

Projectile Motion

Textbook pp. 36–43

Vocabulary

projectile

range (Δd_x)

projectile motion

MAIN IDEA: A projectile is an object that moves along a trajectory with only the force of gravity acting on it. An object moving with projectile motion has a constant horizontal velocity and a constant vertical acceleration.

Kinematic Equations with Horizontal and Vertical Components




Direction of motion	Description	Equations of motion
horizontal motion (x)	constant-velocity equation for the x -component only	$v_{ix} = v_i \cos \theta$ $v_{ix} = \text{constant}$ $\Delta d_x = v_{ix} \Delta t$ $\Delta d_x = (v_i \cos \theta) \Delta t$
vertical motion (y)	constant-acceleration equations for the y -component; constant acceleration has a magnitude of $ \vec{g} = g = 9.8 \text{ m/s}^2$	$v_{iy} = v_i \sin \theta - g \Delta t$ $\Delta d_y = (v_i \sin \theta) \Delta t - \frac{1}{2} g \Delta t^2$ $v_{iy}^2 = (v_i \sin \theta)^2 - 2g \Delta d_y$





STUDY TIP

Table of Equations

This is an excellent place to make use of your Equation Organizer.



You can use the opportunity to fine tune how you have the equations organized, and add notes on where they apply.




- A red ball is launched horizontally at a speed of 5.0 m/s. A green ball is dropped at the same time from the same point. If both balls land on the same level floor, which statement is true? Explain your answer.   

 - The red ball will hit the floor before the green ball.
 - The green ball will hit the floor before the red ball.
 - Both balls will hit the floor at the same time.
 - There is not enough information to make the determination.
- A golfer hits a ball, and it lands at the same vertical level it was launched. The launch angle can be increased from 0° to 90° . Which statement is true? Explain why your choice is correct, and the other choices are not correct.    

 - The time the ball spent in the air is the same for all launch angles.
 - The range will increase as the launch angle is increased from 0° to 90° .
 - The maximum height reached is the same for all launch angles.
 - The time spent in the air increases as the launch angle is increased from 0° to 90° .

MAIN IDEA: The horizontal and vertical motions of a projectile are independent. The time that a projectile spends moving in the horizontal direction is the same time that it moves in the vertical direction.





- An archer released an arrow at a speed of 80.0 m/s at an angle of 40° above the horizontal. 1.63 s later, the arrow struck the target at the same height above ground as the launch point. How far was the target from the archer?  



4. A punter kicks a football at an angle of 30.0° above the horizontal. The football lands 86.9 m from the point it was kicked 3.20 s later.   

(a) What is the launch speed of the football?

(b) What is the maximum height reached by the football?

MAIN IDEA: To solve projectile motion problems, apply the constant-velocity equation for the horizontal displacement, and apply the constant-acceleration equations for the vertical motion.

5. A catapult constructed by a student can launch a bowling ball at a speed of 19.6 m/s. What is the expected maximum range of the catapult, assuming that the ball lands at the same height from which it is launched? Explain your reasoning.    

6. A pumpkin farm holds an annual pumpkin launch. Visitors may guess the distance a launched pumpkin will travel. The farm's catapult launches the pumpkin at a speed of 25.2 m/s. Assume that the pumpkin will land at the same height from which it is launched. George guesses a range of 60.0 m. Christy guesses a range of 65.0 m. Who guessed correctly? Explain your answer.  

7. Andrew is standing 10.0 m from Juliet's house. Andrew tosses a ball to Juliet, and the ball travels at 5.00 m/s at an angle of 50.0° above the ground. The ball passes through Juliet's window. How far above the ground is the window? 