Answer on Question #63296, Physics / Mechanics | Relativity

You throw a ball downward from a window at a speed of 4.50 m/s (about 10.1 mph). What is the velocity of the ball as it hits the sidewalk 3.80 m (about 12 feet) below?

What would the impact velocity have been if you had thrown the ball upward with a speed of 4.50 m/s?

Solution:

An object in free fall experiences an acceleration g of -9.8 m/s^2. (The - sign indicates a downward acceleration.) Whether explicitly stated or not, the value of the acceleration in the kinematic equations is -9.8 m/s^2 for any freely falling object.

The kinetic equations are

$$y = y_0 + v_o t + \frac{1}{2}at^2$$

$$y - y_0 = \frac{v^2 - v_0^2}{2a}$$

where

in first case for positive y axis upward:

$y_0 = 3.80\ m$ is initial position

$y = 0$ is final position

$v_0 = -4.50\ m/s$ is initial speed

$a = -g = 9.8\ m/s^2$ is acceleration

Thus, the final velocity is

$$v = \sqrt{2gy_0 + v_0^2} = \sqrt{2 \cdot 9.8 \cdot 3.80 + 4.50^2} = 9.73\ \text{m/s} = 21.77\ \text{mph}$$

When you had thrown the ball upward it goes up to its peak and returns to the point it was thrown from. When it returns to that point, it has the same speed but in the opposite direction, EXACTLY LIKE THE BALL THAT WAS THROWN DOWN!!!

Answer: $9.73\ \frac{\text{m}}{\text{s}}$ (about 21.77 mph).