Interesting Facts Regarding Projectile Motion

1. Assume several projectiles are launched with the same initial speed but different projection angles, θ_1 and θ_2. The same range will be obtained if θ_1 and θ_2 are complementary

$$\theta_1 + \theta_2 = 90^\circ$$

2. The maximum range of the projectile occurs when $\theta_1 = \theta_2 = 45^\circ$

3. When a projectile is fired at a target, it will always find its mark provided that

(a) the projectile leaves the gun at the same time the target is dropped from rest.

(b) the projectile is aimed exactly at the target at the start of its fall.

(c) the projectile has enough initial velocity to reach the target before it hits the ground.

Relative Velocity

Observers in different frames of reference may measure different displacements or velocities for an object in motion.

For motion with zero acceleration, the equations

$$\Delta x = v_{ox}t + \frac{1}{2}a_x t^2 \qquad \Delta x = \frac{1}{2}(v_{ox} + v_x)t$$

simply reduce to

$$\Delta x = v_{ox}t = v_x t$$
$$\text{for } a_x = 0\ m/s^2$$

There are no general equations that must be memorized in order to work relative velocity problems. Instead, it is important to develop the picture and label the necessary equations with the appropriate subscripts.

Example: A river flows due east at 1.5 m/s. A boat crosses the river from the south to the north shore by maintaining a constant velocity of 10 m/s due north relative to the water.

(a) what is the velocity of the boat relative to shore?

(b) If the river is 300m wide, how far downstream has the boat moved by the time it reaches the north shore?

Answers

(a) $|\vec{v}| = 10.11$ m/s

$\theta = 81.5°$

(b) $\Delta x = 45$ m

Example: A monkey on a cliff throws a coconut horizontally from a height of 17 m with a speed of 2.1 m/s. If the ground below the cliff is level, how far from the base of the cliff does the coconut strike the ground?

Answer

$x = 3.91\ m$