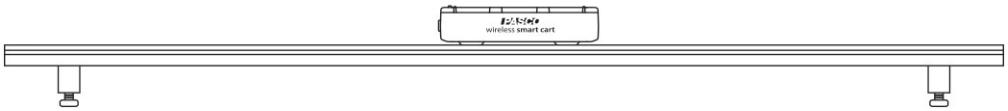
SMART CART – AVERAGE SPEED AND VELOCITY

Materials and Equipment

- Smart cart
- Dynamics track with feet

Part1 – Average Speed and Average Velocity

1. Set up the track and cart like the picture. Adjust the feet to level the track.



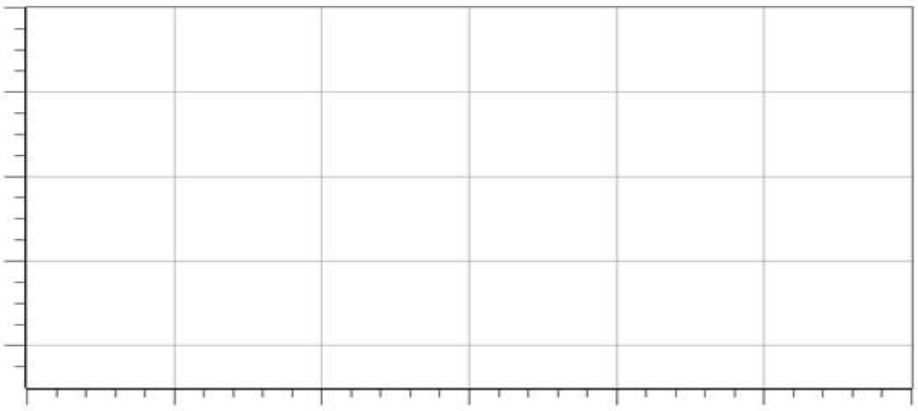
2. Open the experiment file **SC Average Speed &Velocity**, and then power-on the Smart Cart and connect it wirelessly to your software.

3. Page 1 of the experiment file is a graph of Position and Distance versus Time for the cart.

4. Place the cart in the center of the track, Velcro® to the left. Start recording data, and then roll the cart back and forth down the length of the track several times using your hand until data recording stops automatically after 10 seconds.

5. Sketch a copy of your graph below (sketches do not need to be exactly to scale). Indicate in your sketch which line is distance, and which line is position.

Graph 1: Position-time and distance-time graph of a cart rolling back and forth



6. Use the tools in the graph to determine the cart's distance traveled (from $t = 0$ s) and position at the times shown in Table 1. Record the distance and position values into Table 1.

Table 1: Distance and position data of a cart rolling back and forth

Time, t (s)	Distance, d (m)	Position, x (m)
1.0		
2.0		
5.0		
6.0		
9.0		

7. Use your data in Table 1 to calculate the cart's average speed $v_{avg} = \Delta d/\Delta t$ and average velocity $\vec{v}_{avg} = \Delta x/\Delta t$ for the time intervals shown in Table 2. Record your results into Table 2.

Table 2: Average speed and average velocity data of a cart rolling back and forth

Time Interval, Δt (s)	Average Speed v_{avg} (m/s)	Average Velocity $\vec{v}_{avg}$ (m/s)
1.0 – 2.0		
2.0 – 5.0		
5.0 – 6.0		
5.0 – 9.0		

8. Was the cart's average speed and average velocity the same (or close to the same) in any of the time intervals in Table 2?
If **YES**, how do the shapes of your distance-time and position-time graphs compare during the interval?
If **NO**, do you see a different time interval in your graph where they might be the same? What is that interval, and what about the graphs suggests that average speed and average velocity are the same during it?

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9. Was the cart's average speed positive but average velocity negative in any of the time intervals in Table 2?
If **YES**, how do your distance-time and position-time graphs compare during the interval?
If **NO**, do you see a different time interval in your graph where this may be true? What is that interval, and what about the graphs suggests that average speed is positive and average velocity is negative?

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10. Was the cart's average speed negative in any of the time intervals in Table 2? Was the cart's average speed ever negative? Why or why not.

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Part 2 – Instantaneous Velocity

11. Page 2 of the experiment file is a graph of the cart's Position versus Time data.

12. Use the graph's coordinates tool and slope tool to determine the cart's position, and the slope of the cart's position-time graph, at the times shown in Table 3. Record the slope values as Instantaneous Velocity $\vec{v}$ in Table 3.

Table 3: Position and instantaneous velocity of a cart rolling back and forth

Time (s)	Position (m)	Instantaneous Velocity $\vec{v}$ (m/s)
3.0		
5.5		

13. How does the cart's instantaneous velocity at 3.0 s compare to its average velocity during the 2.0 – 5.0 s time interval? Why are they similar or different?

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14. How does the cart's instantaneous velocity at 5.5 s compare to its average velocity during the 5.0 – 6.0 s time interval? How would the comparison differ if average velocity had been calculated over a shorter time interval from 5.45 s to 5.55 s? Explain your answer.

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15. Is it possible for the cart to have positive position and negative instantaneous velocity, and vice versa? How do you know?

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