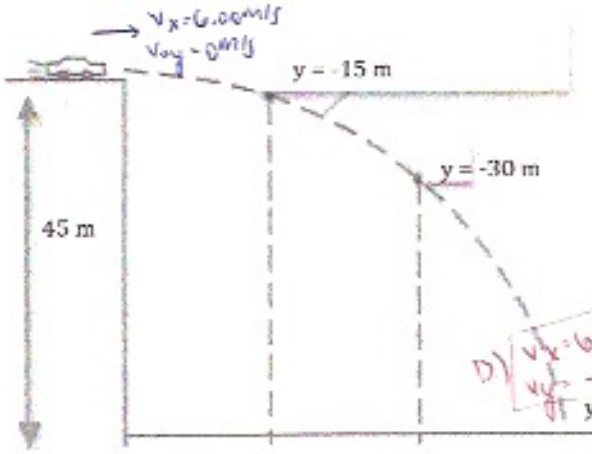
Example 5:
A car is initially traveling with a constant, horizontal velocity of 6.00 m/s. The car reaches the edge of a cliff that is 45.0 m high.

Calculate the velocity in the x-direction, the velocity in the y-direction, and the magnitude of the resultant velocity for the car at four locations.

A. At the very top: y = 0 m
B. At y = -15.0 m
C. At y = -30.0 m
D. At y = -45.0 m (the very bottom)



D) v_x = 6.00 m/s, v_y = -29.7 m/s

A.) At the very top
v_x = 6.00 m/s
v_{oy} = 0 m/s

B) At y = -15.0 m
v_x = constant
v_x = 6.00 m/s

v_y = ?
y = -15.0 m
v_{oy} = 0 m/s
a_y = -9.8 m/s²

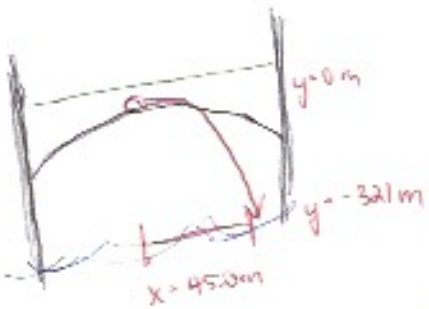
$v_y^2 = v_{oy}^2 + 2a_y \cdot y$
$v_y^2 = (0)^2 + 2(-9.8)(-15)$
$v_y^2 = 0 + 294$
$v_y^2 = 294$
v_y = -17.1 m/s

C.) At y = -30 m
v_x = constant
v_x = 6.00 m/s

v_y = ?
y = -30 m
v_{oy} = 0 m/s
a_y = -9.8 m/s²

$v_y^2 = v_{oy}^2 + 2a_y \cdot y$
$v_y^2 = (0)^2 + 2(-9.8)(-30)$
$v_y^2 = 0 + 588$
$v_y^2 = 588$
v_y = -24.2 m/s

Example 6:
The Royal Gorge Bridge in Colorado rises 321 m above the Arkansas River. Let's say you kick a rock horizontally off the bridge. The rock hits the water a horizontal distance of 45.0 m away from the base of the bridge.
With what velocity did you kick the rock?



x
x = 45.0 m
v_x =
t =

y
a_y = 0 m (at the top)
y = -321 m (at the bottom)
v_{oy} = 0 m/s
v_y =
a_y = -9.8 m/s²
t =

t = ?
v_{oy} = 0 m/s
a_y = -9.8 m/s²
y = -321 m

$y = v_{oy}t + \frac{1}{2}a_y t^2$
$-321 = (0)t + \frac{1}{2}(-9.8)t^2$
$-321 = 0 - 4.9t^2$
$-321 = -4.9t^2$
$\frac{-321}{-4.9} = t^2$
$t^2 = 65.5$
t = 8.09 s

At the very beginning, v_{oy} = 0 m/s, so the only velocity the rock would have is v_x. But - we have too many unknowns - we'll need to find time first - we can use our y-variables to do this

$x = v_x \cdot t$
$45.0 = v_x \cdot t$
* use y to find time
$45.0 = v_x \cdot (8.09)$
$v_x = \frac{45.0}{8.09}$
v_x = 5.56 m/s