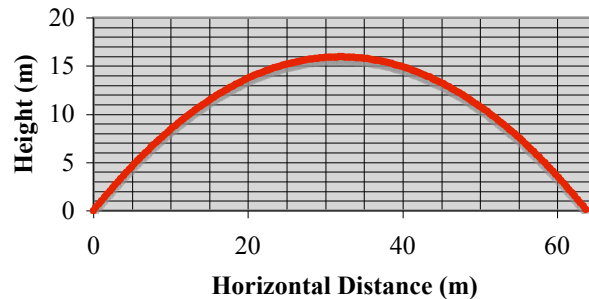


Range of a Projectile

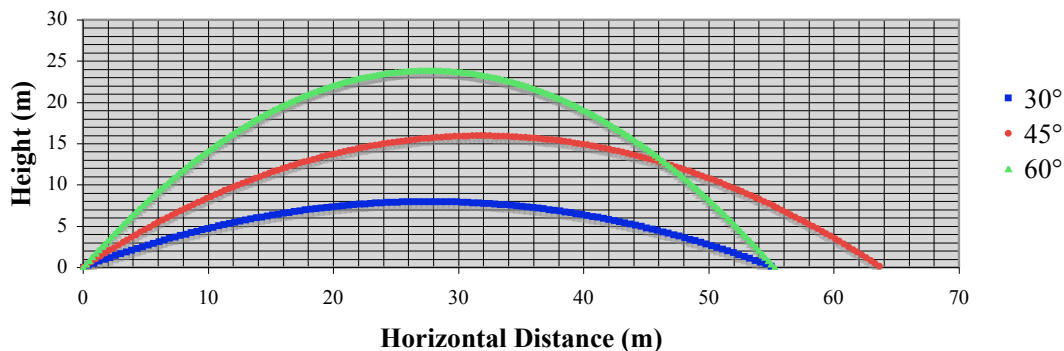
A projectile is an airborne object that is under the sole influence of gravity. As it rises and falls, air resistance has a negligible effect. The **launch angle** of a projectile is the angle between the horizontal direction and the launch direction. The trajectory plot in **Figure 1** shows the path of a projectile launched with a launch speed of 25.0 m/s at a launch angle of 45°.

Figure 1: Trajectory Plot



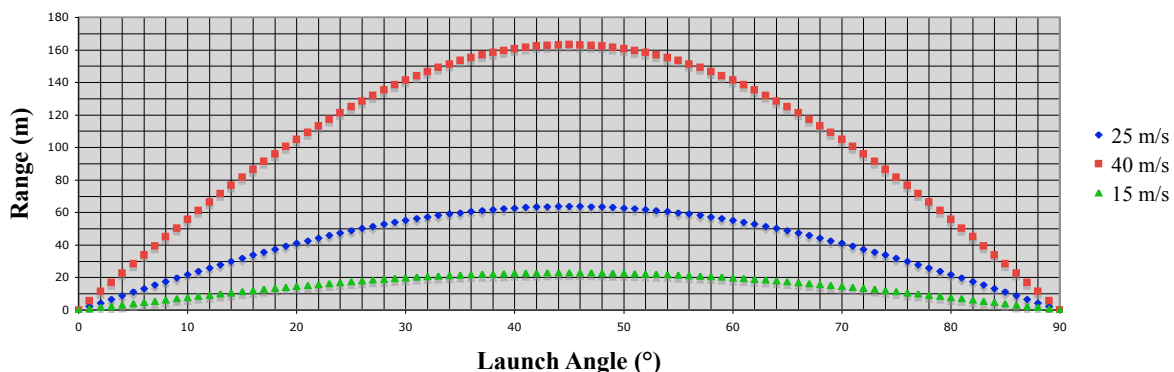
The trajectory plot of a projectile looks the same regardless of the launch angle. The shape of the trajectory is mathematically described as being a parabola. **Figure 2** represents the trajectory plot for three different launch angles for a projectile launched at 25.0 m/s.

