

Joseph stands on top of a building 120 meters high. He throws a ball vertical downward with an initial velocity of 25 m/s. The acceleration due to gravity is 9.8 m/s².

(a) What is the velocity of the ball after it falls for 2 seconds?

(b) What is the position of the ball after 2 seconds?

(c) What time did the ball reach the ground?

(d) What is the velocity of the ball as it strikes the ground?

Solution

If the height of building is $H = 120m$, initial velocity is $v_{in} = 25m/s$, acceleration due to gravity

is $g = 9.8 \frac{m}{s^2}$ we have

(a) The velocity of ball is

$$v(t) = v_{in} + gt$$

$$t = 2s$$

$$v = 19.6m/s + 25m/s = 44.6m/s$$

(b) The ball is situated at a height of

$$h = H - \frac{gt^2}{2} - v_{in}t$$

$$t = 2s$$

$$h = 120m - 19.6m - 50m = 50.4m$$

(c) We have when ball strikes the ground:

$$h_f = 0$$

$$0 = H - \frac{gt^2}{2} - v_{in}t \Rightarrow$$

$$t = \frac{-v_{in} + \sqrt{v_{in}^2 + 2Hg}}{g} \approx 3.016$$

(d) According the law of conservation of energy we have (velocity of the ball is v_f)

$$\frac{mv_{in}^2}{2} + mgH = \frac{mv_f^2}{2} + mgh$$

$$h_f = 0$$

$$v_f = \sqrt{v_{in}^2 + 2mgH} \approx 54.56m/s$$

