7. Motion, Force and Work

- Speed is the rate of change of position in ‘distance’. Distance can be measured by ‘odometer’.

$$\text{Speed} = \frac{\text{Total distance covered}}{\text{Total time}}$$

- Velocity is the rate of change of ‘displacement’. Velocity is a quantity that has both magnitude and direction.

$$\text{Velocity} = \frac{\text{Total displacement}}{\text{Total time}}$$

- Magnitude of velocity = Magnitude of average speed, only when there is no change in direction.

$$\text{Average velocity} = \frac{\text{final velocity} + \text{initial velocity}}{2} = \frac{v+u}{2}$$

- Uniform motion: A body is said to be in uniform motion if there is no change in **velocity**. That is, no change in speed or direction. Eg. A body moving in a straight line

- Non-uniform motion – Velocity (in terms of speed/ direction or both) changes with time

- Acceleration: A body is said to be ‘accelerating’ when its velocity changes with time.

- $$\text{Acceleration} = \frac{\text{Final velocity - Initial velocity}}{\text{Time}} = \frac{v-u}{t}$$

- Uniform acceleration: Uniform change in velocity with time is uniform acceleration.

- Non-uniform acceleration: Non-uniform change in velocity with time.

- The acceleration is positive when the velocity of the moving body increases with time .

- The acceleration is negative when the velocity of the moving body decreases with time .

- The acceleration of a body is considered to be zero when the velocity of the moving body does not change.

- **Inertia**

    - The property of a body to resist any change is called inertia e. g. when a horse starts suddenly, the rider falls backwards due to the inertia of rest of the upper part of his body.

- **Newton's First Law**

    - Every body continues to be in its state of rest or uniform motion in a straight line, unless compelled by some external force acting on it.
    - Example: Any object continues lying where it is, unless it is moved.
    - Newton's first law gives the definition of Inertia.

- **Condition for scientifically work to be done**

    1. **There must be a displacement**
    2. Displacement must be along the direction of applied force

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        - **When is no work done?**

1. **No displacement [No work is done in circular path]**
2. Displacement occurs perpendicularly to the applied force

Work = Force × Displacement [along force direction]

$$W = F \times s \quad [\text{Unit} - \text{Joule}, 1\ \text{J} = 1\ \text{N} \times 1\ \text{m}]$$