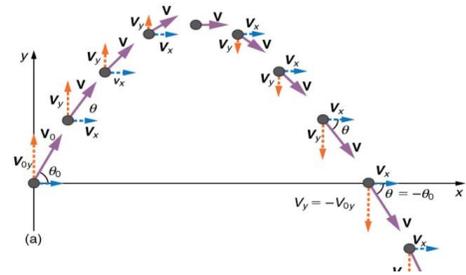


## Physics 01-08 Projectile Motion

Name: \_\_\_\_\_

- Objects in \_\_\_\_\_ only under influence of \_\_\_\_\_
- x and y components are \_\_\_\_\_
- \_\_\_\_\_ is only quantity that is the \_\_\_\_\_ in both dimensions
- x-component velocity \_\_\_\_\_ since nothing pulling it sideways
  - Use \_\_\_\_\_
- y-component \_\_\_\_\_ because gravity pulling it down
  - Use \_\_\_\_\_
- If the starting and ending height are the \_\_\_\_\_, the distance the object goes can be found with the \_\_\_\_\_ equation.



A Veggie-meatball with  $v = 5.0$  m/s rolls off a 1.0 m high table. How long does it take to hit the floor if no one sneezes?

What is its velocity when it hits the floor?

A truck ( $v = 11.2$  m/s) turned a corner too sharp and lost part of the load. A falling box will break if it hits the ground with a velocity greater than 15 m/s. The height of the truck bed is 1.5 m. Will the box break?

While driving down a road a bad guy shoots a bullet straight up into the air. If there was no air resistance where would the bullet land in front, behind, or on him?

If a gun were fired horizontally and a bullet were dropped from the same height at the same time, which would hit the ground first?

A batter hits the ball at  $35^\circ$  with a velocity of 32 m/s. How high did the ball go?

How long was the ball in the air?

How far did the ball go?

### Homework

1. Is the acceleration of a projectile equal to zero when it reaches the top of its trajectory? If not, why not?
2. A tennis ball is hit upward into the air and moves along an arc. Neglecting air resistance, where along the arc is the speed of the ball (a) a minimum and (b) a maximum? Justify your answers.
3. A tennis ball is hit upward into the air and moves along an arc. Neglecting air resistance, where along the arc is the acceleration of the ball (a) a minimum and (b) a maximum? Justify your answers.
4. A wrench is accidentally dropped from the top of the mast on a sailboat. Will the wrench hit at the same place on the deck whether the sailboat is at rest or moving with a constant velocity? Justify your answer.
5. A stone is thrown horizontally from the top of a cliff and eventually hits the ground below. A second stone is dropped from rest from the same cliff, falls through the same height, and also hits the ground below. Ignore air resistance. Discuss whether each of the following quantities is different or the same in the two cases; if there is a difference, describe the difference: (a) displacement, (b) speed just before impact with the ground, and (c) time of flight.
6. A projectile is launched at ground level with an initial speed of 50.0 m/s at an angle of 30.0° above the horizontal. It strikes a target above the ground 3.00 seconds later. What are the x and y distances where the projectile was launched to where it lands? (OpenStax 3.25) **1.30 × 10<sup>2</sup> m, 30.9 m**
7. A ball is thrown horizontally from the top of a 60.0-m building and lands 100.0 m from the base of the building. Ignore air resistance. (a) How long is the ball in the air? (b) What must have been the initial horizontal component of the velocity? (c) What is the vertical component of the velocity just before the ball hits the ground? (d) What is the velocity (including both the horizontal and vertical components) of the ball just before it hits the ground? (OpenStax 3.27) **3.50 s, 28.6 m/s, - 34.3 m/s, 44.7 m/s at 50.2° below x-axis**
8. (a) A daredevil is attempting to jump his motorcycle over a line of buses parked end to end by driving up a 32° ramp at a speed of 40.0 m/s (144 km/h). How many buses can he clear if the top of the takeoff ramp is at the same height as the bus tops and the buses are 20.0 m long? (b) Discuss what your answer implies about the margin of error in this act—that is, consider how much greater the range is than the horizontal distance he must travel to miss the end of the last bus. (Neglect air resistance.) (OpenStax 3.28) **7 buses**
9. An arrow is shot from a height of 1.5 m toward a cliff of height H. It is shot with a velocity of 30 m/s at an angle of 60° above the horizontal. It lands on the top edge of the cliff 4.0 s later. (a) What is the height of the cliff? (b) What is the maximum height reached by the arrow along its trajectory? (c) What is the arrow's impact speed just before hitting the cliff? (OpenStax 3.34) **27.0 m, 36.0 m, 20 m/s**
10. The world long jump record is 8.95 m (Mike Powell, USA, 1991). Treated as a projectile, what is the maximum range obtainable by a person if he has a take-off speed of 9.5 m/s? State your assumptions. (OpenStax 3.36) **9.21 m**
11. An eagle is flying horizontally at a speed of 3.00 m/s when the fish in her talons wiggles loose and falls into the lake 5.00 m below. Calculate the velocity of the fish relative to the water when it hits the water. (OpenStax 3.40) **10.3 m/s, 73.1° below the horizontal**
12. Can a goalkeeper at his goal kick a soccer ball into the opponent's goal without the ball touching the ground? The distance will be about 95 m. A goalkeeper can give the ball a speed of 30 m/s. (OpenStax 3.43) **91.8 m, No**
13. A tennis ball is struck such that it leaves the racket horizontally with a speed of 28.0 m/s. The ball hits the court at a horizontal distance of 19.6 m from the racket. What is the height of the tennis ball when it leaves the racket? (OpenStax 3.14) **2.40 m**
14. A diver runs horizontally with a speed of 1.20 m/s off a platform that is 10.0 m above the water. What is his speed just before striking the water? (RW) **14.1 m/s**
15. The 1994 Winter Olympics included the aerials competition in skiing. In this event skiers speed down a ramp that slopes sharply upward at the end. The sharp upward slope launches them into the air, where they perform acrobatic maneuvers. In the women's competition, the end of a typical launch ramp is directed 63° above the horizontal. With this launch angle, a skier attains a height of 13 m above the end of the ramp. What is the skier's launch speed? (Cutnell 3.24) **18 m/s**