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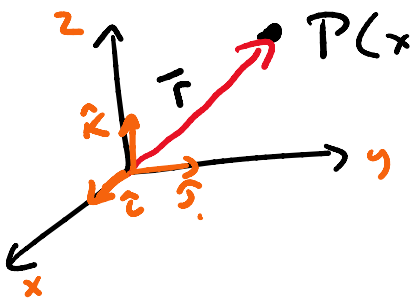
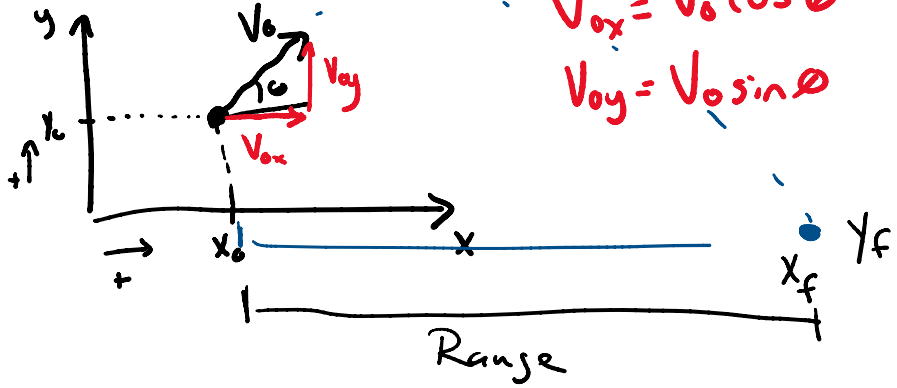


$\bar{r} = x\hat{i} + y\hat{j} + z\hat{k}$

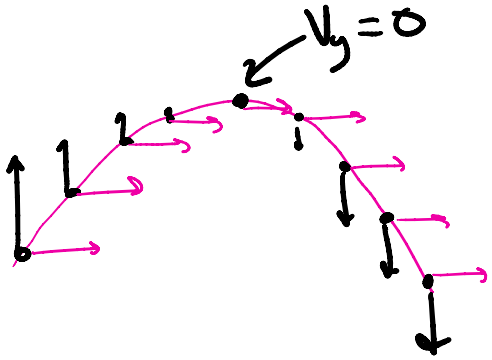
$a_y = -g\hat{j}$
$a_x = 0$

Projectile Motion



$V_{ox} = V_0 \cos\theta$

$V_{oy} = V_0 \sin\theta$



Vertical

$V_{fy} = V_{oy} + at$

$Y = Y_0 + V_{oy}t + \frac{1}{2}at^2$

$V_{fy}^2 = V_{oy}^2 + 2a(y - y_0)$

horizontal

$V_{fx} = V_{ox} + at$ $V_{fx} = V_{ox}$

$X = X_0 + V_{ox}t$

times are the same between vertical and horizontal

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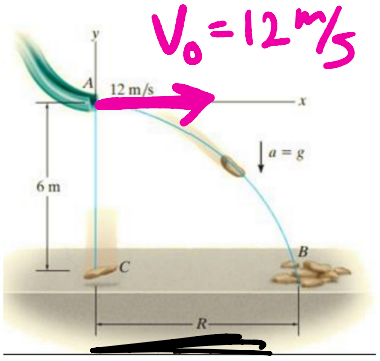
Example 1:

A sack slides off the ramp with a horizontal velocity of 12 m/s. If the height of the ramp is 6m from the floor, determine the time needed for the sack to strike the floor, and the range R where sacks begin to pile up



(only in x)

