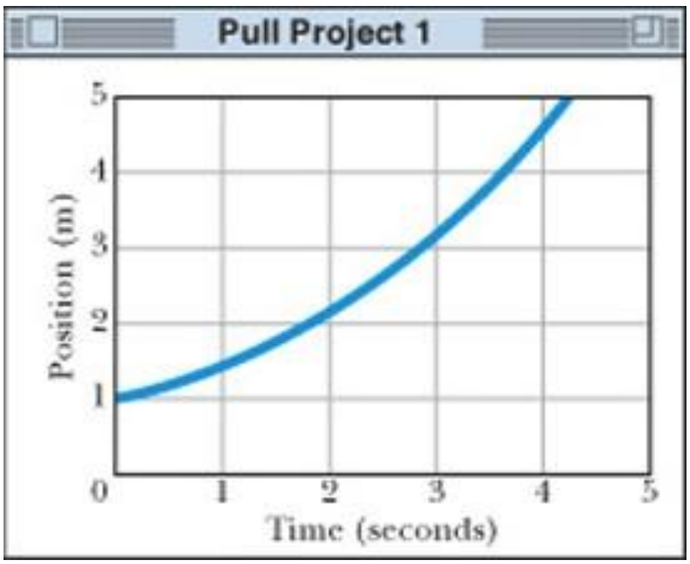
Unit 5 *Homework Problems*

5-1) Edward pulls Linda across a smooth floor with a big spring scale that is stretched to a constant length. In one case she is riding on a low friction cart and in the other case she is sliding along the floor while sitting on a blanket. A motion detector is set up to track her motion in each time.

The graph and data table that follow below shows data recorded by a motion detector for Linda's position vs. time as she is being pulled across the floor with a steady force while riding on a low friction cart.

(a) Since the graph looks parabolic (that is, like a 2nd order polynomial), find a kinematic equation that describes the position data in the first 3 seconds of Linda's motion (for the first 7 data points). To do this, transfer the first 3 seconds of data to an Excel *ModelingWorksheet* spreadsheet and model the data. I want you to continue practicing your modeling skills, so please do ***not*** use the "Add Trendline" feature of Excel. Write down the equation you found in the form $x = A\,t^2 + B\,t + C$. In other words, determine the best fit estimates for the values of A, B, and C. (Don't forget your units!)



t (s)	x (m)
0.00	1.05
0.50	1.20
1.00	1.44
1.50	1.59
2.00	1.99
2.50	2.52
3.00	3.15
3.50	3.88
4.00	4.66

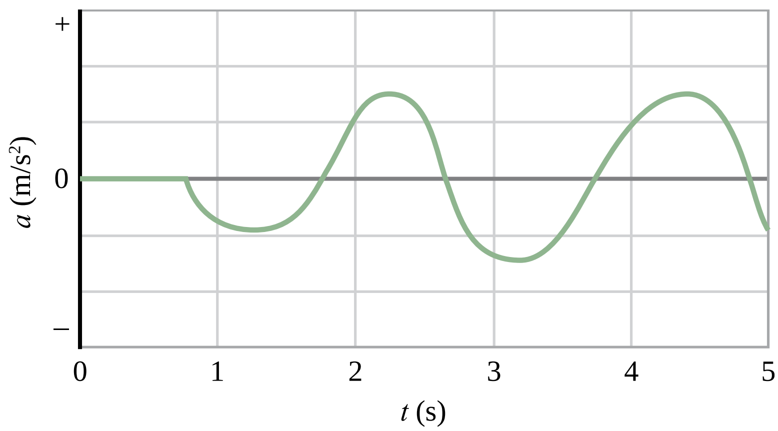
(b) According to the equation you obtained, what is Linda's initial position relative to the motion detector (at $t = 0.0$ s)? What is her initial velocity (at $t = 0.0$ s)? What is the value of the acceleration between $t = 0.0$ s and $t = 3.0$ s? Hint: The acceleration is not A.

(c) According to the equation, when is the acceleration positive, negative, or zero during the time period between 0.00 s and 3.00 s? Is the acceleration constant during that entire period of time? What is the evidence for this?

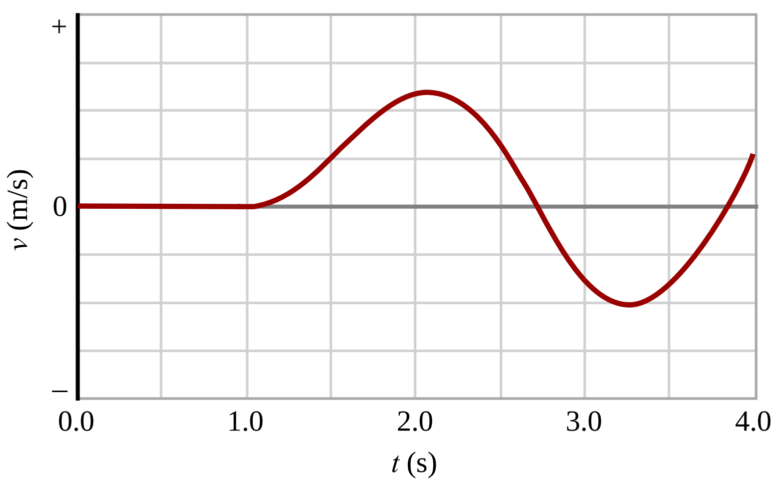
(d) Use the kinematic equation you found to predict the x-value of Linda's position at $t = 4.00$ s. Recall that this is a special case where $t_1 = 0$ s, so that $(t - t_1) = (t - 0\text{ s}) = t$.

