4. [15 points]
A load of bricks is being lifted by a crane at a constant speed of 5.6 m/s. A brick falls off the stack. The fallen brick’s height, in meters above the ground, \( t \) seconds after falling off the stack is given by \( h(t) = 15.4 + 5.6t - 4.9t^2 \).

Throughout this problem, remember to include units and show your work and/or explain your reasoning clearly. (Recall Instruction #7 from the front page.) All answers should be given either in exact form or to at least two decimal places.

a. [2 points] How high above the ground was the brick when it fell off the stack?

Solution: The brick fell off the stack at time \( t = 0 \) and \( h(0) = 15.4 \), so the brick was 15.4 meters above the ground when it fell off the stack.

b. [3 points] How long does it take for the brick to hit the ground?

Solution: If the brick hits the ground at time \( g \), then \( h(g) = 0 \), so we solve for \( g \) in the equation 15.4 + 5.6\( g \) - 4.9\( g^2 \) = 0. By the quadratic formula, solutions to this equation are given by

\[
g = \frac{-5.6 \pm \sqrt{5.6^2 - 4(-4.9)(15.4)}}{2(-4.9)} = \frac{-5.6 \pm \sqrt{333.2}}{-9.8} = \frac{-5.6 \pm 18.26}{-9.8}.
\]

These two solutions are approximately equal to -1.291 and 2.434. Only the positive solution makes sense in the context of this problem. So, the brick hits the ground approximately 2.434 seconds after it falls from the stack.

(Note: Alternatively, we could use a graphing calculator to find the positive zero of the function \( h(t) \).)

c. [3 points] When does the brick reach its highest point?

Solution: Since the graph of \( h \) opens downward, \( h \) reaches its maximum at its vertex, so the brick reaches its highest point at the \( t \)-coordinate of its vertex, which is

\[
t = \frac{-5.6}{2(-4.9)} = \frac{4}{7}.
\]

(We can find this by beginning the process of completing the square, i.e. \( h(t) = -4.9(t^2 + \frac{5.6}{4.9}t) + 15.4 \) so the \( t \)-coordinate of the vertex is at \( t = -\frac{1}{2}(\frac{5.6}{4.9}) \), or by using the “maximum” feature of the graphing calculator.) At \( t = 4/7 \), the height of the brick is \( h(4/7) = 17 \) meters. So, \( 4/7 \) seconds after falling from the stack, the brick reaches its highest point, which is 17 meters above the ground.

d. [3 points] Find the domain and range of the function \( h \) in the context of this problem.

Solution: In the context of this problem, the domain is approximately \([0, 2.434]\) (based on part (b)) and the range is \([0, 17]\) (based on part (c)).

Domain: \([0, 2.434]\) Range: \([0, 17]\)

e. [4 points] The supervisor of the construction site sees the brick fall as it passes in front of his office window, which is at a height of 3 meters above the ground. How much time passes between when the supervisor sees the brick and when the brick hits the ground?

Solution: To solve \( h(t) = 3 \), we can use the quadratic equation (to solve \(-4.9t^2 + 5.6t + 12.4 = 0\)) or the “intersect” feature of the graphing calculator to find \( t \approx 2.2617 \), so the supervisor sees the brick approximately 2.2617 seconds after it falls, from the stack. This is about \( 2.4341 - 2.2617 = 0.1724 \) seconds before the brick hits the ground. Hence the supervisor sees the brick about \( 0.172 \) seconds before the brick hits the ground.