Figure 2: Trajectory Plots for 25.0 m/s at 30°, 45°, and 60°



The distance traveled horizontally from the launch position to the landing position is known as the **range**. The range of an angled-launch projectile depends upon the launch speed and the launch angle. **Figure 3** illustrates the effect of launch angle on the range of a projectile for three different launch speeds.

Figure 3: Range vs. Launch Angle



Questions:

1. Based on **Figure 1**, what is the highest height obtained by a projectile launched with a speed of 25.0 m/s at a launch angle of 45°?
 - a. Approximately 16 meters
 - b. Approximately 32 meters
 - c. Approximately 45 meters
 - d. Approximately 63 meters
2. A projectile is launched with a speed of 25 m/s and a launch angle of 60°. What will be the range of the projectile?
 - a. 11 meters
 - b. 24 meters
 - c. 36 meters
 - d. 55 meters
3. For any given launch speed, what launch angle will result in the greatest range for a projectile?
 - a. 40 degrees
 - b. 45 degrees
 - c. 60 degrees
 - d. 90 degrees
 - e. It depends on the actual launch speed that is used.
4. For a launch speed of 25 m/s, what launch angle will result in the same range as a projectile launched at an angle of 30°?
 - a. 0 degrees
 - b. 25 degrees
 - c. 45 degrees
 - d. 60 degrees
 - e. Nonsense! Every angle will result in the same range as long as the launch speed is 25 m/s.
5. What effect does increasing launch angle have upon the range of a projectile?
 - a. Increasing the launch angle always increases the range.
 - b. Increasing the launch angle always decreases the range.
 - c. Increasing the launch angle has no predictable effect upon the range.
 - d. For angles less than 45°: increasing the launch angle increases the range; the opposite is true for angles over 45°.
6. Which of the following projectiles will travel the highest?
 - a. A projectile launched with a speed of 25 m/s and a launch angle of 30°.
 - b. A projectile launched with a speed of 25 m/s and a launch angle of 45°.
 - c. A projectile launched with a speed of 25 m/s and a launch angle of 60°.
 - d. Nonsense! Each of these projectiles will travel to the same height.

7. Consider the following two projectiles:

Projectile	Launch Speed	Launch Angle
A	40 m/s	30°
B	40 m/s	45°

Which projectile has the greatest range and how much further does it travel than the other projectile?

- Projectile A travels further by approximately 141 meters.
 - Projectile B travels further by approximately 22 meters.
 - Projectile B travels further by approximately 82 meters.
 - Projectile B travels further by approximately 163 meters.
 - The two projectiles travel the same distance.
8. Consider the following two projectiles:

Projectile	Launch Speed	Launch Angle
A	15 m/s	25°
B	40 m/s	65°

Which projectile has the greatest range and how much further does it travel than the other projectile?

- Projectile A travels further by approximately 62 meters.
 - Projectile B travels further by approximately 62 meters.
 - Projectile B travels further by approximately 108 meters.
 - Projectile B travels further by approximately 116 meters.
 - The two projectiles travel the same distance.
9. Consider a projectile launched with a speed of 25 m/s at an angle of 45°. How much higher is it after traveling a horizontal distance of 45 meters than it was after traveling a horizontal distance of 10 meters?
- Approximately 5 meters.
 - Approximately 8 meters.
 - Approximately 13 meters.
 - Approximately 35 meters.
 - Nonsense! The projectile is actually lower after a horizontal distance of 45 meters.
10. Suppose that the football kicked by a place-kicker travels as a projectile (i.e., without air resistance). It is kicked with a speed of 25.0 m/s at a 30° angle. It must pass over field goal posts that are approximately 3 meters high. What would be the maximum field goal distance that could be kicked?
- 6 meters
 - 11 meters
 - 49 meters
 - 55 meters