**MOTION IN ONE DIMENSION**

As a first step in studying classical mechanics, we describe the motion of an object while ignoring the interactions with external agents that might be affecting or modifying that motion. This portion of classical mechanics is called ***kinematics***. (The word kinematics has the same root as cinema.)

***Motion*** of an object represents a continuous change in the object’s position.

**MOTION ALONG A STRAIGHT LINE (Rectilinear Motion)**

We start our study with the simplest type of motion a body can undergo. This is called rectilinear motion or motion along a straight line. For the analysis, we will be considering the line of motion as a coordinate axis, i.e. the x-axis if the line of motion is horizontal or inclined or the y-axis if the line of motion is vertical.

BASIC CONCEPTS:

1. **Time (t)**

* measured in terms of change
* Motion always takes place over a period of time.

**Time instant** is a point in time, i.e. at the time 5 seconds after starting.

**Time interval**  is a length of time, i.e. during the time t1 = 5secs to t2 = 10 seconds, etc.

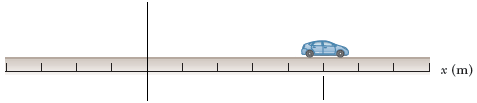
1. **Position (x)** of the body

This is to indicate the location of the body at any time as it moves. It is the distance from a given reference point along the path at any time.

Reference point

Path

Position of the body at time t

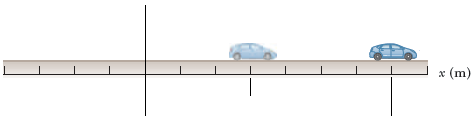


x

* In cases where the line of motion is the y-axis, position is denoted by (y).

1. **Displacement (x)**

Displacement is defined as the change in position during some time interval.



Body at time tf

Body at time ti

Reference point

x = xf -xi

xi

xf

* Displacement is different from distance traveled in the sense that displacement is a vector quantity directed from the initial to the final position. Distance is the length of a path followed by a particle. However, in one directional rectilinear motion, the magnitude of the displacement is the same as the distance traveled.

Example 1. What is the total distance travelled and the displacement of a shopper in a downtown mall who first walks 100m straight east and then walks 125m straight west?

1. **Velocity** of the body describes how fast that body is moving including its direction of motion.

**Average velocity (vave)** is the rate of change in the position of the body, that is the displacement of the body per time interval taken between two points along its path.

**Instantaneous velocity (v)** is the velocity of a body at a particular time instant or point along its path.

* **Speed** – *distance* per unit time

Example 2. A commuter drives 6 km due east to his work. Calculate the average velocity in kilometers per hour if it takes him 15 min. to drive to work.

1. **Acceleration** of the body is the rate of change in the velocity of the body.

**Average acceleration (aave)** is the acceleration of the body taken during a time interval or during a certain displacement. It is the rate of change of the velocity.

**Instantaneous acceleration (a)** is the acceleration at a given time instant or point along its path.

Example 3. Calculate the acceleration in m/s2 of a car that changes its velocity from (a) zero to 90 km/hr due west in 15 sec. (b) 20m/s to 15m/s.

**UNIFORMLY ACCELERATED RECTILINEAR MOTION (UARM)**

A very common and simple type of one-dimensional motion is that the acceleration is constant. In such a case, at any instant within the interval, and the velocity changes at the same rate throughout the motion.

Basic equations used for analyzing UARM:

***To simplify the equations****, it will be assumed here that at time t = 0, the position xi = 0,*

*Thus the time interval Δt will be the same as time instant t (Δt = t) because ti = 0 and tf = t.*

*The displacement Δx will also become same as position x (Δx = x) because xi = 0 and xf = x at time instant t.*

Example 4. An object starts from rest with a constant acceleration of 8 m/s2 along a straight line. Find (a) the speed at the end of 5sec, (b) the average speed for the 5sec interval, and (c) the distance traveled in the 5sec.

Example 5. At time t = 0, a skier has a speed of 1m/s and slides 9 m down a slope in 3 s. (a) Calculate the acceleration of the skier. (b) In what time after starting will the skier acquire a speed of 20 m/s?

Example 6. A truck’s speed decreases uniformly from 60m/s to 15m/s in 20s. Determine (a) the average speed, (b) the acceleration, and (c) the distance traveled.

Free Fall – a special case of rectilinear motion with constant acceleration

* the path is always vertical
* the acceleration is constant and of known magnitude and direction
* a = g = -9.8 m/s2 (in the MKS system)

= -980 cm/s2 (in the CGS system)

* the (-) sign indicates that the acceleration is directed downward.

Equations applied in the analysis:

Where: g = -9.8 m/s2

y = vertical displacement of the body and it can be (+) or (-)

\* (+) if measured above the starting point

\* (-) if measured below the starting point

v = (+) upward motion

(-) downward motion

Ex. 7. A ball falls freely from rest. Find (a) its acceleration, (b) the distance it falls in 3s, (c) its speed after falling 70m, (d) the time required to reached a speed of 25 m/s, and (e) the time taken to fall 300m.

8. A stone is thrown straight downward with initial speed 8m/s from a height of 25m. Find (a) the time it takes to reach the ground and (b) the speed with which it strikes.

9. An object is thrown straight upward at the top of a 50m-building with a speed of 30m/s. (a) How high will it rise (with respect to the top of the building)? (b) How long after it leaves the hand will it return to the starting point? (c) What would be its speed the moment it will hit the ground?