1. **(1 pt) mathbioLibrary/setABiocLabs/Lab121_I1_vert_ball.pg**
Because of the accuracy of WebWork, you should use 5 or 6 significant figures on all problems.

A ball is thrown vertically and data are collected at various times in its flight.

Time (sec)	Distance (m)	Time (sec)	Distance (m)
0.5	7.7	2	16.3
1	13	2.5	14.3
1.5	16	3	9.9

Assume that air resistance can be ignored, then the height of the ball satisfies the quadratic equation:

$$h(t) = v_0 t - \frac{g}{2}t^2,$$

due to gravity. (Note: There is no constant term as we are assuming that the height of the ball is zero at $t = 0$.)

a. Use the Excel's trendline to find the best constants v_0 and g that fit the data in the table. (Remember that when you are using trendline, you must decide if your graph passes through the origin. Does this one? (Yes or No) ___)
$v_0 =$ _____ m/sec
$g =$ _____ m/sec^2
Find the time that your model predicts the ball will hit the ground.
Time ball hits the ground = _____ sec
Find how high the ball goes, and find the time that it reaches this highest point.
Maximum height = _____ m
Time of Maximum height = _____ sec

b. In your Lab Report, create a graph of the quadratic function and the data. How well does the model fit the data?

c. The average velocity between two times t_1 and t_2 is given by the formula:

$$v_{ave} = \frac{h(t_2) - h(t_1)}{t_2 - t_1}.$$

Compute the average velocity with the function $h(t)$ that you found above between each of the following pairs of times:
Between $t_1 = 1$ and $t_2 = 2$, $v_{ave} =$ _____ m/sec
Between $t_1 = 1$ and $t_2 = 1.5$, $v_{ave} =$ _____ m/sec
Between $t_1 = 1$ and $t_2 = 1.1$, $v_{ave} =$ _____ m/sec
Between $t_1 = 1$ and $t_2 = 1.01$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2$ and $t_2 = 3$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2$ and $t_2 = 2.2$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2$ and $t_2 = 2.05$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2$ and $t_2 = 2.002$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2.8$ and $t_2 = 3$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2.9$ and $t_2 = 3$, $v_{ave} =$ _____ m/sec
Between $t_1 = 3$ and $t_2 = 3.01$, $v_{ave} =$ _____ m/sec
Between $t_1 = 2.999$ and $t_2 = 3$, $v_{ave} =$ _____ m/sec

d. As seen in the lecture notes, the velocity of the ball at a given time is the derivative of the height function at that time. Use the techniques from class or Maple to compute the derivative of $h(t)$,

$$h'(t) = v(t).$$

$v(t) =$ _____ m/sec
Evaluate the velocity at $t = 1, 2, 3$
$v(1) =$ _____ m/sec
$v(2) =$ _____ m/sec
$v(3) =$ _____ m/sec

e. In your Lab Report, write a brief paragraph describing how the computed velocities in Part d compare to the average velocities computed in Part c.

f. For this part of the problem, you again compute some average velocities:

$$v_a(t_m) = \frac{h(t_2) - h(t_1)}{t_2 - t_1} \quad \text{where} \quad t_m = \frac{t_1 + t_2}{2}.$$

Create the following coordinate pairs, $(t_m, v_a(t_m))$, given values of t_1 and t_2.
For $t_1 = 0$ and $t_2 = 0.02$, then $(t_m, v_a(t_m)) =$ (____ , ____).
For $t_1 = 0.99$ and $t_2 = 1.01$, then $(t_m, v_a(t_m)) =$ (____ , ____).
For $t_1 = 1.99$ and $t_2 = 2.01$, then $(t_m, v_a(t_m)) =$ (____ , ____).
For $t_1 = 2.99$ and $t_2 = 3.01$, then $(t_m, v_a(t_m)) =$ (____ , ____).

g. In your Lab Report, use the coordinate pairs found above to create a graph of $v_a(t)$ versus t using these data. Use trendline (or any other method) to find the equation of this graph.
$v_a(t) =$ _____ m/sec
The v_a-intercept = _____ m/sec
The t-intercept = _____ sec
In your Lab Report, describe the graph that you have produced. Compare this equation to the equation of the derivative $h'(t)$ that you obtained above.