Honors Physics: Kinematics in Two-Dimensions
Class Examples

Sections Covered

- Chapter 7, Section 2: pages 155 – 161
- *Additional Reading

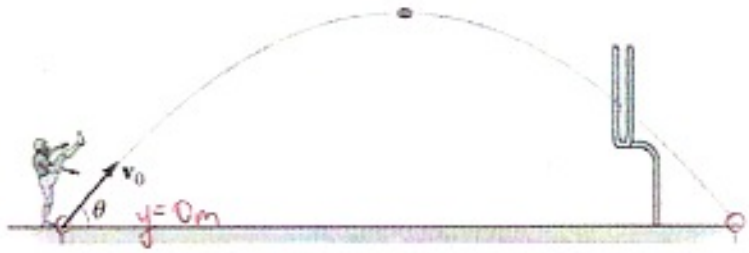
Topics Covered

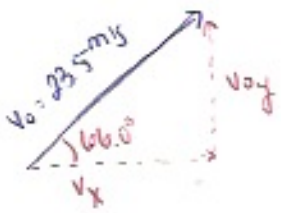
- Motion in two dimensions (x and y)
- Projectile Motion
  - ½ Projectile
  - Full projectile

Full Projectile:

Example 1:
A football is kicked with an initial velocity (v_o) of 23.5 m/s at an angle of 66.0° above the horizontal. Find the following:

A. The maximum height
B. The hang time or time of flight
C. The range
D. At the moment of impact, the velocity in the x-direction, velocity in the y-direction, the magnitude of the final velocity, and the angle of impact.





$v_x = \cos(66.0°) \cdot 23.5$
$v_x = 9.56\ m/s$
$v_{oy} = \sin(66.0°) \cdot 23.5$
$v_{oy} = 21.5\ m/s$

x
$x = 42.0\ m$
$v_x = 9.56\ m/s$
$t = 4.39\ s$ (to the end)

y
$y = 0\ m$ (start and end)
$*y_{max} = 23.6\ m$
$v_{oy} = 21.5\ m/s$
$v_y =$
$a_y = -9.8\ m/s^2$
$t = 4.39\ s$ (to the end)

A.) Max height (y_{max})
v_y will be 0 m/s at highest point
$y_{max} = ?$
$v_{oy} = 21.5\ m/s$
$v_y = 0\ m/s$
$a_y = -9.8\ m/s^2$

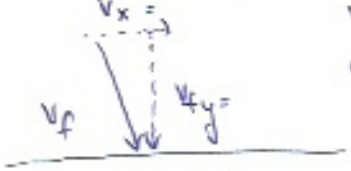
$v_y^2 = v_{oy}^2 + 2a_y y$
$(0)^2 = (21.5)^2 + 2(-9.8)y$
$0 - 462.25 = -19.6y$
$-462.25 = -19.6y$
$y = 23.6\ m$

B.) hang time
*time when $y = 0\ m$ again
$t = ?$
$y = 0\ m$
$v_{oy} = 21.5\ m/s$
$a_y = -9.8\ m/s^2$

$y = v_{oy}t + \frac{1}{2}a_y t^2$
$0 = 21.5 \cdot t + \frac{1}{2}(-9.8)t^2$
$0 = 21.5 \cdot t - 4.9t^2$
$0 = (21.5 - 4.9t)t$
two solutions
$t = 0\ s$
$21.5 - 4.9t = 0$
$-4.9t = -21.5$
$t = 4.39\ s$

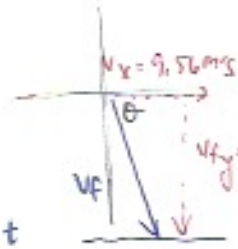
C.) $x = v_x \cdot t$
$x = (9.56)(4.39)$
$x = 42.0\ m$

D) Final Velocity
$v_{fy} = ?$
$v_{oy} = 21.5\ m/s$
$a_y = -9.8\ m/s^2$
$t = 4.39$



v_x is constant
$v_x = 9.56\ m/s$

$v_{fy} = v_{oy} + a_y t$
$v_{fy} = 21.5 + (-9.8)(4.39)$
$v_{fy} = 21.5 - 43.0$
$v_{fy} = -21.5\ m/s$



$v_f = \sqrt{v_x^2 + v_{fy}^2}$
$v_f = 23.5\ m/s$
$\theta = \tan^{-1}\left(\frac{-21.5}{9.56}\right)$
$\theta = -66.0°$