PHYSICS

PROJECTILE MOTION

Recall simple motion …

Ex 1 (Vertical Question): An object is dropped from rest a height of 20 m, how long does it take to hit the ground?

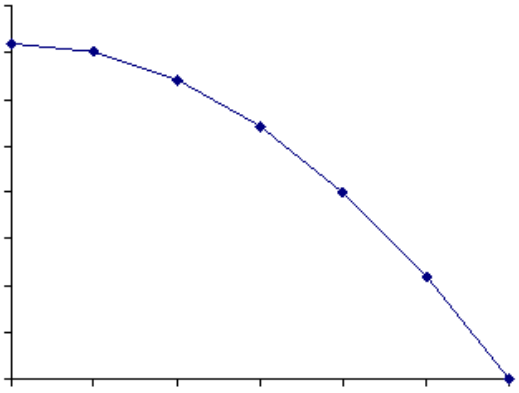
Ex 2 (Horizontal Question): An object travels at a constant speed of 2 m/s for 2 seconds. How far does it travel?

PHYSICS

PROJECTILE MOTION

PROJECTILE MOTION

A projectile is an object that exhibits both vertical and horizontal motion at the same time. The combination of these horizontal and vertical vectors create a curved path.



In order to solve problems involving projectiles, one must separate the vertical and horizontal components.

Ex: What is the horizontal displacement of an object that is pushed off a 20 m tall cliff with an initial horizontal velocity of 2 m/s?

PHYSICS

PROJECTILE MOTION

NOTE: ***-*** *Because we are ignoring air resistance, the horizontal speed remains constant throughout the motion.*
- *The vertical velocity will be subject to the acceleration due to gravity.*

Impact Velocity

The impact velocity is the vector quantity that tells us how fast the object hit the ground. It is calculated by combining the vertical v_2 with the horizontal v_2.

Ex: Using the example from above, find the impact velocity.

PHYSICS

PROJECTILE MOTION

http://www.youtube.com/watch?v=qErh402eJgI

Ex 2: *Ex: A cannon ball is shot horizontally with an initial speed of 100 m/s from a 60 m high cliff. The cannon ball lands in the water below.*

a) *How long is it in the air?*

b) *How far from the base of the cliff will the ball go?*

c) *Find the impact velocity of the cannon ball.*

PHYSICS

HOMEWORK

1. Explain why an airplane moving through the air is not an example of projectile motion.
2. A stone is thrown horizontally under negligible air resistance. What are its vertical acceleration and its horizontal acceleration?
3. A marble rolls off a table with a velocity of 1.93 m/s [horizontally]. The tabletop is 76.5 cm above the floor. If air resistance is negligible, determine
   (a) how long the marble is airborne
   (b) the horizontal range
   (c) the velocity at impact
4. A stone is thrown horizontally with an initial speed of 8.0 m/s from a cliff. Air resistance is negligible.
   (a) Determine the horizontal and vertical components of displacement and instantaneous velocity at $t = 0.0$ s, 1.0 s, 2.0 s, and 3.0 s.
   (b) Draw a scale diagram showing the path of the stone.
   (c) Draw the instantaneous velocity vector at each point on your diagram.
   (d) Determine the average acceleration between 1.0 s and 2.0 s, and between 2.0 s and 3.0 s. What do you conclude?
5. A baseball pitcher throws a ball horizontally under negligible air resistance. The ball falls 83 cm in travelling 18.4 m to the home plate. Determine the ball's initial horizontal speed.

30. A child throws a snowball with a horizontal velocity of 18 m/s directly toward a tree, from a distance of 9.0 m and a height above the ground of 1.5 m.
   (a) After what time interval does the snowball hit the tree?
   (b) At what height above the ground will the snowball hit the tree?
   (c) Determine the snowball's velocity as it strikes the tree.
31. Determine the initial velocity of a projectile that is launched horizontally, and falls 1.5 m while moving 16 m horizontally.

Answers

3. (a) 0.395 s
   (b) 76.3 cm
   (c) 4.33 m/s [63.5° below the horizontal]
4. (a) At 3.0 s, $\Delta x = 24$ m, $\Delta y = 44$ m, and $\vec{v} = 3.0 \times 10^1$ m/s [75° below the horizontal].
   (d) 9.8 m/s^2 [down]
5. 45 m/s

PHYSICS

Practice Questions

1) A ball rolls with a speed of 2.0 m/s across a level table that is 1.0 m above the floor. Upon reaching the edge of the table, it follows a parabolic path to the floor. How far along the floor is the landing spot from the table? **[0.90 m]**

2) A rescue pilot drops a survival kit while her plane is flying at an altitude of 2000.0 m with a forward velocity of 100.0 m/s. If air friction is disregarded, how far in advance of the starving explorer's drop zone should she release the package? **[2020 m]**

3) A rifle is fired horizontally and travels 200.0 m [E]. The rifle barrel is 1.90 m from the ground. What speed must the bullet have been travelling at? Ignore friction. **[321 m/s]**

4) A skier leaves the horizontal end of a ramp with a velocity of 25.0 m/s [E] and lands 70.0 m from the base of the ramp. How high is the end of the ramp from the ground? **[38.5 m]**

5) An astronaut stands on the edge of a lunar crater and throws a half-eaten Twinkie™ horizontally with a velocity of 5.00 m/s. The floor of the crater is 100.0 m below the astronaut. What horizontal distance will the Twinkie™ travel before hitting the floor of the crater? (The acceleration of gravity on the moon is $1/6^{th}$ that of the Earth). **[55.3 m]**