

Chapter 11 Motion

Summary

11.1 Distance and Displacement

➤ To describe motion accurately and completely, a frame of reference is necessary.

- A **frame of reference** is a system of objects that are not moving with respect to one another.
- **Relative motion** is movement in relation to a frame of reference.

➤ Distance is the length of the path between two points. Displacement is the direction from the starting point and the length of a straight line from the starting point to the ending point.

- Displacement gives information both about how far away an object is from a given point and in what direction the object is from that point. Displacement is a vector.

➤ Add displacements using vector addition.

- A **vector** is a quantity that has magnitude and direction. The magnitude can be size, length, or amount.
- When two vectors have the same direction, you can add their magnitudes. When two vectors are in opposite directions, subtract one magnitude from the other.
- When two or more vectors have different directions, combine them by graphing.
- The **resultant vector** is the vector sum of two or more vectors.

11.2 Speed and Velocity

➤ Average speed is computed for the entire duration of a trip, and instantaneous speed is measured at a particular instant.

- **Speed** is the ratio of the distance an object moves to the amount of time the object moves.
- **Average speed** is the total distance traveled divided by the time it takes to travel that distance. The formula for average speed is $\bar{v} = \frac{d}{t}$.
- **Instantaneous speed** is the rate at which an object is moving at a given moment in time.

➤ The slope of a line on a distance-time graph is speed.

➤ Velocity is a description of both speed and direction of motion. Velocity is a vector.

- Together, the speed and direction in which an object is moving are called **velocity**. A change in velocity can be the result of a change in speed, a change in direction, or both.

➤ Two or more velocities add by vector addition.

11.3 Acceleration

➡ Acceleration can be described as changes in speed, changes in direction, or changes in both. Acceleration is a vector.

- The rate at which velocity changes is called **acceleration**.
- **Free fall** is the movement of an object toward Earth solely because of gravity.
- **Constant acceleration** is a steady change in velocity.

➡ You calculate acceleration for straight-line motion by dividing the change in velocity by the total time.

➡ The slope of a speed-time graph is acceleration.

- In a **linear graph**, the displayed data form straight-line parts.
- In a **nonlinear graph**, a curve connects the data points that are plotted.

➡ Instantaneous acceleration is how fast a velocity is changing at a specific instant.