# Physics I: Classical Mechanics

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# Contents



Primary Textbook: Young's University Physics
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# 1 Chapter 2 - One Dimensional Motion

## 1.1 Displacement, Time, and Average Velocity

1. All objects are placed on a coordinate system, and viewed as a particle, or a single point of negligible size and shape
2. The displacement is equal to the vector from the initial point to the final point, written $\delta x = x_f - x_i$, measured in meters (m)
   (a) Displacement is typically drawn as a function of time on an x-t graph, such that the secant line from two points is the average velocity within
   (b) Distance is defined as the scalar quantity of the movement of the particle in the time interval
3. Velocity is the rate of change of position with respect to time, in m/s
4. $v_{average} = \frac{\delta x}{\delta t}$, such that $\delta t$ is the scalar change in time during the movement
   (a) Speed is defined as the scalar distance over change in time, or $s = \frac{d}{\delta t}$
   (b) $\delta t$ is typically represented as going from 0 to t, such that $\delta t$ is often represented at t

## 1.2 Instantaneous Velocity

1. Instantaneous velocity is the velocity at a specific point in time or position
   (a) v ¡ 0 is moving backward, v ¿ 0 forward, and v = 0 is not moving
   (b) Instantaneous speed is the instantaneous velocity, as a scalar quantity
2. $v_{instantaneous} = \frac{dx}{dt}$
   (a) Can be drawn on a graph as the slope of the secant line at a specific time and point
3. Velocity can be drawn on a motion diagram, drawing a line for the x-axis, then a specific point in time on the line, with an instantaneous velocity vector drawn on it at that time

## 1.3 Average and Instantaneous Acceleration

1. Acceleration is the rate of change of velocity with respect to time, in $m/s^2$
   (a) On a v-t graph, it is interpreted the same as velocity is on an x-t graph
   (b) On an x-t graph, it is viewed as the concavity of the graph, equal to 0 at a point of inflection, or where there is no concavity
   (c) Can be drawn on a motion diagram showing the change in velocity from one point in time to another, similarly to how velocity is drawn
   (d) On an a-t graph, $\delta v$ is the area under the curve to the x-axis
2. $a_{average} = \frac{\delta v}{t}$
3. $a_{instantaneous} = \frac{dv}{dt} = \frac{d^2x}{dt^2}$

## 1.4 Motion with Constant Acceleration

1. Drawn by a straight line on an a-t graph, or a parabola on an x-t graph such that there is a constant rate of change of velocity
2. $v_f = v_i + at$
3. $v_{average} = \frac{v_i + v_f}{2}$

4. $\delta x = v_i t + \frac{at^2}{2}$
5. $v_f^2 - v_i^2 = 2a\delta x$

### 1.5 Freely Falling Bodies

1. Particles falling without any force other than gravity acting on them are said to be in free fall, and move with constant acceleration of g, which is 9.8 $m/s^2$

### 1.6 Motion with Non-Constant Acceleration

1. $\delta v = \int_0^t a(t)dt$
2. $\delta x = \int_0^t v(t)dt$
3. $\delta d = \int_0^t |v(t)|dt$
4. To get proper functions and values, the boundary conditions must always be used on integrals, rather than simply used as indefinite integrals