4. [9 points] In both parts of this problem, you should **show your work** and write your final answers *in the spaces provided*. Note that *part (b) is independent of part (a)*.

a. [4 points] When the brakes on a car are applied at full force while the car is moving, the car does not just come to an immediate halt. In fact, a car initially traveling at a speed v (measured in meters per second) will travel an additional $D(v)$ meters before coming to a complete stop, where

$$D(v) = v\left(2 + \frac{v}{14}\right) \qquad \text{for } v \geq 0$$

If it took a car 100 meters to come to a complete stop, how fast was it moving before the brakes were applied? Your final answer should be found *algebraically* and can be exact or accurate to three decimal places.

Solution: We need to find the values of v for which $D(v) = 100$. This happens when $\frac{1}{14}v^2 + 2v - 100 = 0$ which, by the quadratic formula, means:

$$v = \frac{-2 \pm \sqrt{4 + \frac{400}{14}}}{\frac{1}{7}}$$

so $v \approx 25.950$ or $v \approx -53.950$. Since we have $v \geq 0$ in the problem, this means that the car was traveling at approximately 25.950 meters per second.

The car was traveling at a speed of 25.950 m/s

b. [5 points] Martin is visiting the planet Nomae and throws a rock vertically upwards into the air. It takes the rock 0.5 seconds for it to reach its maximum height of 4 meters above the ground, and the rock was 1.5 meters above the ground when Martin released it. Find a formula for the height $h(t)$ (in meters) of the rock above the ground in terms of the time t (in seconds) elapsed since the rock was released, given that $h(t)$ is a quadratic function of t.

Solution: We know that $h(t)$ is a quadratic function with vertex $(0.5, 4)$, and hence $h(t) = a(t - 0.5)^2 + 4$. We also know that $h(0) = 1.5$, so $a(-0.5)^2 + 4 = 1.5$, and hence $a = \frac{-2.5}{0.25} = -10$.

$h(t) =$ $-10(t - 0.5)^2 + 4$