Answer on Question 74120, Physics, Other

Question:

A mass is launched at 30° to the horizontal with initial speed $25\ m/s$.

a) What is the maximum height obtained?

b) After what time does the mass move a horizontal distance of 3 m.

Solution:

a) Let's first find the projections of the initial velocity of the mass on axis x and y:

$$v_{0x} = v_0 cos\alpha = 25\ \frac{m}{s} \cdot cos30^{\circ} = 21.65\ \frac{m}{s},$$

$$v_{0y} = v_0 sin\alpha = 25\ \frac{m}{s} \cdot sin30^{\circ} = 12.5\ \frac{m}{s}.$$

Let's consider the motion of the mass in the vertical direction. We can find the time t_{rise} that the mass need to reach the maximum height from the kinematic equation:

$$v = v_{0y} - gt_{rise},$$

here, v_{0y} is the projection of the initial velocity of the mass on axis y, $v = 0$ is the velocity of the mass at maximum height, $g = -9.8\ \frac{m}{s^2}$ is the acceleration due to gravity.

Then, we get:

$$t_{rise} = \frac{v_{0y}}{g} = \frac{12.5\ \frac{m}{s}}{9.8\ \frac{m}{s^2}} = 1.27\ s.$$

Finally, we can find the maximum height reached by the mass from another kinematic equation:

$$y_{max} = v_{0y} t_{rise} - \frac{1}{2} g t_{rise}^2 = 12.5\ \frac{m}{s} \cdot 1.27\ s - \frac{1}{2} \cdot 9.8\ \frac{m}{s^2} \cdot (1.27\ s)^2 = 7.97\ m.$$

b) We can find the time that mass need to move a horizontal distance of 3 m from the kinematic equation:

$$x = v_{0x} t,$$

here, x is the distance, v_{0x} is the projection of the initial velocity of the mass on axis x, and t is time.

Then, we get:

$$t = \frac{x}{v_{0x}} = \frac{3.0\ m}{21.65\ \frac{m}{s}} = 0.14\ s.$$

Answer:

a) $y_{max} = 7.97\ m.$

b) $t = 0.14\ s.$