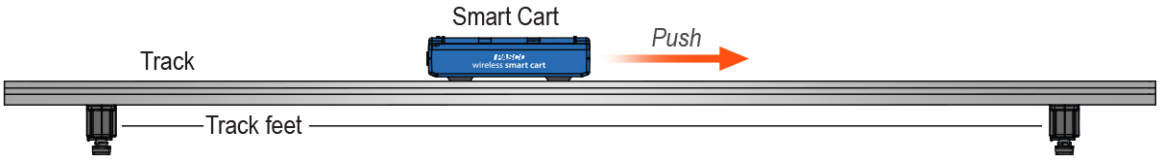
Investigation 3B: Motion graphs

Essential Question: How do we predict and object's position at a later time?

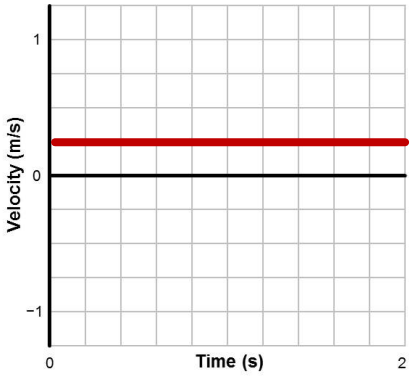
Graphs and equations are valuable methods for describing the motion of an object. Position versus time and velocity versus time graphs can describe where an object is located, how fast it is going, and which direction it is headed. In this activity, you will adjust the motion of a Smart Cart to match the velocity-time graphs below.

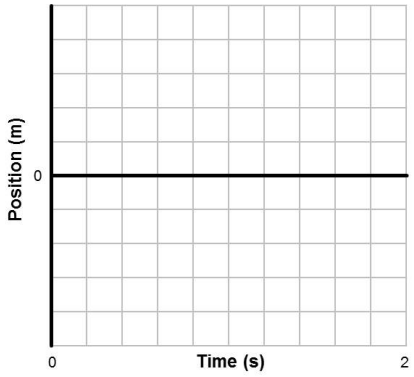
Part 1: Matching the motion of a Smart Cart



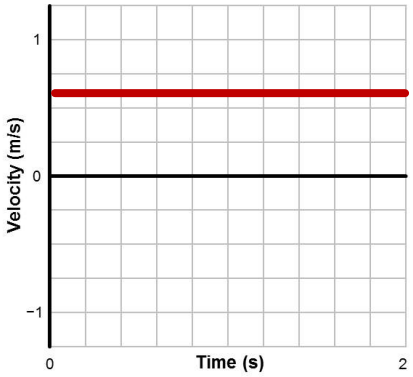
1. Set up your equipment like the picture.
2. Open the experiment file **03B_MotionGraphs**, and then power-on the Smart Cart and connect it wirelessly to the software.
3. Do the following for each velocity-time graph below:
   a. Sketch a *prediction* for the corresponding position-time graph. Label the prediction.
   b. Find the page in the experiment file with the corresponding velocity-time match graph. Hide any data so the position-time graph is blank and only the velocity-time match graph is shown.
   c. Place the cart on the track and record data as you push, pull, roll, or use your hand to move the cart so that its velocity-time data matches the velocity-time match graph.
   d. Sketch the *actual* position-time graph in the same graph as your prediction.

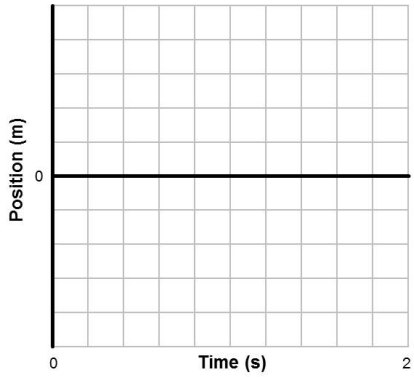
Moving forward at a slow speed (Ex. pg1)



