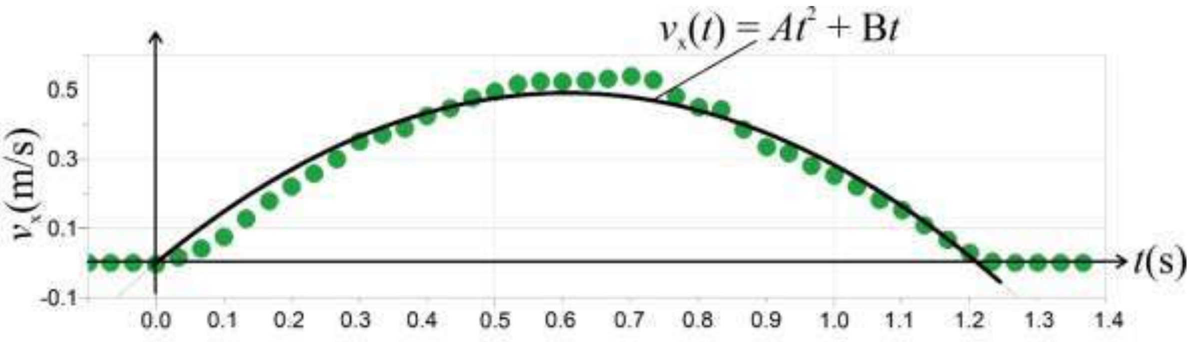
Pull-back car

Watch the following video that shows launching a pull-back car on a horizontal track
https://youtu.be/lPPH8VgJ6L0

a. Draw a motion diagram for the car. We recommend that your motion diagram consists of about 7 points. Do not forget to draw the $\Delta\vec{v}$ vectors as well.

The figure below shows the velocity-versus-time graph for the cart in the experiment. The time t=0 is the moment when the car is released.



We used graph analysis tools to determine the following mathematical function that best fits the measured points:

$$v_x(t) = At^2 + Bt$$
$$A = -1.3 \text{ m/s}^3$$
$$B = 1.6 \text{ m/s}^2$$

b. Are the units of the constants *A* and *B* correct? How do you know? Explain.

c. Using the function $v_x(t)$, determine the function $a_x(t)$ that describes the time dependence of the acceleration of the car over the observed time interval.

d. Sketch the graphs of the functions $v_x(t)$ and $a_x(t)$ on the whiteboard one below the other (the units on the vertical axes are not important). Do the graphs match the motion diagram you drew in step a? Explain. Give as many details as possible that show that the graphs and the motion diagram describe the same motion.

e. Find the zeros of the function $v_x(t)$ and explain their physical meaning.

f. Using the function $v_x(t)$, calculate the distance *d* travelled by the car from t=0 to the time when it reached its final position.

g. Watch the video again and compare the calculated distance *d* with the actual distance in the experiment. If you have done your calculations correctly, you will find that the results differ by less than 3%. How is it that the agreement is so good even though, as you can see in the graph above, the function deviates from the measured points by well over 3% in several places?