One Dimensional Kinematics

2-1 Motion

One dimension implies motion along a straight line or in a single direction. Consider a car or a person driving down a straight road or jogging on a straight track. Think of an object being tossed vertically into the air and then watching it fall. These are examples of one-dimensional motion. There are four main factors to keep track of when evaluating the motion of objects. **Time, displacement, velocity**, and **acceleration** are the four variables; time is a scalar quantity, and the other three are vector quantities

Mechanics: the study of motion, has two parts

1. Kinematics is the mathematical description of motion.
2. Dynamics is the study of the causes of motion (including forces, energy, etc.)

- **<u>There are three types of motion</u>** :

• Translational motion is moving from one location in space to another

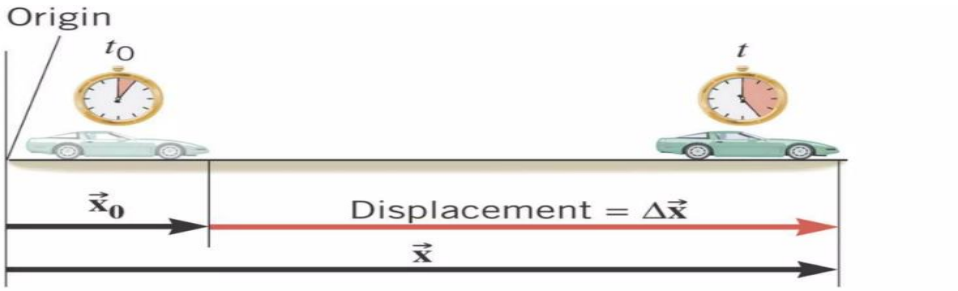
• Rotational Motion is changing orientation (direction) without necessarily changing location.

• Vibrational Motion is oscillatory motion about an average position.

2-2 Translational Kinematics

- **x** = position at time t, the "current position" for whatever time you prefer (a variable).
- $\mathbf{x_0}$ = position at time t=0, the initial position for the reference frame you've chosen (a constant).

- When looking at the position of the same object at different times (apart from t=0) we will use x1, x2, x3, etc. to denote the position at times t1, t2, t3, etc, respectively.
- **Δx** = $x - x_0$ = Displacement.
  - Displacement is a vector. In 1D motion this just means it has a sign attached (+ or –)
  - If x_0 is greater than x, Δx will be negative.



$\vec{x}_o$ = initial position $\vec{x}$ = final position

$$\Delta\vec{x} = \vec{x} - \vec{x}_o = \text{displacement}$$

2-3 Speed and Velocity

$$\textbf{Average Speed} = \frac{\textbf{Total Distance Travelled}}{\textbf{Time}}$$

$$\textbf{Average Velocity} = \frac{\textbf{Displacement}}{\textbf{Time}}$$

$$V_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

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• The units of speed and velocity are m/s (length /time).

• Speed (distance) is always positive while velocity (displacement) can be negative.

- Distance (d) Total length of the path travelled Measured in meters (scalar)
- Displacement ($\Delta \mathbf{x}$) Change in position regardless of path Measured in meters (Vecter)

The instantaneous velocity (or simply velocity v)of a moving particle is

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$where\ \Delta x = x_2 - x_1\ and\ \Delta t = t_2 - t_1$

EXAMPLE 1:

The train move a uniform velocity of 36kmh^{-1}for 10s.find the distance travel it?

Solve

Velocity v=36 kmh^{-1} $= \frac{36 \times 1000\ m}{60 \times 60\ s} = \frac{36000\ m}{3600 s} = 10\ ms^{-1}$

Distance(d) = v$\times\ t$

$= 10 ms^{-1} \times 10 s = 100 m$

EXAMPLE 2:

Car travels 274 miles from Dallas to San Antonio in 4.50 hours and then turns around and drives 81 miles back from San Antonio to Austin in 1.40 hours. Over this full trip from Dallas to Austin, determine A) the car's average speed, and B) the magnitude of the car's average velocity.

