Chapter 5   Projectile Motion

Summary

THE BIG IDEA : Projectile motion can be described by the horizontal and vertical components of motion.

5.1 Vector and Scalar Quantities

☑ **A vector quantity includes both magnitude and direction, but a scalar quantity includes only magnitude.**

- Sketches in physics often include arrows, where each arrow represents the magnitude and the direction of a certain quantity.
- Velocity is a vector quantity, as is acceleration.
- Scalars can be added, subtracted, multiplied, and divided like ordinary numbers.

5.2 Velocity Vectors

☑ **The resultant of two perpendicular vectors is the diagonal of a rectangle constructed with the two vectors as sides.**

- An airplane's velocity is a combination of the velocity of the airplane relative to the air and the velocity of the air relative to the ground (the wind velocity).
- For two velocity vectors that are perpendicular, the result of adding the two vectors, called the *resultant*, is the diagonal of the rectangle described by the two vectors.
- To add equal-magnitude vectors, a square is constructed, and the resultant is the diagonal of the square. For any square, the length of the diagonal is $\sqrt{2}$, or 1.414 times either of its sides.

5.3 Components of Vectors

☑ **The perpendicular components of a vector are independent of each other.**

- Two vectors at right angles that add up to a given vector are known as the **components** of the vector they replace.
- The process of determining the components of a vector is called **resolution.**
- Any vector drawn on a piece of paper can be resolved into vertical and horizontal components that are perpendicular.

5.4 Projectile Motion

☑ **The horizontal component of motion for a projectile is just like the horizontal motion of a ball rolling freely along a level surface without friction. The vertical component of a projectile's velocity is like the motion for a freely falling object.**

- A cannonball shot from a cannon, a stone thrown into the air, a ball rolling off the edge of a table, a spacecraft circling Earth—all of these are examples of projectiles.

Chapter 5   **Projectile Motion**

- A **projectile** is any object that moves through the air or space, acted on only by gravity (and air resistance, if any).
- When no horizontal force acts on a projectile, the horizontal velocity remains constant.
- The horizontal component of motion for a projectile is completely independent of the vertical component of motion.

5.5 Projectiles Launched Horizontally

✔ **The downward motion of a horizontally launched projectile is the same as that of free fall.**

- When projectiles are launched horizontally, gravity acts only downward, so the only acceleration is downward.
- The vertical distance fallen has nothing to do with the horizontal component of motion.
- The path traced by a projectile accelerating only in the vertical direction while moving at constant horizontal velocity is a *parabola*.

5.6 Projectiles Launched at an Angle

✔ **The vertical distance a projectile falls below an imaginary straight-line path increases continually with time and is equal to $5t^2$ meters.**

- The maximum horizontal range for projectiles is attained at a projection angle of 45°.
- When the effect of air resistance on a projectile's motion is significant, the range is diminished and the path is not a true parabola.
- If air resistance is negligible, a projectile hits the ground with the same speed it had originally when it was projected upward from the ground.