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 $\boxed{\text{15.4 meters}}$ 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 $15.4 + 5.6g - 4.9g^2 = 0$. By the quadratic formula, solutions to this equation are given by $g = \dfrac{-5.6 \pm \sqrt{5.6^2 - 4(-4.9)(15.4)}}{2(-4.9)} = \dfrac{-5.6 \pm \sqrt{333.2}}{-9.8} = \dfrac{5.6 \pm \sqrt{333.2}}{9.8}$. These two solutions are approximately equal to -1.291 and 2.434. Only the postive solution makes sense in the context of this problem. So, the brick hits the ground $\boxed{\text{approximately 2.434 seconds}}$ 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?
How high above the ground is the brick at that time?

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 $\frac{-5.6}{2(-4.9)} = \frac{4}{7}$. (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, $\boxed{4/7 \text{ seconds}}$ after falling from the stack, the brick reaches its highest point, which is $\boxed{17 \text{ meters}}$ 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 $\boxed{0.172 \text{ seconds}}$ before the brick hits the ground.