Answer on Question #80340 - Physics – Mechanics, Relativity

You throw a ball straight up with an initial velocity of 16.2 m/s. It passes a tree branch on the way up at a height of 6.53 m. How much additional time (in s) will pass before the ball passes the tree branch on the way back down?

Solution.

The formulas for uniformly accelerated motion:

$$v = v_0 + at$$

$$h = v_0 t + \frac{at^2}{2} = \frac{v^2 - v_0^2}{2a}$$

where v is the current speed, v_o is the initial speed, h is the passed way.

In this case, there is the gravitational acceleration g directed down to the ground and equal to 9.8 m/s^2.

When the ball moves upward, its speed is also directed upward, and the acceleration is directed downward.

Therefore, we get:

$$v = v_0 - gt$$

$$h = v_0 t - \frac{gt^2}{2} = \frac{v_0^2 - v^2}{2g}$$

At the height of h = 6.53 m a ball has the velocity (we consider that v_0 = 16.2 m/s):

$$v_1 = \sqrt{v_0^2 - 2gh} = \sqrt{16.2^2 - 2 \times 9.8 \times 6.53}\ \frac{m}{s} = \sqrt{134.45} \approx \frac{m}{s} = 11.6\ m/s$$

At the highest point, the speed of the ball is equal to zero.

Let us find the time of lifting the ball from the point at the height of 6.53 meters to the highest point of its trajectory.

$$0 = v_1 - gt$$

$$t = \frac{v_1}{g} \approx 1.2\ s$$

The movement downwards from the top point of the trajectory (in which the velocity is zero) to the point at the height of 6.53 m, takes the same amount of time (due to the symmetry of the movement).

Thus, the total time that will pass before the ball passes the tree branch again is 2t = 2.4 s

Answer: 2.4 s