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:

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

(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

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

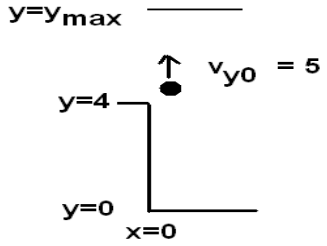
with an initial velocity vector given by

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

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

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

Draw a sketch of the situation.



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

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

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

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

Substitute and solve for v_y=0:

$$0=v_{0,y}^2-2g\Delta y\Rightarrow\Delta y=\frac{v_{0,y}^2}{2g}=\frac{5^2}{2x9.8}=1.28\,m$$

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

h=4+1.28=5.28m

(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:

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

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

$$v_y^2=0-2g\Delta y\Rightarrow v_y=\pm\sqrt{-2g\Delta y}=\pm\sqrt{-2x9.8x(0-5.28)}=\pm10.2\frac{m}{s}$$

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

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

(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:

$$v_y = v_{0,y} + a_y t \Rightarrow -10.2 = 5 - g t \Rightarrow -10.2 - 5 = -g t$$

$$\Rightarrow -15.2 = -g t \Rightarrow t = \frac{-15.2}{-g} = 1.55\,s$$