Answer on Question#55168 – Physics – Mechanics | Kinematics | Dynamics

Question

A ball thrown upwards returns to the ground with the initial speed of u. The ball is at a height of $80\ m$ at two times, the time interval being $6\ s$. Find u by assuming $g = 10\frac{m}{s}$.

Solution

"Ball returns to the ground with the initial speed", hence there is no friction.

If there is no friction, we can use the conservation law: $mgh = \frac{mv^2}{2}$, where $m -$ mass of the ball, $h -$ highest position of the ball, $v \equiv u -$ initial speed of the ball.

Due to the symmetry of process (once again, because there is no friction) it takes the same time for the ball to move upward from $80\ m$ to h, as to move downward from h to $80\ m$.

Thus, we can formulate next equation:

$$h - 80 = \frac{g * 3^2}{2}$$

It comes from general formula (free fall): $s = \frac{gt^2}{2} + v_0 t$, we consider covered distance (s) to be the distance between the highest point and $80\ m$, respective time according to the statement above is $\frac{6}{2} = 3\ s$, we consider start of movement to be at the reflection point, hence initial speed (v_0) is 0.

Plug in g and solve for h:

$$h = 80 + \frac{10 * 3^2}{2} = 80 + 5 * 9 = 80 + 45 = 125\ (m)$$

As far as we know h, we can get v from the conservation law:

$$mgh = \frac{mv^2}{2}$$

$$v^2 = 2gh$$

$$v = \sqrt{2gh}$$

$$v = \sqrt{2 * 10 * 125} = \sqrt{2 * 2 * 5 * 5^3} = \sqrt{2^2 * 5^4} = 2 * 5^2 = 50\ \left(\frac{m}{s}\right)$$

$$u \equiv v = 50\frac{m}{s}$$