The **position** \( s(t) \) [height, in feet] of an object at time \( t \), thrown with an initial velocity \( v_0 \) [in feet per sec], from initial position \( s_0 \) [in feet], is given by:

\[
s(t) = -16t^2 + v_0 t + s_0
\]

The **instantaneous velocity** \( v(t) \) of an object at time \( t \) [in seconds] is given by:

\[
v(t) = s'(t) = -32t + v_0
\]

**Example**

A ball is thrown upward with initial velocity 64 ft/s and released at a height of 4 feet. The position and velocity functions are given by:

In General

\[
s(t) = -16t^2 + v_0 t + s_0
\]

\[
v(t) = -32t + v_0
\]

Example

\[
s(t) = -16t^2 + 64t + 4
\]

\[
v(t) = -32t + 64
\]

Use your graphing calculator to graph the position function on the axes below:

\[y = s(t) = -16t^2 + 64t + 4\]

1) Find the positions of the ball at \( t = 0, 1, 2, 3 \) and 4 seconds. (hint: use table mode)

2) Find the maximum height of the ball. (hint: graph, then 2nd Calc Maximum)

3) When does the ball attain its maximum height?

4) Find the Average Velocity from \( t = 0 \) to \( t = 1 \) seconds.

5) Find the Average Velocity from \( t = 1 \) to \( t = 2 \) seconds.

6) Find the Instantaneous Velocities of the ball at \( t = 0, 1, 2, 3 \) and 4 seconds.

<table>
<thead>
<tr>
<th>Position &amp; Velocity Table</th>
<th>Position</th>
<th>Position vs. Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>Position (height)</td>
<td>Velocity</td>
</tr>
<tr>
<td>0 sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 sec</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( t )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>1</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
</tr>
</tbody>
</table>

\[1 \quad 2 \quad 3 \quad 4 \quad x\]
Tangent Line v.s. Secant Line

Instantaneous Velocity v.s. Average Velocity
Position v.s. Velocity

\[ y = s(t) \]

\[ y = v(t) = s'(t) \]
Position v.s. Velocity

\[ y = s(t) \]

\[ y = v(t) = s'(t) \]