

TOPIC 1.1

Kinematics: Motion in One Dimension

Required Course Content

ENDURING UNDERSTANDING

CHA-1

There are relationships among the vector quantities of position, velocity, and acceleration for the motion of a particle along a straight line.

LEARNING OBJECTIVE

CHA-1.A

- Determine the appropriate expressions for velocity and position as a function of time for an object accelerating uniformly in one dimension with given initial conditions.
- Calculate unknown variables of motion such as acceleration, velocity, or positions for an object undergoing uniformly accelerated motion in one dimension.
- Calculate values such as average velocity or minimum or maximum velocity for an object in uniform acceleration.

ESSENTIAL KNOWLEDGE

CHA-1.A.1

The kinematic relationships for an object accelerating uniformly in one dimension are:

$$x = x_0 + v_{x_0}t + \frac{1}{2}a_x t^2$$

$$v_x = v_{x_0} + a_x t$$

$$v_x^2 = v_{x_0}^2 + 2a_x(x - x_0)$$

- The constant velocity model can be derived from the above relationships.

$$v_x = \frac{\Delta x}{\Delta t}$$

- The average velocity and acceleration models can also be derived from the above relationships.

$$v_{x(\text{avg})} = \frac{\Delta x}{\Delta t}$$

$$a_{x(\text{avg})} = \frac{\Delta v_x}{\Delta t}$$

LEARNING OBJECTIVE

CHA-1.B

Determine functions of position, velocity, and acceleration that are consistent with each other, for the motion of an object with a nonuniform acceleration.

CHA-1.C

Describe the motion of an object in terms of the consistency that exists between position and time, velocity and time, and acceleration and time.

ESSENTIAL KNOWLEDGE

CHA-1.B.1

Differentiation and integration are necessary for determining functions that relate position, velocity, and acceleration for an object with nonuniform acceleration.

$$v_x = \frac{dx}{dt}$$

$$a_x = \frac{dv_x}{dt}$$

- These functions may include trigonometric, power, or exponential functions of time.
- They may also include a velocity-dependent acceleration function (such as a resistive force).

CHA-1.C.1

Position, velocity, and acceleration versus time for a moving object are related to each other and depend on an understanding of slope, intercepts, asymptotes, and area or upon conceptual calculus concepts.

- These functions may include trigonometric, power, exponential functions (of time) or velocity-dependent functions.