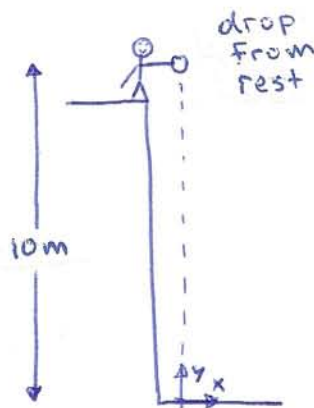


Kinematics example



drop
from
rest

$$\vec{x}_0 = 0\hat{i} + 10\hat{j}$$

$$\vec{x}_f = 0\hat{i} + 0\hat{j}$$

$$\vec{v}_0 = 0\hat{i} + 0\hat{j}$$

$$\vec{v}_f = 0\hat{i} + \hat{j}$$

$$\vec{a} = 0\hat{i} - 9.81\hat{j}$$

$$t =$$

$$x_0 = 0 \text{ m}, y_0 = 10 \text{ m}$$

$$x_f = 0 \text{ m}, y_f = 0 \text{ m}$$

$$v_{x0} = 0 \text{ m/s}, v_{y0} = 0 \text{ m/s}$$

$$v_{xf} = 0 \text{ m/s}, v_{yf} =$$

$$a_x = 0 \text{ m/s}^2, a_y = -9.81 \text{ m/s}^2$$

$$t =$$

or

one dimensional motion in the y-direction

use a kinematics equation to solve for v_{yf} :

$$\vec{v}^2 = \vec{v}_0^2 + 2\vec{a}(\Delta\vec{x}) = \vec{v}_0^2 + 2\vec{a}(\vec{x} - \vec{x}_0)$$

$$\cancel{v_{xf}^2}\hat{i} + v_{yf}^2\hat{j} = \left[\cancel{v_{x0}^2} + 2a_x(\cancel{x - x_0}) \right]\hat{i} + \left[v_{y0}^2 + 2a_y(y - y_0) \right]\hat{j}$$

$$v_{yf}^2 = v_{y0}^2 + 2a_y(y - y_0)$$

$$v_{yf} = \pm \sqrt{v_{y0}^2 + 2a_y(y_f - y_0)} = \pm \sqrt{(0)^2 + 2(-9.81)(0 - 10)}$$

$$v_{yf} = -14 \text{ m/s}$$

use a kinematics equation to solve for t :

$$\vec{v} = \vec{v}_0 + \vec{a}t \Rightarrow v_{yf} = v_{y0} + a_y t$$

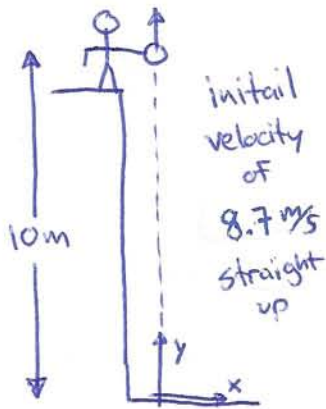
$$v_{yf} - v_{y0} = a_y t$$

$$\frac{v_{yf} - v_{y0}}{a_y} = t$$

$$t = \frac{v_{yf} - v_{y0}}{a_y} = \frac{-14 - 0}{-9.81} = 1.4 \text{ s}$$

$$t = 1.4 \text{ s}$$

Kinematics example



$$x_0 = 0$$

$$x_f = 0$$

$$v_{x0} = 0$$

$$v_{xf} = 0$$

$$a_x = 0$$

$$t =$$

$$y_0 = 10$$

$$y_f = 0$$

$$v_{y0} = 8.7$$

$$v_{yf} =$$

$$a_y = -9.81$$

Solve for v_{yf} using a kinematics equation:

$$\vec{v}^2 = \vec{v}_0^2 + 2\vec{a}(\Delta\vec{x}) \Rightarrow v_{yf}^2 = v_{y0}^2 + 2a_y(y_f - y_0)$$

$$\begin{aligned} v_{yf} &= \pm \sqrt{v_{y0}^2 + 2a_y(y_f - y_0)} \\ &= \pm \sqrt{(8.7)^2 + 2(-9.81)(0 - 10)} \\ &= -16.49 \text{ m/s} \end{aligned}$$

$$\boxed{v_{yf} = -16 \text{ m/s}}$$

Solve for time using a kinematics equation:

