

Worksheet 3: Trajectories

Objectives

- Represent position, velocity and acceleration as vectors.
- Work with ballistic trajectories in the vertical and horizontal directions.

Problems

1. Three identical steel balls are released at the same time from the same height above the ground. One is released with initial speed 0 m/s, one with initial speed v_0 upward, and one with initial speed v_0 downward. Once released, all are in free-fall until they hit the ground.
 - a. Draw a diagram of the initial situation. Show axis directions and the location of the origin.
 - b. Construct, for each ball, the kinematic equation giving height as a function of time.
 - c. Construct equations for the height differences as functions of time between:
 - The ball initially moving upward and the ball released from rest.
 - The ball released from rest and the ball initially moving downward.
 - d. Find the maximum height above the ground reached by the ball initially moving upward.
 - e. Substitute the height found in part d into the height equation for the ball released from rest and solve for t to find when this ball reaches that height. What do you find? What does it mean?

2. The distance-distance grid below shows two vectors: A , the change in position of a ball after 1 s in flight, and B , the vector that is added to the change every second by the acceleration due to gravity. Determine the subsequent positions of the ball at 1-s intervals using the following procedure:

- Starting at the ball's current position, copy the displacement vector from the previous second.
- Add to it the vector B .
- The sum is the displacement vector for the current second. The ball is now at the end of the sum vector.
- Repeat steps a–c until the ball hits the ground.

