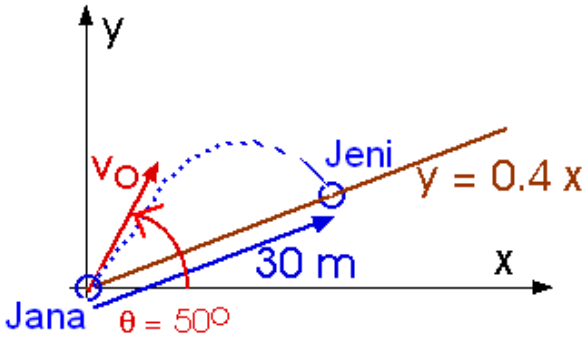
Answer on Question #62465, Physics / Mechanics | Relativity

Jana is standing on a hillside and Jeni is standing on a hilltop. The horizontal direction of Jana and Jeni is 30 m. The slope of the hill satisfies equation y=0.4x (assuming Jane and Jeni are located in xy coordinates). If Jana shoots a ball with an elevation angle of 50 degrees with respect to the horizontal direction, what is the speed of the ball so it exactly reaches Jeni?

Solution:



$v_{xo} = v_o \cos 50^o = 0.643\ v_o$

$v_{yo} = v_o \sin 50^o = 0.766\ v_o$

For the hill, $\theta = \tan^{-1} 0.4 = 21.8^o$

$r_{Jeni} = 30$ m

$x_{Jeni} = (30\text{ m})(\cos 21.8^o) = (30\text{ m})(0.928) = 27.85$ m

$y_{Jeni} = (30\text{ m})(\sin 21.8^o) = (30\text{ m})(0.371) = 11.14$ m

$x_{ball} = v_{xo}t$

$y_{ball} = v_{yo}t + (1/2)\, a_y t^2 = v_{yo}t - (1/2)\, g\, t^2$

For some time t, we require $x_{ball} = x_{Jeni}$ and $y_{ball} = y_{Jeni}$

$x_{ball} = x_{Jeni}$

$v_{xo}t = 27.85$ m

$0.643\ v_o\ t = 27.85$ m

$t = (27.85\text{ m}) / (0.643\ v_o)$

$t = 43.31 / v_o$

Now we use this value of the time in

$y_{ball} = y_{Jeni}$

$v_{yo}t - (1/2)\, gt^2 = 11.14$ m

$[0.766\ v_o] \cdot [43.31 / v_o] - (1/2) \cdot [9.8] \cdot [43.31 / v_o]^2 = 11.14$

$33.18 - 9191 / v_o^2 = 11.14$

$9191 / v_o^2 = 22.04$

$v_o^2 = 9191 / 22.04 = 417$

$v_o = 20.4$ m/s

Answer: 20.4 m/s