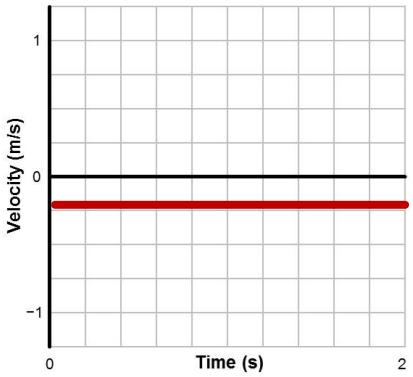


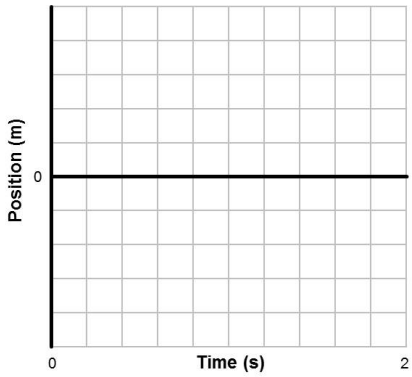
Moving forward at a fast speed (Ex. pg2)



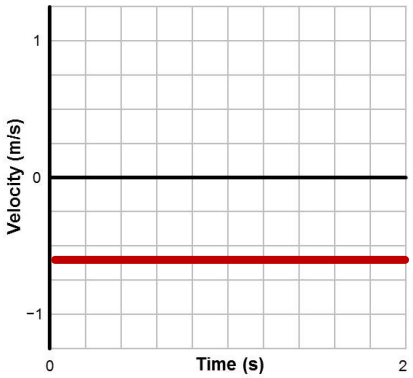


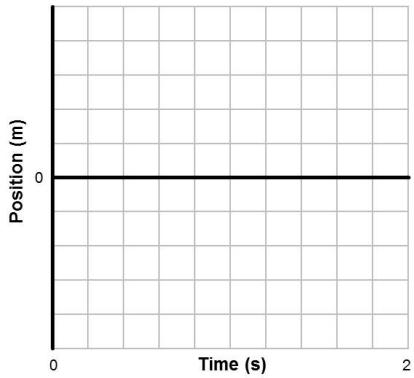
Moving backward at a slow speed (Ex. pg3)





Moving backward at a fast speed (Ex. pg4)





Questions

a. How does the position graph for a high positive velocity differ from a lower positive velocity?

b. How does the velocity graph for a high positive velocity differ from a lower positive velocity?

c. How does the position graph for a negative velocity differ from positive velocity?

d. How does the velocity graph for a negative velocity differ from a positive velocity?

e. Describe a situation for which the position versus time graph and the velocity versus time graph are both flat (zero slope) horizontal lines.

f. Go to page 5 in the experiment file and hide any data so the velocity-time graph is blank and only the position-time match graph is shown.

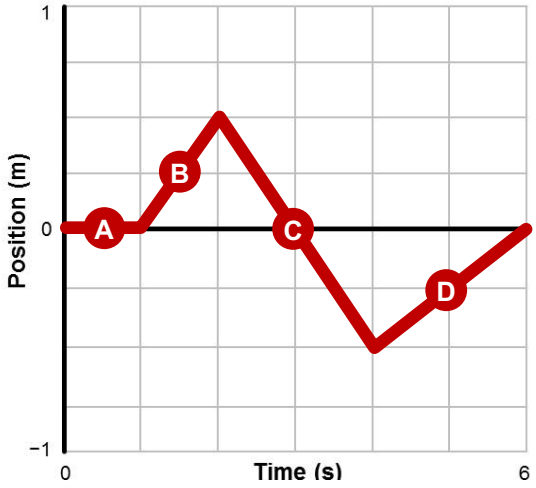
Record data to match the position-time graph, and then describe the motion of the cart during each section shown in the graph to the right. Use terms such as forward, backward, at rest, fast, and slow.

