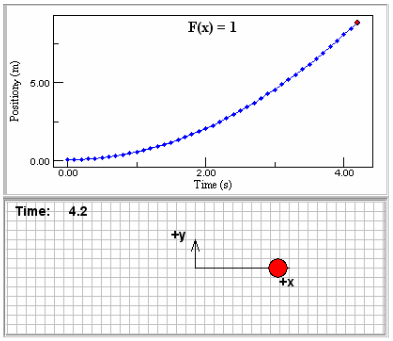
Worksheet for Exploration 4.8: Enter a Formula for the Force Applied



This Exploration allows you to choose initial conditions and forces and then view how that force affects the red ball. You can right-click on the graph to make a copy at any time. If you check the "strip chart" mode box, the top graph will show data for a time interval that you set. Note that the animation will end when the position of the ball exceeds +/-100 m from the origin. Restart.

*Remember to use the proper syntax, such as: -10+0.5*t, -10+0.5*t*t, and -10+0.5*t^2. Revisit Exploration 1.3 to refresh your memory.*

Differential equations can be difficult to solve analytically. One way around this is to use a numerical method to generate a solution at discrete time steps. The above animation does just that by advancing the position of the red ball from its initial value at time t_o to a new value at $t_1 = t_o + dt$. This process can be repeated over and over to approximate the solution as a function of time.

Clearly there are pitfalls in the above procedure. If the time step is too large (1 year for example) interesting phenomena can be missed. This is clearly not an informative dataset if something interesting happens during the time interval. On the other hand, if the time step is too small (1 nanosecond for example) the computer may take a very long time to plot a representative set of points so that you can see the motion of the ball.

For each of the following forces, first describe the force (magnitude and direction) and then predict the motion of the ball. How close were you? Don't forget to determine how the initial position and velocity affect the motion of the ball for each of the forces.

a. $F_x(x, t) = 1$

   i. Describe the motion for the given force.

   ii. For this force write out the differential equation describing motion.

   iii. See if you can set up an integral expression to determine v(t).

b. $F_x(x, t) = -1$

c. $F_x(x, t) = 1*\text{step}(3-t)$ This function is a constant until $t = 3$ s when it turns off.

d. $F_x(x, t) = x$

e. $F_x(x, t) = -x$

f. $F_x(x, t) = \cos(x)$

g. $F_x(x, t) = \cos(t)$