Projectiles Fired at an Angle

In many real-world situations, the initial velocity of a projectile is not horizontal. Fortunately, the physics that we applied to analyzing the motion of horizontal projectiles still applies, even if the projectile is fired at an angle.

To analyze the motion of a projectile that is launched at an angle, we must still consider the horizontal and vertical components of the object's motion separately. The major difference between these projectiles and those launched horizontally is that projectiles launched at an angle will have an initial velocity in the vertical direction.

Below is a summary of some of the most significant characteristics of projectiles launched at an angle:

- the horizontal component of the velocity is constant
- when the object reaches the peak of its trajectory, the vertical component of its velocity will be zero
- the time taken to reach the peak of its trajectory will equal the time required to return to ground level
- the vertical component of the initial velocity and the vertical component of the final velocity will have equal magnitudes but opposite directions
- position and velocity at any time is the SUM of the x and y components at that time

Example
A ball is projected with an initial velocity of 20 $m/s\ [37^\circ\ ATH]$. Determine:

a) the maximum height to which the ball rises.

b) the total time in the air.

c) the range (horizontal displacement).

d) the velocity at its maximum height.

e) the acceleration at its maximum height.

f) the position of the ball at $t = 1\ s$.

g) the velocity of the ball at $t = 2\ s$.

Projectiles Worksheet #3

1. A shell has a velocity of 125 m/s $\left[40° \; ATH\right]$. Find the horizontal and vertical components of its velocity. (95.8 m/s, horizontally; 80.3 m/s, up)

2. A cannon fires a 5 kg shell with a muzzle velocity of 200 m/s $\left[30° \; ATH\right]$. Determine:

   a) the net force acting on the shell. (-49 N)

   b) the vertical components of the net force. (-49 N)

   c) the horizontal components of the net force. (0 N)

   d) the vertical acceleration of the shell. (-9.8 m/s^2)

   e) the horizontal acceleration of the shell. (0 m/s^2)

   f) the vertical component of the muzzle's velocity. (+100 m/s)

   g) the horizontal component of the muzzle's velocity. (+173.2 m/s)

3. A ball is thrown with a speed of 16.6 m/s $\left[37° \; ATH\right]$. It returns to the level from which it was thrown in free flight. Determine:

   a) the horizontal and vertical components of its initial velocity. (+13.3 m/s, +10 m/s)

   b) the time of flight of the ball. (2.04 s)

   c) the range of the ball. (27.0 m)

   d) the position of the ball at $t = 0.6\ s$. (9 m $\left[28° \; ATH\right]$)

   e) the velocity of the ball at $t = 1.2\ s$ (13.4 m/s $\left[8° \; BTH\right]$)

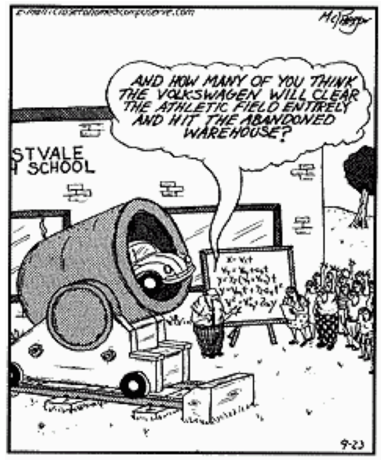
   f) the maximum height to which the ball rises. (5.1 m)

   g) the velocity of the ball at maximum height. (13.3 m/s, horizontally)

   h) the velocity of impact on return to ground level. (16.6 m/s $\left[37° \; BTH\right]$)

4. A ball is thrown with a speed of 16.6 m/s $\left[37° \; ATH\right]$ from the top of a building 122.5 m high. What is its time of flight and range? (6.1 s, 81.1 m)

5. A ball is thrown with a velocity of $10\ m/s\ [45°\ ATH]$. It lands on the roof of a building $2.3\ m$ above the point from which it was thrown. What is its time of flight? ($0.946\ s$)



Thanks to the innovative labs of teacher Herb Krenley, physics quickly became Westvale High's most popular course.