

1A.5. Equations of Motion

1 OF 1

For a particle (i.e., a projectile or a ball, etc.), the height y , as a function of time t , is

$$y = y_0 + v_0 t - \frac{1}{2} g t^2$$

where $y_0 \equiv$ height of particle at time $t=0$

$v_0 \equiv$ upward velocity of particle at time $t=0$

$g \equiv$ acceleration of gravity ($g \approx 32.2 \frac{\text{ft}}{\text{sec}^2} = 9.81 \frac{\text{m}}{\text{sec}^2}$)

Example. Mr. Lody hits a baseball at home plate with an initial upward velocity of $125 \frac{\text{ft}}{\text{sec}}$. The ball lands in the stands, which are 50 ft above home plate. How long after the ball is hit does it land in the stands?

Solution: home plate is $y_0 = 0$, $v_0 = 125$, $g = 32.2 \Rightarrow$

$$y = y_0 + v_0 t - \frac{1}{2} g t^2 = 0 + 125t - \frac{1}{2}(32.2)t^2, \quad y = -16.1t^2 + 125t.$$

$$y = 50 \text{ when the ball lands in the stands} \Rightarrow 50 = -16.1t^2 + 125t,$$

$$-16.1t^2 + 125t - 50 = 0, \quad 16.1t^2 - 125t + 50 = 0, \quad a = 16.1, \quad b = -125, \quad c = 50$$

$$\text{Quadratic Formula } t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{125 \pm \sqrt{(-125)^2 - 4(16.1)(50)}}{2(16.1)} =$$

$$= \frac{125 \pm \sqrt{12,405}}{32.2}$$

$$t = \frac{125 - \sqrt{12,405}}{32.2} = 0.423 \text{ sec (on the way up)} \quad \times$$

$$t = \frac{125 + \sqrt{12,405}}{32.2} = 7.341 \text{ sec (on the way down)} \quad \checkmark$$