Chapter 2: Kinematics in One Dimension

Essential Concepts and Summary

Displacement

- Displacement is a vector pointing from an objects' initial position to its final position, and has a magnitude equal to the shortest distance between the points
- SI Unit: meter

$$\overrightarrow{\Delta x} = \vec{x} - \overrightarrow{x_0}$$

Speed and Velocity

- Average velocity is the change in displacement over change in time.
- Average speed is change in distance over change in time.
- Velocity has direction, speed doesn't

$$\overline{\vec{v}} = \frac{\overrightarrow{\Delta x}}{\Delta t}$$

$$\vec{v} = \lim_{\Delta t \to 0} \frac{\overrightarrow{\Delta x}}{\Delta t}$$

Acceleration

- Average acceleration is the change in velocity over a change in time

$$\overline{\vec{a}} = \frac{\overrightarrow{\Delta v}}{\Delta t}$$

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\overrightarrow{\Delta v}}{\Delta t}$$

Kinematics for Constant Acceleration

- These set of four equations apply when an object moves with constant acceleration along a straight line

$$v = v_0 + at$$

$$x = \frac{1}{2}(v_0 + v)t$$

$$x = v_0 t + \frac{1}{2}at^2$$

$$v^2 = v_0^2 + 2ax$$

Derivation

$$x = \frac{1}{2}(v_0 + v)t$$

$$v = v_0 + at$$

$$t = \frac{(v - v_0)}{a}$$

$$x = \frac{1}{2}(v + v_0)\frac{(v - v_0)}{a}$$

$$2ax = v^2 - v_0^2$$

$$v^2 = v_0^2 + 2ax$$

Freely Falling Bodies

- Idealized motion, where air resistance is neglected and acceleration is nearly constant, is referred to as free-fall.
- Acceleration due to gravity on earth, g, is 9.80 m/s^2
- Kinematics equations are the same but

  $a = g$

Graphical Analysis

- Slope of position vs. time plot is velocity
- Slope of velocity vs. time plot is acceleration
- The area underneath a velocity vs. time plot is distance

Summary of Equations

$$\overrightarrow{\Delta x} = \vec{x} - \overrightarrow{x_0}$$

$$\bar{\vec{v}} = \frac{\overrightarrow{\Delta x}}{\Delta t}$$

$$\vec{v} = \lim_{\Delta t \to 0} \frac{\overrightarrow{\Delta x}}{\Delta t}$$

$$\bar{\vec{a}} = \frac{\overrightarrow{\Delta v}}{\Delta t}$$

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\overrightarrow{\Delta v}}{\Delta t}$$

$$v = v_0 + at$$

$$x = \frac{1}{2}(v_0 + v)t$$

$$x = v_0 t + \frac{1}{2}at^2$$

$$v^2 = v_0^2 + 2ax$$