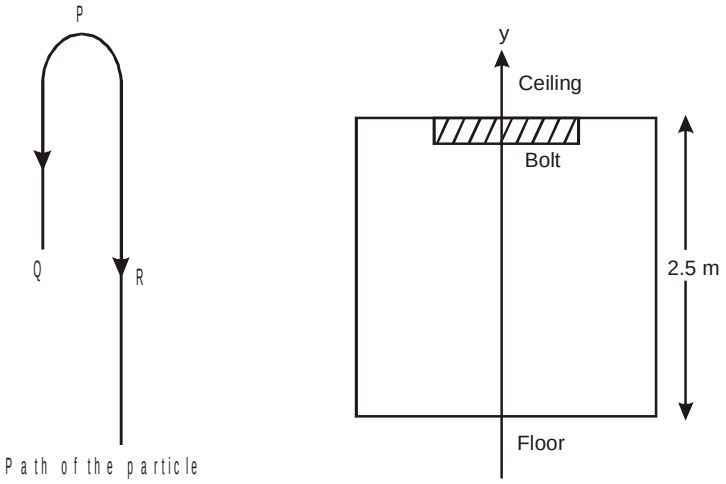
Answer on Question #42976, Physics, Mechanics | Kinematics | Dynamics

A lift whose floor to ceiling distance is 2.50m starts ascending with a constant acceleration of 1.25m/s. One second after the start, a bolt begins to fall from the ceiling of the lift. The time which the bolt hits the floor is (take g =10m/s).

Solution:



Let us consider the line of motion of elevator and bolt as the Y-axis and the floor's initial position (when the bolt starts falling) as origin.

At the moment when the bolt starts falling, speed of the elevator and the bolt is

$$v_1 = v_0 + at = 0 + 1.25 \cdot 1 = 1.25 \text{ m/s}$$

Let t_1 be the time after which the bolt strikes the floor.

The y-coordinate of the bolt at time t_1 is

$$y_{bolt} = y_0 + v_1 t_1 + \frac{a{t_1}^2}{2} = y_0 + v_1 t_1 - \frac{g{t_1}^2}{2} = 2.5 + 1.25t_1 - \frac{10{t_1}^2}{2}$$

(As the bolt is freely falling, its acceleration is -g).

The y-coordinate of the floor at time t_1 is

$$y_{floor} = y_0 + v_1 t_1 + \frac{a{t_1}^2}{2} = 0 + 1.25t_1 + \frac{1.25{t_1}^2}{2}$$

As the bolt strikes the floor at time t_1, $y_{bolt} = y_{floor}$

Thus,

$$2.5 + 1.25t_1 - \frac{10{t_1}^2}{2} = 0 + 1.25t_1 + \frac{1.25{t_1}^2}{2}$$

$${t_1}^2 = \frac{5}{10 + 1.25} = \frac{5}{11.25} = 0.444$$

$$t_1 = \sqrt{0.444} = 0.67 \text{ s}$$

Answer: $t_1 = 0.67$ s.