UNIT 3 READING A

Two-Dimensional Motion

The position of an object can be represented by a vector, as described in Unit 1 Reading B. The velocity of an object is then defined by:

$$\bar{\mathbf{v}} = \frac{\mathbf{x}_f - \mathbf{x}_i}{t_f - t_i}$$

where $\mathbf{x}_f$ is the final position vector, $\mathbf{x}_i$ is the initial position vector, t_f is the final time, t_i is the initial time. The velocity, **v**, is the rate of change of the position vector. Because this is a vector equation, it is very hard to use in this form and it is easier to understand, if it is separated into its x- and y- components:

$$\bar{v}_x = \frac{x_f - x_i}{t_f - t_i}$$

$$\bar{v}_y = \frac{y_f - y_i}{t_f - t_i}$$

The acceleration is defined as

$$\bar{\mathbf{a}} = \frac{\mathbf{v}_f - \mathbf{v}_i}{t_f - t_i}$$

where $\mathbf{v}_f$ is the final velocity vector, $\mathbf{v}_i$ is the initial velocity vector, t_f is the final time, t_i is the initial time. The acceleration, **a**, is the rate of change of the velocity vector. Because this is a vector equation, it is very hard to use in this form and it is easier to understand, if it is separated into its x- and y- components:

$$\bar{a}_x = \frac{v_{xf} - v_{xi}}{t_f - t_i}$$

$$\bar{a}_y = \frac{v_{yf} - v_{yi}}{t_f - t_i}$$

If the acceleration and the velocity are separated into their x- and y- components, then the equations of motion can be applied independently to the x- and y- directions:

$$x_f - x_i = \frac{v_{xf} + v_{xi}}{2} t$$

$$v_{xf} - v_{xi} = \bar{a}_x t$$

$$x_f - x_i = v_{xi} t + \frac{1}{2} \bar{a}_x t^2$$

$$2\bar{a}_x \left(x_f - x_i\right) = v_{xf}^2 - v_{xi}^2$$

$$y_f - y_i = \frac{v_{yf} + v_{yi}}{2} t$$

$$v_{yf} - v_{yi} = \bar{a}_y t$$

$$y_f - y_i = v_{yi} t + \frac{1}{2} \bar{a}_y t^2$$

$$2\bar{a}_y \left(y_f - y_i\right) = v_{yf}^2 - v_{yi}^2$$