

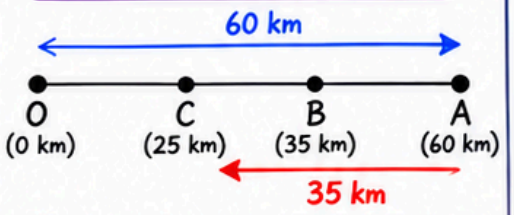
CHAPTER 1
MOTION
Class 9 Science – Key Notes

Remember!
- Motion means a change in the position of an object with time.
- It is relative and described with respect to a reference point.

What is Motion?
- **Motion:** A change in the position of an object with time.
- It is **relative.** For a passenger in a moving bus, trees appear to move backwards.
- **Types of motion:** straight line, circular, rotational, vibrational or a combination.

Motion is Relative


Describing Motion
- The location of an object is described using a reference point (origin).
- **Example:** A school is 2 km north of the railway station. (The station is the reference point.)

Distance and Displacement (Motion along a Straight Line)


Distance = 60 + 35 = 95 km

Displacement = OC = 25 km

Term	Meaning
Distance	Total path length covered. Scalar. Only magnitude, never negative.
Displacement	Shortest distance from initial to final position, in a straight line with direction. Vector. Can be zero, positive or negative.

Key Points
- Magnitude of displacement = distance only for straight-line motion in one direction.
- Magnitude of displacement is never greater than distance.
- Displacement can be zero even when distance is not zero (e.g. return to start: distance = 120 km, displacement = 0).
- SI unit of both: metre (m).

Uniform and Non-uniform Motion
- **Uniform motion:** Equal distances in equal intervals of time (e.g. 5 m every second).
- **Non-uniform motion:** Unequal distances in equal intervals of time (e.g. a car on a crowded street).

Speed
- Distance travelled per unit time.
- $v = \frac{s}{t}$ (SI unit: $m\,s^{-1}$)
- Average speed = $\frac{\text{Total distance}}{\text{Total time}}$

Velocity (Speed with Direction)
- Velocity is the speed in a definite direction. It is a vector.
- Velocity changes if speed, direction or both change.
- Average velocity = $\frac{\text{Total displacement}}{\text{Total time}}$
- If velocity changes at a uniform rate:

$$v_{av} = \frac{u + v}{2}$$

Speed vs Velocity

Speed	Velocity
Scalar	Vector
Distance / time	Displacement / time
Always positive	Can be positive, negative or zero
Average speed is never zero for a moving body	Average velocity can be zero

Acceleration
- Acceleration is the change in velocity per unit time.

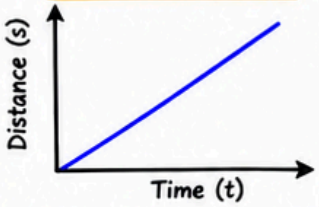
$$a = \frac{v - u}{t}$$

- SI unit: $m\,s^{-2}$.
- Positive acceleration: (speeding up).
- Negative acceleration (retardation): (slowing down).

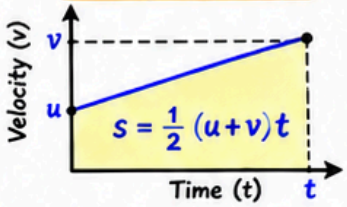
Equations of Motion (Uniform Acceleration)
1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$
3. $v^2 = u^2 + 2as$

Where: u = initial velocity, v = final velocity, a = acceleration, t = time, s = displacement.

Graphical Representation of Motion

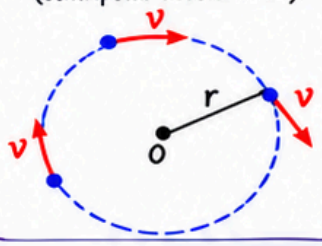
Distance–Time Graph


- Time on x-axis, distance on y-axis.
- Uniform speed: straight line ($s \propto t$).
- Slope gives speed ($v = \frac{\Delta s}{\Delta t}$).

Velocity–Time Graph


- Time on x-axis, velocity on y-axis.
- Uniform acceleration: straight line.
- Slope gives acceleration ($a = \frac{\Delta v}{\Delta t}$).
- Area under the graph gives displacement: $s = \frac{1}{2}(u + v)t$.

Uniform Circular Motion
- Motion with constant speed along a circular path.
- The velocity is tangential at every point.
- The direction of velocity changes at every point, so it is an accelerated motion (centripetal acceleration).



Important Formulas & Units

Quantity	Formula	SI Unit
Speed (v)	$v = \frac{s}{t}$	$m\,s^{-1}$
Velocity (v)	$v = \frac{s}{t}$	$m\,s^{-1}$
Acceleration (a)	$a = \frac{v - u}{t}$	$m\,s^{-2}$
Displacement (s)	$s = ut + \frac{1}{2}at^2$	m

Key Takeaways
- Motion is a change in position with time and is relative.
- Distance is a scalar; displacement is a vector.
- Speed = distance/time; velocity = displacement/time.
- Acceleration = change in velocity per unit time.
- Three equations of motion: $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$.
- In uniform circular motion, speed is constant but velocity changes continuously.

Unit Check
- Distance, Displacement (s) → metre (m)
- Time (t) → second (s)
- Speed, Velocity (v) → $m\,s^{-1}$
- Acceleration (a) → $m\,s^{-2}$

Study Smart. Understand Concepts. Practice More!

Compiled by Cracker Notes