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solve

A) Average Speed $= \frac{\text{Total Distance Travelled}}{\text{Time}} = \frac{274\ miles + 81\ miles}{4.50\ hours + 1.40\ hours} = \frac{355\ miles}{5.9h}$

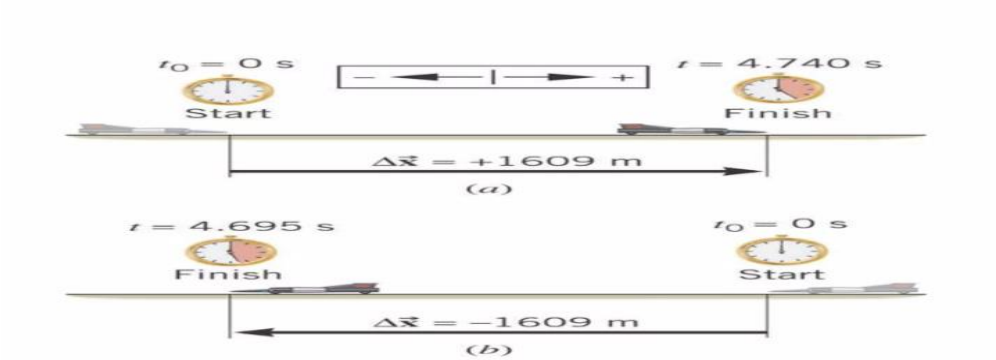
$$= 60.2 \frac{miles}{h}$$

B) Average Velocity = $= \frac{\text{Displacement}}{\text{Time}} = \frac{274\ miles - 81\ miles}{4.50\ hours + 1.40\ hours} = \frac{193\ miles}{5.9\ h}$

$$= 32.7 \frac{m}{h}$$

EXAMPLE 3:

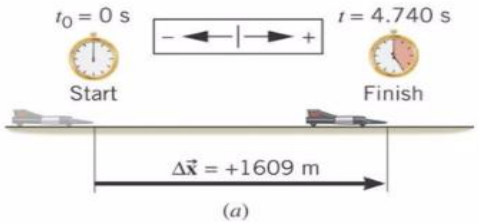
Andy Green in the car set a world record of 341.1 m/s in 1997. To establish such a record, the driver makes two runs through the course, one in each direction to nullify wind effects. From the data, determine the average velocity for each run.



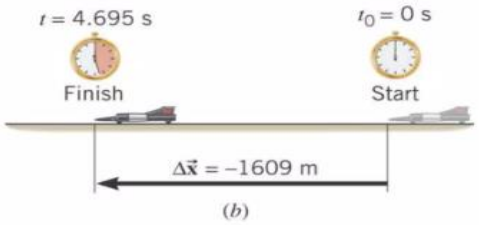
SLOVE

Lecture Two: One Dimensional Kinematics.

$$\bar{\mathbf{v}} = \frac{\Delta \vec{\mathbf{x}}}{\Delta t} = \frac{+1609\,\mathrm{m}}{4.740\,\mathrm{s}} = +339.5\,\mathrm{m/s}$$



$$\bar{\mathbf{v}} = \frac{\Delta \vec{\mathbf{x}}}{\Delta t} = \frac{-1609\,\mathrm{m}}{4.695\,\mathrm{s}} = -342.7\,\mathrm{m/s}$$



H.W

1-Aman swims the length of a 50m pool in 20s and makes the return trip to the starting position in 22s.determent his average velocity in (a: the first half of the swim .b: the second half of the swim . c: the round trip)

2- The coordinate of a particle moving along the x-axis depends on time according to the expression $x = 5t^2 - 2t^3$ where x in meter and t is in seconds.

Find a: The velocity and acceleration of the particle as a function of time.

b: find displacement during the first 2 second.

c: find velocity and acceleration of the particle after 2 second.

3- A particle moving along the x-axis according to the equation $x = 2t - 3t^2$

where x in meter and t is in seconds. Calculate the instantaneous velocity at t=3s.

4- The motion of a body along a straight line is described by the equation $x=t^3+4t^2-2t+5$. (where 'x' is in metre and 't'is in second):
a) Find the velocity of the body at t=4s.
b) Find the average velocity during the time interval from t=0 to t=4s.