

Physics 240: Unquiz 01 R20

A ball is thrown upward from an initial position of

$$\vec{R}=0\hat{x}+4\hat{y}\text{ m}$$

with an initial velocity vector given by

$$\vec{v}=0\hat{x}+5\hat{y}\frac{\text{m}}{\text{s}} .$$

(1) How high does the ball travel above the coordinate given by:

$$\vec{P}=0\hat{x}+0\hat{y} \text{ ?}$$

(2) Find the velocity vector when the ball strikes the ground.

(3) How long is the ball in flight?

Physics 240: Unquiz 01 Solution

A ball is thrown upward from an initial position of

$$\vec{R}=0\hat{x}+4\hat{y}\text{ m}$$

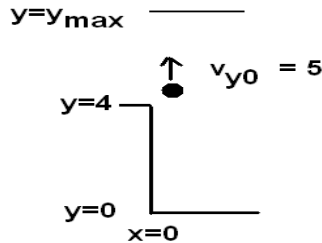
with an initial velocity vector given by

$$\vec{v}=0\hat{x}+5\hat{y}\frac{\text{m}}{\text{s}}.$$

(1) How high does the ball travel above the coordinate given by:

$$\vec{P}=0\hat{x}+0\hat{y}?$$

Draw a sketch of the situation.



Use the 3rd. equation of motion here and recognize that this is 1-dimensional motion.

$$v_y^2 = v_{0,y}^2 + 2 a_y \Delta y.$$

At the top, the y component of the velocity is zero. The acceleration is replaced by:

$$a_y = -g \text{ where } g = +9.8 \frac{\text{m}}{\text{s}^2}.$$

Substitute and solve for $v_y=0$:

$$0 = v_{0,y}^2 - 2g\Delta y \Rightarrow \Delta y = \frac{v_{0,y}^2}{2g} = \frac{5^2}{2 \times 9.8} = 1.28 \text{ m}$$

This is above the ground a distance of 4 m. The total height above the ground is:

$$h = 4 + 1.28 = 5.28 \text{ m}$$

(2) Find the velocity vector when the ball strikes the ground.

Use the 3rd. equation of motion here, recognizing that the total distance the ball falls is 5.28m:

$$v_y^2 = v_{0,y}^2 + 2 a_y \Delta y$$

The ball starts with zero initial y velocity at the top. Solve this equation for v_y :

$$v_y^2 = 0 - 2g\Delta y \Rightarrow v_y = \pm \sqrt{-2g\Delta y} = \pm \sqrt{-2 \times 9.8 \times (0 - 5.28)} = \pm 10.2 \frac{\text{m}}{\text{s}}$$

The physical solution is the - sign here. So the desired final velocity vector is:

$$\vec{v}_f = 0\hat{x} - 10.2\hat{y} \frac{\text{m}}{\text{s}}$$

(3) How long is the ball in flight?

The simplest approach here is to use the velocity above and solve the problem in one step with the second equation of motion:

$$\begin{aligned}v_y &= v_{0,y} + a_y t \Rightarrow -10.2 = 5 - gt \Rightarrow -10.2 - 5 = -gt \\ \Rightarrow -15.2 &= -gt \Rightarrow t = \frac{-15.2}{-g} = 1.55 \text{ s}\end{aligned}$$