MECHANICS → Kinematics

Chapter 2 - Motion along a straight line

I. Position and displacement

II. Velocity

III. Acceleration

IV. Motion in one dimension with constant acceleration

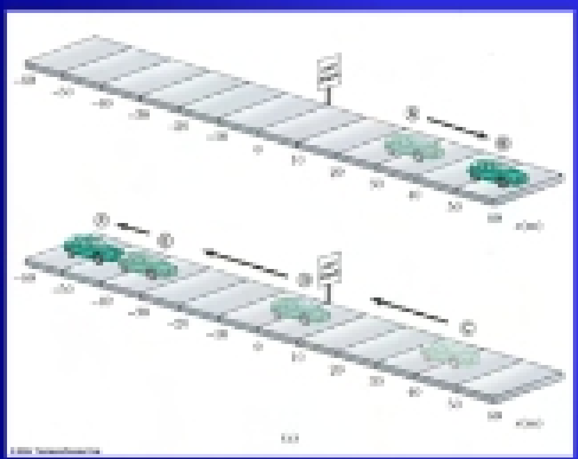
V. Free fall

Particle: point-like object that has a mass but infinitesimal size.

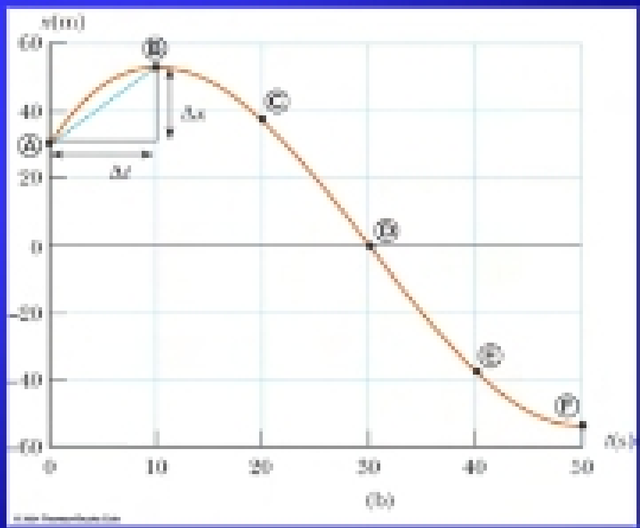
I. Position and displacement

Position: Defined in terms of a frame of reference: x or y axis in 1D.

- The object's position is its location with respect to the frame of reference.



Position-Time graph: shows the motion of the particle (car).



The smooth curve is a guess as to what happened between the data points.

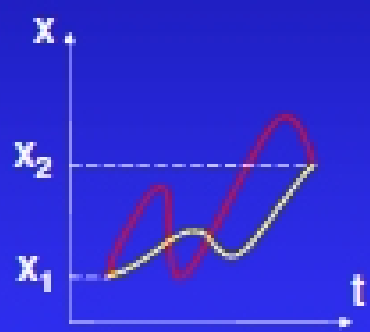
I. Position and displacement

Displacement: Change from position x_1 to x_2 → during a time interval.

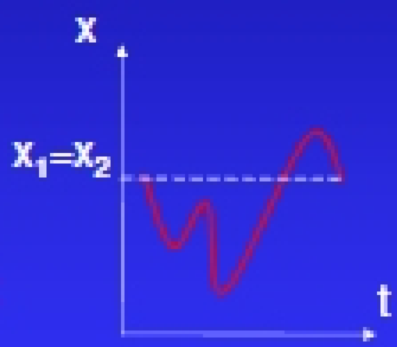
$$\Delta x = x_2 - x_1 \qquad (2.1)$$

- Vector quantity: Magnitude (absolute value) and direction (sign).

- Coordinate (position) ≠ Displacement → $x \neq \Delta x$

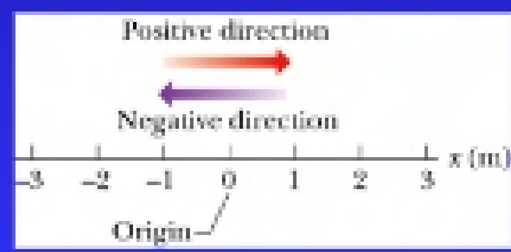


$\Delta x > 0$



$\Delta x = 0$

Coordinate system



Only the initial and final coordinates influence the displacement → many different motions between x_1 and x_2 give the same displacement.

Distance: length of a path followed by a particle.

- Scalar quantity

Displacement ≠ Distance

Example: round trip house-work-house → distance traveled = 10 km
displacement = 0

Review:

- Vector quantities need both magnitude (size or numerical value) and direction to completely describe them.

  - We will use + and – signs to indicate vector directions.

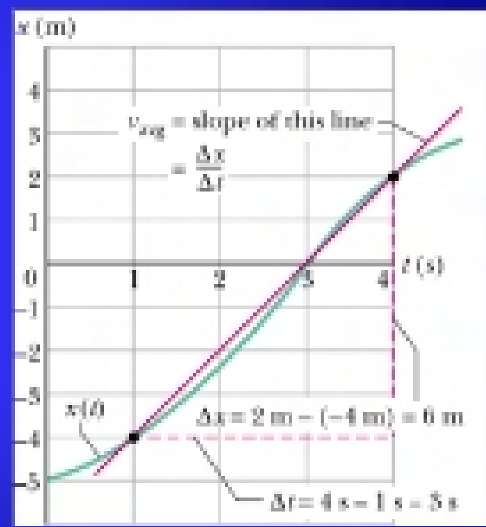
- Scalar quantities are completely described by magnitude only.

II. Velocity

Average velocity: Ratio of the displacement Δx that occurs during a particular time interval Δt to that interval.

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1} \qquad (2.2)$$

Motion along x-axis



-Vector quantity → indicates not just how fast an object is moving but also in which direction it is moving.

- SI Units: m/s

- Dimensions: Length/Time [L]/[T]

- The slope of a straight line connecting 2 points on an x-versus-t plot is equal to the average velocity during that time interval.

Average speed: Total distance covered in a time interval.

$$S_{avg} = \frac{\text{Total distance}}{\Delta t} \qquad (2.3)$$

$S_{avg} \neq$ magnitude V_{avg}

S_{avg} always >0

Scalar quantity

Same units as velocity

Example: A person drives 4 mi at 30 mi/h and 4 mi and 50 mi/h → Is the average speed >,<,= 40 mi/h ? <40 mi/h

t_1= 4 mi/(30 mi/h)=0.13 h ; t_2= 4 mi/(50 mi/h)=0.08 h → t_{tot}= 0.213 h

→ S_{avg}= 8 mi/0.213h = 37.5mi/h