A:

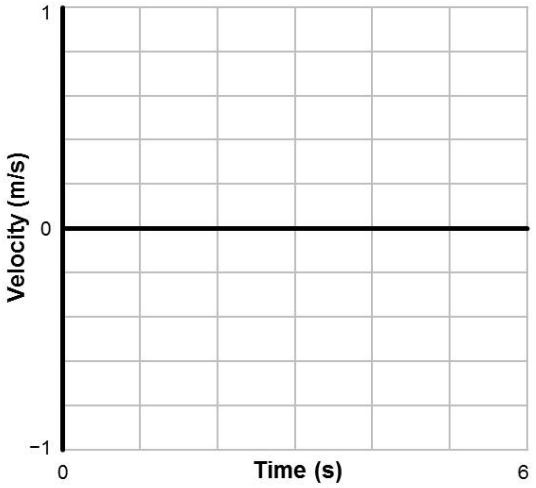
B:

C:

D:



g. Draw the resulting velocity-time graph. Label each section corresponding to the letters in the position-time graph above.



h. Use the slope tool in your software to find the slope of the position-time graph in each section A, B, C, and D. Record the slopes below. How does the slope of the position time graph compare to the velocity recorded during the same period?

A:

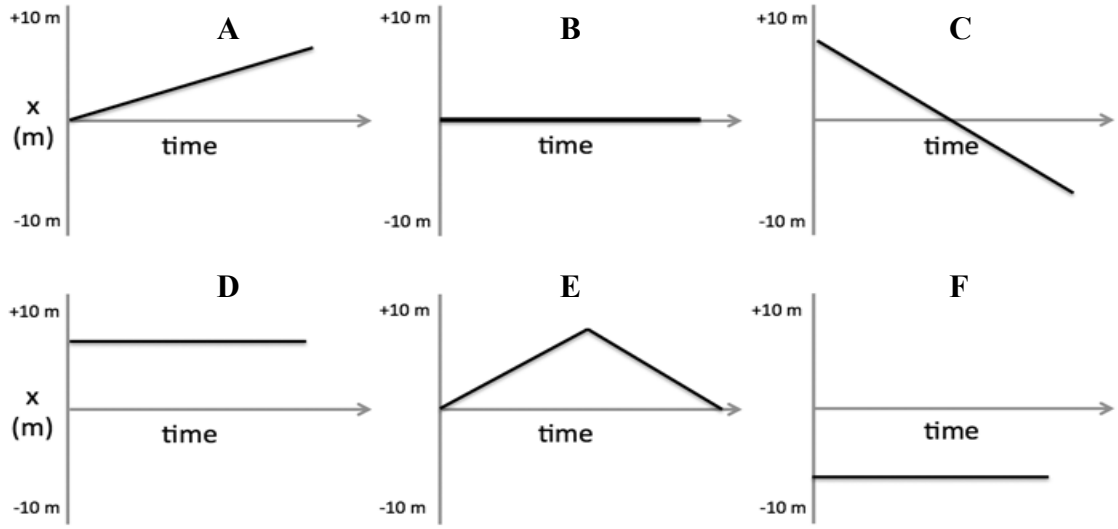
B:

C:

D:

