

Trajectories Worksheet

Objective

- Work with ballistic trajectories in the vertical and horizontal directions.

Problems

1. A batter hits a baseball so that it leaves the bat with an initial speed $v_0 = 37.0$ m/s at an initial angle $\alpha_0 = 53.1^\circ$, at a location where $g = 9.80$ m/s. Assume, contrary to truth and reason, that air resistance is negligible.
 - a. Write down the equations for the horizontal and vertical components of the ball's velocity and position.
 - b. Find the position and velocity of the ball 2.00 s after it leaves the bat.
 - c. Find the time at which the ball reaches the highest point in its flight.
 - d. Find the greatest height the ball reaches in its flight.
 - e. Find the *horizontal range*: the horizontal distance from the bat where the ball first touches the ground. Make reasonable guesses for any quantities that you need but were not specified.
2. A 10,000-N car comes to a bridge during a storm and finds the bridge washed out. The driver must get to the other side, so he decides to try leaping it with his car. The bank the car is on is 21.3 m above the river, while the opposite bank is 1.8 m above the river. The gap is 61.0 m wide.
 - a. How fast should the car be traveling as it leaves the cliff to just clear the river and land on the other side?
 - b. What will be the vertical component of the car's velocity right before it lands?
3. A 2.7-kg ball is thrown with an initial speed of 20.0 m/s from the edge of a 45.0-m high cliff. At the instant the ball is thrown, a woman starts running away from the base of the cliff with a constant speed of 6.00 m/s. She runs in a straight line along level ground, and air resistance can be ignored.
 - a. At what angle above horizontal should the ball be thrown so that the runner will catch it just before it hits the ground?
 - b. How far does she run before catching the ball?

4. Two tanks are engaged in a training exercise on level ground. The first tank fires a paint-filled training round with a muzzle speed of 250 m/s at 10.0° above horizontal while advancing directly toward the second tank with a speed of 15.0 m/s relative to level ground. The second tank is retreating at 35.0 m/s relative to the ground, but is hit by the shell. You can ignore air resistance and assume that the shell hits at the same level above the ground at which it was fired.
- What was the distance between the tanks when the round was fired?
 - What was the distance between the tanks at the time of impact?
5. In a carnival booth, you win a stuffed giraffe if you toss a quarter into a small dish. The dish is on a shelf higher than the point where the quarter leaves your hand, and is a horizontal distance of 2.1 m away. The coin lands in the dish if you toss it with a speed of 6.4 m/s at an angle of 60° above the horizontal. Ignore air resistance.
- What is the height of the shelf above the point where the coin leaves your hand?
 - What is the vertical component of the velocity of the coin just before it lands in the dish?
 - What is the speed of the coin just before it lands in the dish?