1. (1 pt) mathbioLibrary/setABiocLabs/Lab121_I1_vert_ball.png
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.

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Distance (m)</th>
<th>Time (sec)</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>7.7</td>
<td>2</td>
<td>16.3</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>2.5</td>
<td>14.3</td>
</tr>
<tr>
<td>1.5</td>
<td>16</td>
<td>3</td>
<td>9.9</td>
</tr>
</tbody>
</table>

Assume that air resistance can be ignored, then the height of the ball satisfies the quadratic equation:
\[ h(t) = v_0 t - \frac{gt^2}{2}, \]
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/sec²

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:
\[ v_a(t_m) = \frac{h(t_2) - h(t_1)}{t_2 - t_1}, \] where \( t_m = \frac{t_1 + t_2}{2} \).
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 \( t_1 = 2.999 \) 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.

3