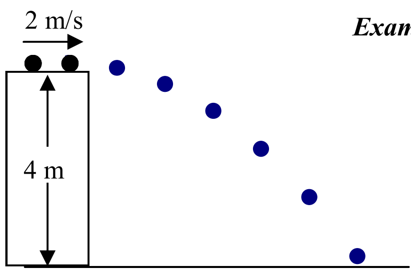
Projectile Motion Special Situations

All projectile motion problems work the same. First you resolve the initial velocity into Vx_i and Vy_i. Second, you write everything you know in the x and y-directions. Third, remembering that $t_y = t_x$ (times are the same in both directions), you solve. This, of course, assumes that you know the basics, such as $a_y = -9.8$ m/s^2 and $a_x = 0$ m/s^2, etc.

Horizontal Launch

For any horizontally launched object, θ = 0º, Vx_i = V and Vy_i = 0 m/s.



Example 1: A ball is shot 2 m/s horizontally from 4 m up. How far away will it land?

You should already know:

$a_y = -9.8$m/s^2	$a_x = 0$m/s^2
$\Delta y = -4$ m	$Vx = 2$ m/s
$Vy_i = 0$ m/s	

As always, find time in the y-direction:

Variables:
$a_y = -9.8$m/s^2
$\Delta y = -4$ m
$Vy_i = 0$ m/s
t = ______
Vy_f = not used

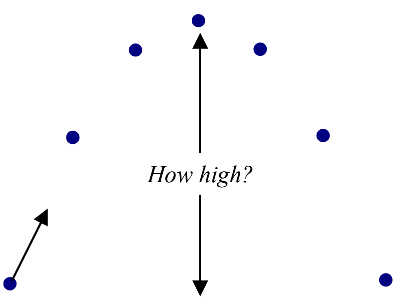
$$\Delta y = (v_i t) + (\frac{1}{2}at^2)$$
$$-4 = (0t) + (\frac{1}{2}(-9.8)t^2)$$
$$-4 = -4.9t^2$$
$$.82 = t^2$$
$$t = .9 \text{ sec}$$

$$\Delta x = (v_i t) + (\frac{1}{2}at^2)$$
$$\Delta x = (2(.9)) + (\frac{1}{2}(0)t^2)$$
$$\Delta x = 1.8 + 0$$
$$\Delta x = 1.8 \text{ m}$$

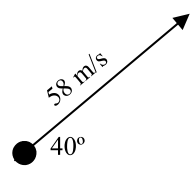
No acceleration in the x-direction, so just use:
$\Delta x = v_x t$

Maximum Height

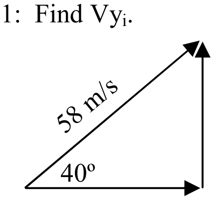
"Find the maximum height" or "how high?" This is a purely y-direction question, so there is not reason to do any work in the x-direction.



Example 2: A ball is shot 58 m/s at 40º. How high up will it go?



Step 1: Find Vy_i.



Vy_i =
58sin40º
= 37.3 m/s

Write what we know in the y-direction and solve:

Variables:
$a_y = -9.8$m/s^2
Δy = ______
$Vy_i = 37.3$ m/s
$Vy_f = 0$ m/s (*at the top*)
t = not used

$$V_f^2 = V_i^2 + (2a\Delta y)$$
$$0 = (37.3^2) + (2(-9.8)\Delta y)$$
$$0 = 1391.29 + (-19.6\Delta y)$$
$$-1391.29 = -19.9\Delta y$$
$$\frac{-1391.29}{-19.9} = \Delta y$$
$$71 \text{ m} = \Delta y$$

As with a ground-to-ground example, these two special situations work the same way each time.

More importantly, though, is for you to see the commonality of all projectile motion problems so that you can solve new problems, if they are given to you.

