EXTRACTING SOLUTIONS FROM THE SOLVE FUNCTION

In lab we studied how to use the Solve function in Mathematica to, well, solve both simple and more complex equations. Let's apply this to the example in class: determine how long an object will be in flight if it is thrown vertically down with an initial speed of 3 m/s from a height of 100 m. We know that the equation of motion for this object (neglecting friction) is

\[ y(t) = 100 - 3t - 4.9t^2 \]

and solving the resulting quadratic when \( y(t) = 0 \) will yield the time of flight. In Mathematica, this is done simply via:

\[
\text{In[54]}:= \text{Clear}[y, t] \\
y[t_] := 100 - 3t - 4.9 t^2 \\
\text{Solve}[y[t] == 0, t]
\]

\[
\text{Out[54]}= \{\{t \rightarrow -4.83402\}, \{t \rightarrow 4.22178\}\}
\]

And we get two solutions, knowing that only the second one is meaningful. How can we extract this one solution from the set of solutions:

\[
\text{In[55]}:= \text{Solve}[y[t] == 0, t][[2]]
\]

\[
\text{Out[55]}= \{t \rightarrow 4.22178\}
\]

The notation \([Q] \) will extract the Qth element of a list. However, suppose we wanted to use this value of time to do a further calculation. Suppose our object wasn't thrown down vertically, but thrown horizontally with an initial horizontal velocity of 5 m/s. How could we determine the horizontal distance traveled by multiplying the horizontal velocity by this time of flight? We use the "slash-dot" command:

\[
\text{In[56]}:= \text{timeofflight} = t / . \text{Solve}[y[t] == 0, t][[2]] \\
\text{range} = 5 \text{timeofflight}
\]

\[
\text{Out[56]}= 4.22178 \\
\text{Out[57]}= 21.1089
\]

You see in the first output line that the time of flight appears as a number (not an element in a list), and the second output line is the correct value of range. The slash dot command substituted into \( t \) the result of \( \text{Solve}[y[t] == 0, t][[2]] \). In the way I solved the semester project, I made use of this formalism to get very important intermediate results. There are many ways of solving the semester project, but this is a useful technique to know.