$V_0 = 12\ m/s$

$t = ?$

$V_{0y} = 0$ $\quad V_{0x} = 12\ m/s$

$Y_0 = 6\ m$ $\quad X_0 = 0$

$a_y = -9.81\ m/s^2$ $\quad a_x = 0$

$Y_f = 0$ $\quad X_f = R$

$$y = Y_0 + V_{0y}t + \frac{1}{2}at^2$$

$$0 = 6 + 0 + \frac{1}{2}(-9.81)t^2$$

$t = -1.11\ s$ $\quad t = 1.11\ s$

$$R = 0 + 12(1.11) = 13.3\ m$$

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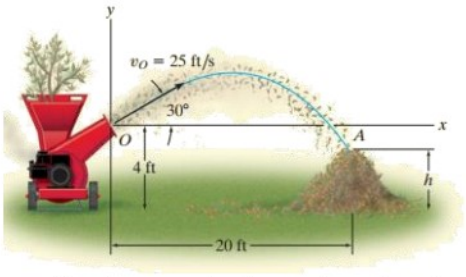
Example 2



The chipping machine is designed to eject wood chips at v_0 = 25 ft/s. If the tube is oriented at 30° from the horizontal, determine the height the chips strike the pile if the land 20 ft from the tube. Determine their velocity at the instant before they land.

$V_{oy} = 25\sin 30$

$Y_0 = 4$

$Y_f = h$

$a_y = -32.2\ ft/s^2$

$V_{ox} = 25\cos 30$

$X_0 = 0$

$X_f = 20$

$a_x = 0$

time

$X = X_0 + V_{ox}t$

$20 = 0 + 25\cos 30\, t$

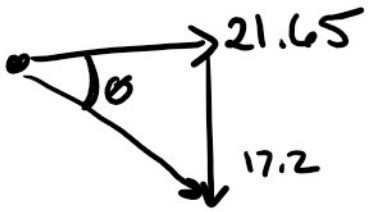
$t = 0.9238\ s$

height

$Y = Y_0 + V_{oy}t + \frac{1}{2}a_y t^2$

$H = 4 + 25\sin 30 + \frac{1}{2}(-32.2)(0.9238)^2$

$H = 1.81\ ft$



final velocity

$V_{fx} = 25\cos 30$

$V_{fx} = 21.65$

$V_{fy} = V_{oy} + at$

$V_{fy} = 25\sin 30 + (-32.2)(0.9238)$

$= -17.2\ ft/s$

$V = \sqrt{(21.65)^2 + (-17.2)^2}$

$= 27.65\ ft/s$

$\theta = \tan^{-1}\left(\frac{17.2}{21.65}\right) = 38.46°$

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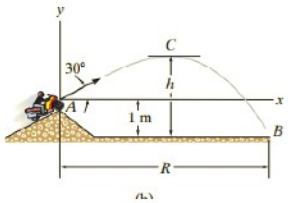
The track for this racing event was designed so that riders jump off the slope at 30°, from a height of 1 m. During a race it was observed that the rider remained in mid air for 1.5 s. Determine the speed at which he was traveling off the ramp, the horizontal distance he travels before striking the ground, and the maximum height he attains. Neglect the size of the bike and rider.



$X_0 = 0$ $Y_0 = 1$

$X_f = R$ $Y_f = 0$

$V_{ox} = V_0 \cos 30$ $V_{oy} = V_0 \sin 30$ ← magnitude

$V_{fx} =$ V_{fy}

$a_x = 0$ $a_y = -9.81$

$t = 1.5$ $t = 1.5$

$$Y = Y_0 + V_{oy}t + \frac{1}{2}at^2$$

$$0 = 1 + V_0 \sin 30(1.5) + \frac{1}{2}(-9.81)(1.5)^2$$

$$V_0 = 13.4 \text{ m/s}$$

$$X = X_0 + V_{ox}t$$

$$R = 0 + 13.4\cos 30\,(1.5) = 17.4 \text{ m}$$

@ Pt C $V_y = 0$

$$V_{fy} = V_{oy} + at$$

$$0 = 13.4\sin 30 + (-9.81)(t)$$

$$t = 0.683 \text{ s}$$

$$Y = Y_0 + V_{oy}t + \frac{1}{2}at^2$$

$$H = 1 + 13.4\sin 30\,(0.683) + \frac{1}{2}(-9.81)(0.683)^2$$

$$H = 3.28 \text{ m}$$