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

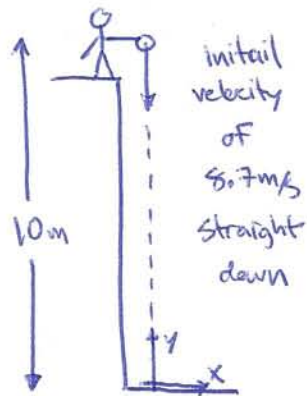
$$\Rightarrow v_{yf} = v_{y0} + a_y t$$

solve for t

$$t = \frac{v_{yf} - v_{y0}}{a_y} = \frac{-16.49 - 8.7}{-9.81} = 2.568 \text{ s}$$

$$\boxed{t = 2.6 \text{ s}}$$

kinematics example



$$x_0 = 0$$

$$y_0 = 10 \text{ m/s}$$

$$x_F = 0$$

$$y_F = 0$$

$$v_{x0} = 0$$

$$v_{y0} = -8.7 \text{ m/s}$$

$$v_{xF} = 0$$

$$v_{yF} =$$

$$a_x = 0$$

$$a_y = -9.81 \text{ m/s}^2$$

$$t =$$

Solve for v_{yF} using a kinematics equation:

$$\vec{V}^2 = \vec{V}_0^2 + 2\vec{a}(\Delta\vec{x})$$

$$\Rightarrow v_{yF}^2 = v_{y0}^2 + 2a_y(y_F - y_0)$$

$$v_{yF} = \pm \sqrt{v_{y0}^2 + 2a_y(y_F - y_0)}$$

$$= \pm \sqrt{(-8.7)^2 + 2(-9.81)(0 - 10)}$$

$$= -16.49 \text{ m/s}$$

$$v_{yF} = -16 \text{ m/s}$$

Solve for time using a kinematics equation:

$$\vec{V} = \vec{V}_0 + \vec{a}t$$

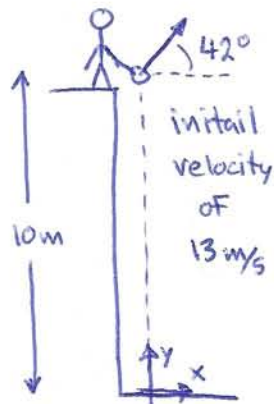
$$\Rightarrow v_{yF} = v_{y0} + a_y t$$

solve for t

$$t = \frac{v_{yF} - v_{y0}}{a_y} = \frac{-16.49 - (-8.7)}{-9.81} = 0.79 \text{ s}$$

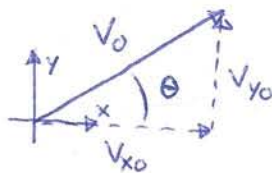
$$t = 0.79 \text{ s}$$

Kinematics example



$$\begin{aligned} x_0 &= 0 & y_0 &= 10 \text{ m} \\ x_f &= & y_f &= 0 \\ v_{x0} &= & v_{y0} &= \\ v_{xf} &= & v_{yf} &= \\ a_x &= 0 & a_y &= -9.81 \text{ m/s}^2 \\ t &= \end{aligned}$$

Determine initial velocity components (v_{x0}, v_{y0}):



$$v_{x0} = V_0 \cos \theta = (13)(\cos(42)) = 9.661 \text{ m/s}$$

$$v_{y0} = V_0 \sin \theta = (13)(\sin(42)) = 8.699 \text{ m/s}$$

Solve for v_{yf} using a kinematics equation:

$$\vec{v}^2 = v_0^2 + 2\vec{a}(\Delta x) \Rightarrow v_{yf}^2 = v_{y0}^2 + 2a_y(\Delta y)$$

$$v_{yf} = \pm \sqrt{v_{y0}^2 + 2a_y(y_f - y_0)}$$

$$= \pm \sqrt{(8.699)^2 + 2(-9.81)(0 - 10)} = -16.49 \text{ m/s}$$

$$v_{yf} = -16 \text{ m/s}$$

Solve for time using a kinematics equation:

$$\vec{v} = \vec{v}_0 + \vec{a}t \Rightarrow v_{yf} = v_{y0} + a_y t$$

Solve for t :

$$t = (v_{yf} - v_{y0}) / a_y = \frac{(-16.49 - 8.699)}{-9.81} = 2.568 \text{ s}$$

$$t = 2.6 \text{ s}$$

Solve for x_f using a kinematics equation:

$$\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2} \vec{a} t^2 \Rightarrow x_f = x_0 + v_{x0} t + \frac{1}{2} a_x t^2 = (0) + (9.661)(2.568) + \frac{1}{2}(0)(2.6)^2$$

$$x_f = 25 \text{ m}$$

Kinematics example continued.

Solve For maximum height of the ball:

Solve For time using a kinematic equation:

$$\vec{V} = \vec{V}_0 + \vec{a}t \Rightarrow v_{yF} = v_{y0} + a_y t$$

solve for t and sub $v_{yF} = 0$

$$t = (v_{yF} - v_{y0}) / a_y = \frac{(0 - 8.699)}{-9.81} = 0.8875$$

Solve For y to determine maximum height using kinematic equation:

$$\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2} \vec{a} t^2 \Rightarrow y = y_0 + v_{y0} t + \frac{1}{2} a_y t^2$$

$$= 10 + (8.699)(0.887) + \frac{1}{2}(-9.81)(0.887)^2$$

$$\boxed{y = 13.9 \text{ m}}$$

Solve for x to determine how far in the x -direction at maximum height:

$$\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2} \vec{a} t^2 \Rightarrow x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$$

$$= 0 + (9.661)(0.887) + \frac{1}{2}(0)(0.887)^2$$

$$\boxed{x = 8.6 \text{ m}}$$