Answer on Question 70570, Physics, Other

Question:

A hot air balloon is rising upward with a constant speed of $2.50\ m/s$. When the balloon is $3.00\ m$ above the ground, the baloonist accidentally drops a compass over the side of the balloon. How much time elapses before the compass hits the ground?

Solution:

We can find the time before the compass hits the ground from the kinematic equation:

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

here, y is the height of the ballon at time t; $y_0 = 3.0\ m$ is the height of the ballon when the compass is released; $v_0 = 2.50\ m/s$ is the initial velocity of the compass when the compass is released (since we choose upwards as a positive direction, the initial velocity of the compass will be with sign plus); t is the time before the compass hits the ground; $g = -9.8\ m/s^2$ is the acceleration of gravity (since we choose upwards as a positive direction, the acceleration of gravity will be with sign minus).

Since we want to find the time before the compass hits the ground, $y = 0$. Then, we get:

$$3.0\ m + \left(2.5\ \frac{m}{s}\right) t - \left(\frac{1}{2} \cdot 9.8 \frac{m}{s^2}\right) t^2 = 0,$$

$$\left(4.9\ \frac{m}{s^2}\right) t^2 - \left(2.5\ \frac{m}{s}\right) t - 3.0\ m = 0.$$

This quadratic equation has two roots:

$$t_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-\left(-2.5\ \frac{m}{s}\right) \pm \sqrt{\left(2.5\ \frac{m}{s}\right)^2 - 4 \cdot 4.9\ \frac{m}{s^2} \cdot (-3.0\ m)}}{2 \cdot 4.9\ \frac{m}{s^2}},$$

$$t_1 = -0.567\ s,\ t_2 = 1.078\ s.$$

Since, time can't be negative, the correct answer is $t = 1.078\ s$.