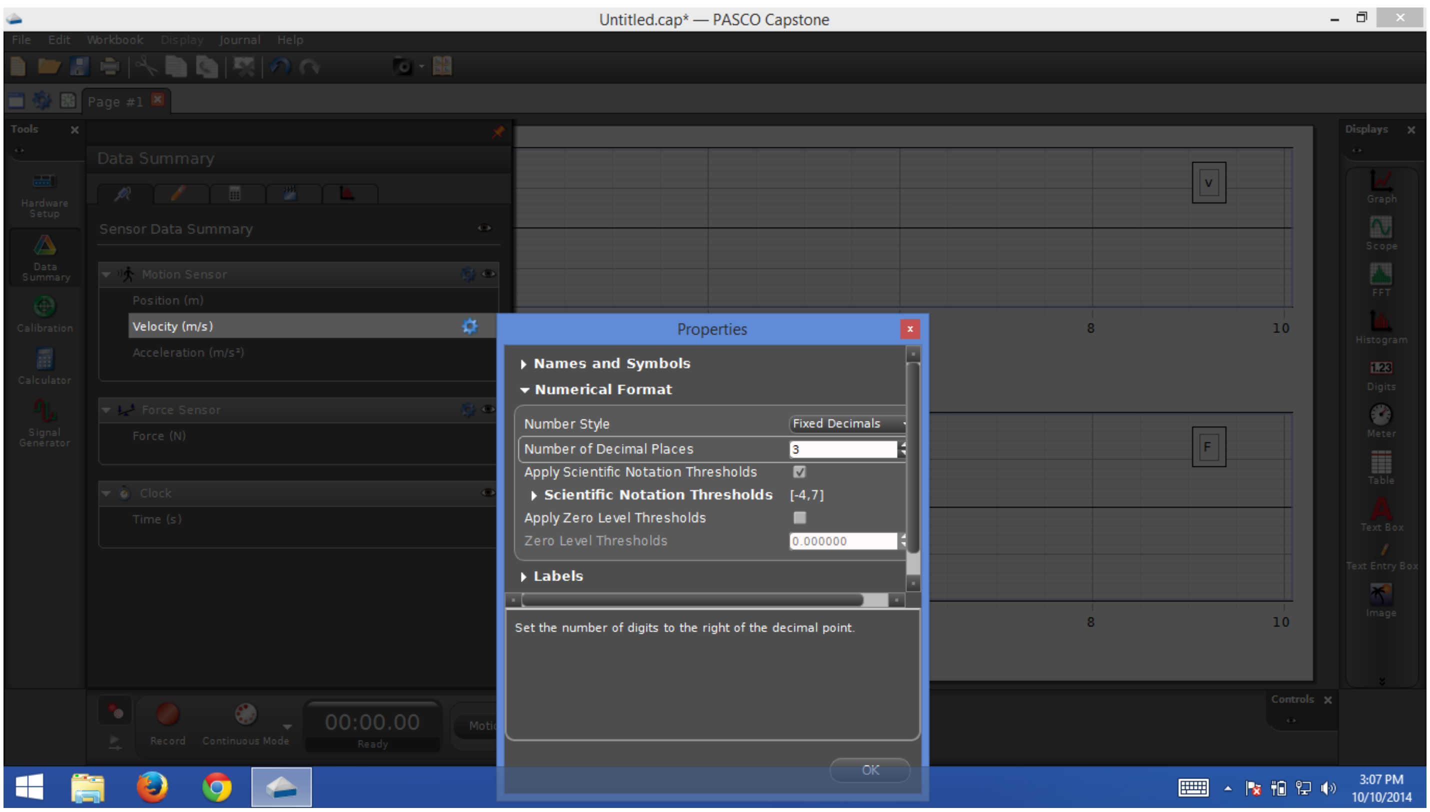
4. Given our coordinate system, when will the velocity be negative?

5. Given our coordinate system, when will the acceleration be positive?

6. Given our coordinate system, when will the acceleration be negative?

Part B: Graphs for speeding up and slowing down

Set up your cart, track, and motion sensor as shown by your TA. Connect the computer to the motion sensor through the USB cable and PASCO interface box. Launch Capstone on your computer then start a new experiment and select “two displays.” 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 moving the cart toward the motion sensor. Then take some practice data while moving the cart away from the motion sensor. Make sure your sign convention is the same as the sign convention used by the software.

7. Use an inclined track to produce a motion where the cart is ***speeding up*** and has a ***positive acceleration***. 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).

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

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

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

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

12. 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 for that part of the motion.

    Acceleration = ____________________ (Remember units)

    Is the acceleration positive as you expected? ________________
    If not, go back to question 7 and try again.
    If it is positive, ***copy the graphs into your Word document***.

13. Now use an inclined track to produce a motion where the cart is ***slowing down*** and has a ***positive acceleration***. Describe the set-up you needed to get that motion.

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

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

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

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

18. Determine the acceleration by finding the slope of the velocity vs. time data for the part of the motion that corresponds to when the cart is slowing down.

    Acceleration = ____________________ (Remember units)

    Is the acceleration positive as you expected? ________________
    If not, go back to question 13 and try again.
    If it is positive, ***copy the graphs into your Word document.***

19. Looking back at the data for the cart speeding up, describe the sign of the velocity and how the magnitude was changing (is magnitude increasing or decreasing?).

20. Explain how these changes in the velocity vector result in a positive acceleration.

21. Looking back at the data for the cart slowing down, describe the sign of the velocity and how the magnitude was changing (is magnitude increasing or decreasing?).

22. Explain how these changes in the velocity vector result in a positive acceleration.

23. From the data for both speeding up and slowing down, what should we conclude about how the velocity vector must be changing to get a positive acceleration?

24. What direction is the acceleration vector in each of these two situations?

Part C: Graphs for motion with a turning point

25. Produce a motion where the cart ***slows down to a stop, then speeds up in the opposite direction***. Describe the set-up you needed to get that motion.

26. Record position vs. time and velocity vs. time graphs using the Capstone software and ***copy the graphs into your Word document.*** Describe the shape of the position vs. time graph identifying which point is the turning point.

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

28. Now look carefully at the velocity vs. time graph.
    Is the velocity positive or negative while the cart is slowing down?

    Is the change in the velocity positive or negative while the cart is slowing down?

    Determine the acceleration for this part of the motion: Acceleration = ________________

29. Is the velocity positive or negative while the cart is speeding up?

    Is the change in the velocity positive or negative while the cart is speeding up?

    Determine the acceleration for this part of the motion: Acceleration = ________________

30. Does the acceleration have the same sign for both parts of the motion? Explain why.

31. Is the magnitude of the acceleration essentially the same for the slowing down and speeding up parts of the motion? Explain why or why not.

32. Determine the acceleration by finding the slope of the velocity vs. time data for the entire motion, slowing down and speeding up. Remember units.

    Acceleration = ____________________

33. What is the acceleration at the point in the motion where the velocity is zero?

34. How can there be a non-zero acceleration when the velocity is zero?

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 "position vs. time" and "velocity vs. time" graphs to the Word document. The graph must contain name of the graph, axes names with units to earn full credits. You should have graphs for speeding up, slowing down, and turning point motions.
3. Pay attention to formatting of the Word document so that you don't waste paper.
4. 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).