(e) How does your predicted position compare with the measured position? Please list both positions as part of your answer. (You may also need to do a % difference – hint, hint.)

5-2) (a) A force is applied to an object that experiences very little friction. This force causes the object to move resulting in the acceleration vs. time graph as shown below. Draw a set of graph axes with the same number of time units as that shown in the acceleration graph and carefully sketch the shape of a possible graph of force vs. time on the object.

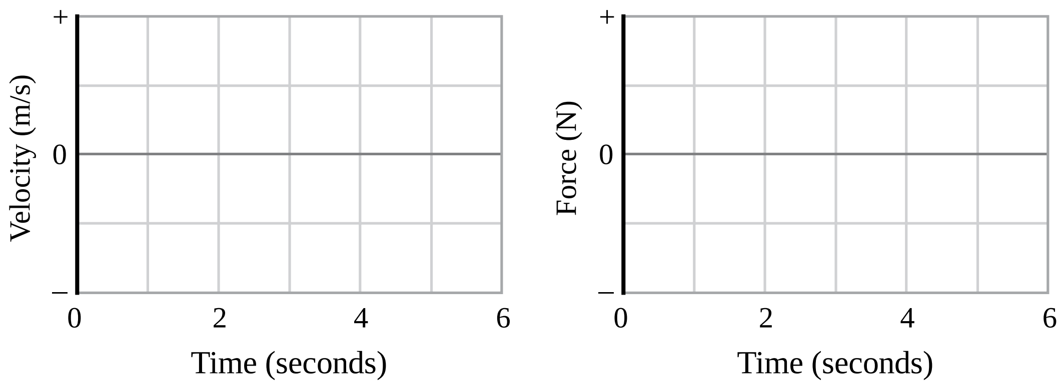


(b) A force is applied to an object that experiences very little friction. This force causes the object to move resulting in the velocity vs. time graph shown below. Draw a set of graph axes with the same number of time units as that shown in the velocity graph and carefully sketch the shape of a possible graph of acceleration vs. time for the object.



(c) Refer to the velocity vs. time graph shown in part (b) or the acceleration vs. time graph you sketched. Draw a set of graph axes with the same number of time units as that shown in the velocity graph and carefully sketch the shape of a possible graph of force vs. time for the object.

5-3) In the following situations friction is small and can be ignored. Consider whether the net or combined force on a small cart needs to be positive, negative or zero to create the following motions. Sketch graphs that show the shapes of the velocity and force functions in each case. Use the format shown in the graphs below. (Draw a separate set of Velocity vs. Time & Force vs. Time graphs for each part (a) through (d).)



(a) The cart is moving in the positive direction away from the origin at a constant velocity.

(b) The cart moves in the negative direction toward the origin speeding up at a steady rate until it reaches a constant velocity after 3 seconds.

(c) The cart moves in the negative direction toward the origin slowing down at a steady rate, turns around after 2 seconds and then moves away from the origin speeding up at the same steady rate.

(d) The cart moves in the positive direction away from the origin and slows down for 3 seconds and then speeds up for 3 seconds.

5-4) Two forces are applied to a cart with two different spring scales as shown below. The spring scale F_A reads 15 N.

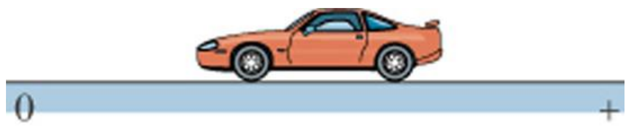
(a) The cart had an initial velocity of 0.00 m/s when the two forces were applied. It remains at rest after the combined forces are applied. What is the net force on the cart? What does spring scale F_B read? Show your calculations and explain.

(b) The cart had an initial velocity of + 0.75 m/s and so it was moving to the right when the two forces were applied. It continues moving to the right at that same velocity after the combined forces are applied. What is the net force on the cart? What does spring scale F_B read? Show your calculations and explain.

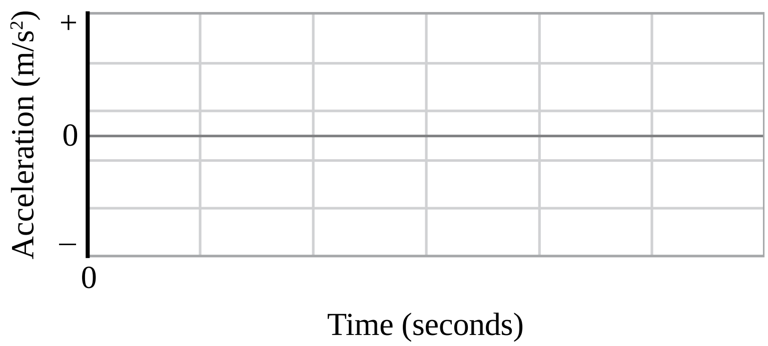
(c) The cart had an initial velocity of – 0.39 m/s and so it was moving to the left when the two forces were applied. It continues moving to the left at that same velocity after the combined forces are applied. What is the net force on the cart? What does spring scale F_B read? Show your calculations and explain.

(d) Which of Newton’s first two laws apply to the situations in this problem?

5-5) (a) Suppose a toy car moves along a horizontal line without friction and a constant force is applied to the car toward the right.



Sketch a set of axes like those shown below and then use a solid line to sketch the shape of the acceleration-time graph of the car.



(b) Two more identical cars are piled/glued on top of the first car and the same constant force is applied to the three cars. Use a dashed line to sketch the acceleration-time graph of the "triple-car". Explain any differences in this graph compared to the acceleration-time graph of the car with the original mass.

5-6) Problem 5.11.1 from the Activity Guide.