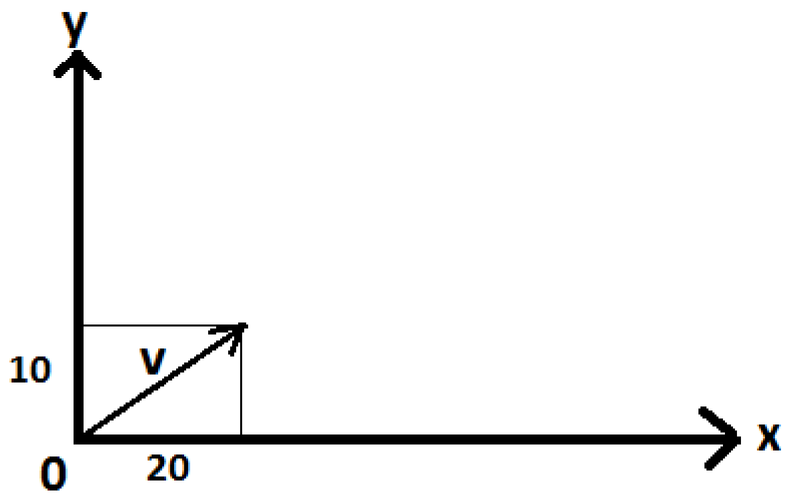
Answer on Question#49946 – Physics – Mechanics | Kinematics | Dynamics

1. $y\left(\frac{V_{yo}}{g}\right) = \frac{V_{yo}^2}{2g} = 5$
2. $x\left(\frac{2V_{yo}}{g}\right) = V_{x0}\frac{2V_{y0}}{g} = 40$
3. $V = 10\sqrt{5}$. Direction is reflection from the x-axis of initial velocity.

Solution



Equations of motion:

$$x(t) = V_{x0}t + x_0$$

$$y(t) = -\frac{gt^2}{2} + V_{y0}t + y_0$$

Initial conditions:

$$x_0 = 0$$

$$y_0 = 0$$

$$V_{x0} = 20$$

$$V_{y0} = 10$$

Thus,

$$x(t) = V_{x0}t$$

$$y(t) = -\frac{gt^2}{2} + V_{y0}t$$

1) the maximum height of the particle

It's value of $y(t)$ at time, when $\frac{dy(t)}{dt} = 0$.

$$\frac{dy(y)}{dt} = -gt + V_{y0} = 0$$

$$t = \frac{V_{y0}}{g}$$

$$y\left(\frac{V_{yo}}{g}\right) = -\frac{g\left(\frac{V_{yo}}{g}\right)^2}{2} + V_{y0}\left(\frac{V_{yo}}{g}\right) = \frac{V_{yo}^2}{2g}$$

Substitute $V_{yo} = 10; \quad g = 10$.

$$y\left(\frac{V_{yo}}{g}\right) = y(1) = \frac{10^2}{2 * 10} = 5$$

2) the horizontal distance from the point of projection when it returns to the ground.

"Returns to ground" $\equiv y(t) = 0,\ t \neq 0$.

$$y(t) = -\frac{gt^2}{2} + V_{y0}t = t\left(-\frac{gt}{2} + V_{y0}\right) = 0$$

$$t = \frac{2V_{y0}}{g}$$

$$x\left(\frac{2V_{y0}}{g}\right) = V_{x0}\frac{2V_{y0}}{g}$$

Substitute $V_{x0} = 20; \quad V_{y0} = 10; \quad g = 10$.

$$x\left(\frac{2V_{y0}}{g}\right) = x(2) = 20 * 2 = 40$$

3) the magnitude and direction of its velocity on landing.

$$\frac{dy}{dt}\left(\frac{2V_{y0}}{g}\right) = -g\left(\frac{2V_{y0}}{g}\right) + V_{y0} = -V_{y0}$$

$$\frac{dx}{dt}\left(\frac{2V_{y0}}{g}\right) = V_{x0}$$

Hence, magnitude still the same

$$V = \sqrt{V_{x0}^2 + V_{yo}^2} = \sqrt{20^2 + 10^2} = \sqrt{400 + 100} = \sqrt{500} = 10\sqrt{5}$$

Direction is reflection from the x-axis of initial velocity.