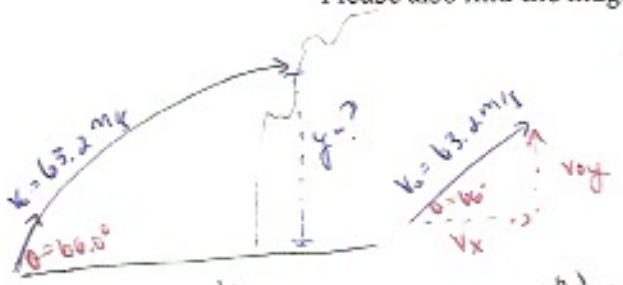
Honors Physics: Kinematics in Two-Dimensions
Class Examples

Full Projectile:

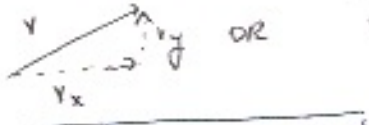
Example 2:
A cannon is fired from ground level up towards a nearby cliff. The cannonball is given an initial velocity of 63.2 m/s at an angle of 66.0°. After 7.60 seconds of flight, the cannonball lands on the side of the cliff.

A. At what height above the ground does the cannonball land?
B. What are the x- and y-components of the cannonball's final velocity at this position? Please also find the magnitude of the cannonball's resultant or final velocity.



$v_x = (\cos(66.0°)) \cdot 63.2$
$v_x = 25.7\ m/s$
$v_{oy} = \sin(66.0°) \cdot 63.2$
$v_{oy} = 57.7\ m/s$

B.)



v_x = constant = $25.7\ m/s$

$v_y = ?$
$v_{oy} = 57.7\ m/s$
$t = 7.60\ s$
$a_y = -9.8\ m/s^2$

$v_y = v_{oy} + at$
$v_y = 57.7 + (-9.8)(7.60)$
$v_y = 57.7 - 74.48$
$v_y = -16.8\ m/s$

x

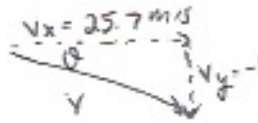
$x =$
$v_x = 25.7\ m$
$t = 7.60\ s$
(end of flight)

y

$y =$
$v_{oy} = 57.7\ m/s$
$v_y =$
$a_y = -9.8$
$t = 7.60\ s$ (end of flight)

A) $y = ?$
$v_{oy} = 57.7\ m/s$
$a_y = -9.8\ m/s^2$
$t = 7.60\ s$

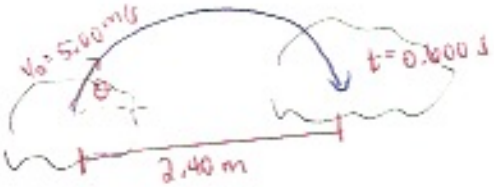
$y = v_{oy}t + \frac{1}{2}a_y t^2$
$y = (57.7)(7.60) + \frac{1}{2}(-9.8)(7.60)^2$
$y = 438.52 - 283.024$
$y = 155\ m$



$v = \sqrt{(25.7)^2 + (-16.8)^2}$
$v = 30.7\ m/s$

$\theta = \tan^{-1}\left(\frac{-16.8}{25.7}\right)$
$\theta = -33.2°$

Example 3:
A giant bullfrog is hopping from one lily pad to another in search of a tasty fly for lunch. Each lily pad is spaced 2.40 m apart and the giant bullfrog leaps with an initial velocity of 5.00 m/s. If he takes 0.600 s to get from one lily pad to another, with what initial angle must the giant bullfrog jump to make it to each lily pad?

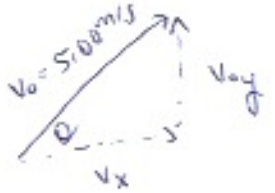


x

$x = 2.40\ m$
$v_x =$
$t = 0.600\ s$

y

$y = 0\ m$ (beginning + end)
$v_{oy} =$
$v_y =$
$a_y = -9.8\ m/s^2$
$t = 0.600\ s$



$v_x = \cos\theta \cdot (5.00)$
$v_{oy} = \sin\theta \cdot (5.00)$

If we can find either v_x or v_{oy} then we can find θ

* solve for v_x
$x = v_x \cdot t$
$2.40 = v_x \cdot (0.600)$
$v_x = 4.00\ m/s$

$v_x = \cos\theta \cdot (5.00)$
$4.00 = \cos\theta \cdot (5.00)$
$\frac{4.00}{5.00} = \cos\theta$
$\cos^{-1}\left(\frac{4.00}{5.00}\right) = \cos^{-1}(\cos\theta)$
$\cos^{-1}\left(\frac{4.00}{5.00}\right) = \theta$
$\theta = 36.9°$