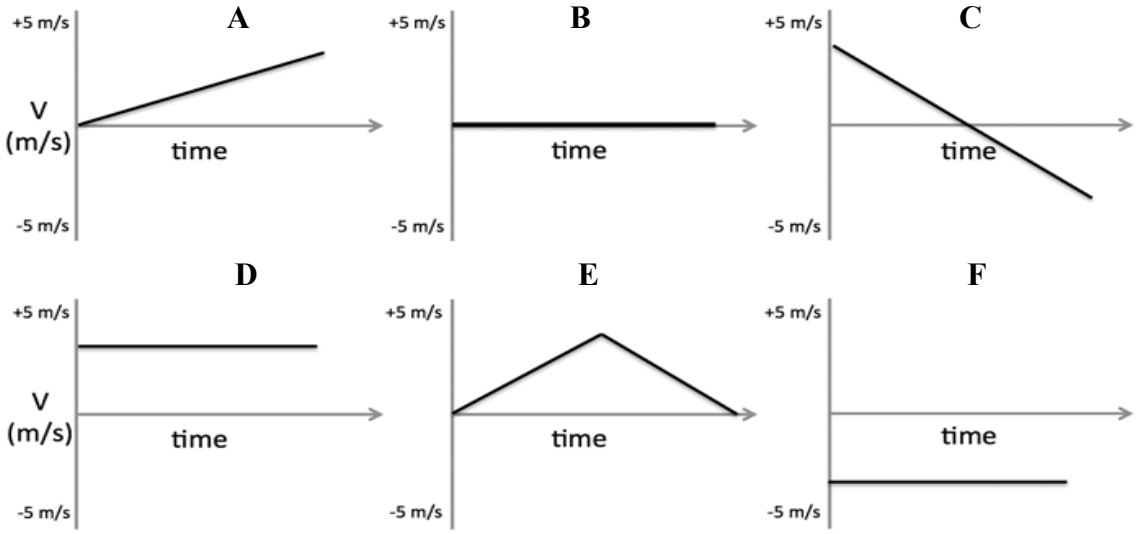
Applying new knowledge

Questions 1 – 4: Match each description of motion with the correct position versus time graph(s). There may be more than one correct answer.



1. The object is stopped. _____
2. The object is moving with constant positive velocity. _____
3. The object is moving with constant negative velocity. _____
4. The object turns around. _____

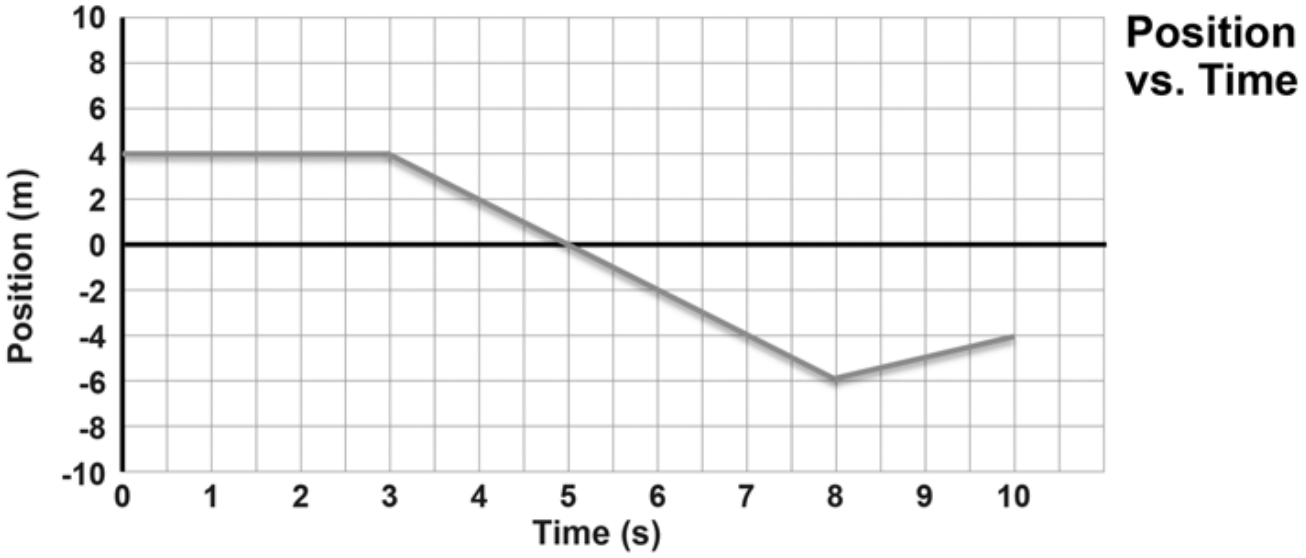
Questions 5 – 8: Match each description of motion with the correct velocity versus time graph(s). There may be more than one correct answer.



5. The object is stopped. _____
6. The object is moving with constant positive velocity. _____
7. The object is moving with constant negative velocity. _____
8. The object turns around. _____

Questions 9 – 11: The motion of a robotic car is shown on the position versus time graph below. Calculate the velocity during each time interval. (DO include signs!)

9. The velocity from 0 to 3 seconds: _____
10. The velocity from 3 to 8 seconds: _____
11. The velocity from 8 to 10 seconds: _____



12. Create the velocity versus time graph for the robotic car.