Chapter: Dynamics

➢ Define linear momentum, and impulse, and establish the relationship between them
➢ Define and use force as the rate of change of momentum
➢ *State and prove the principle of conservation of linear momentum using Newton's second and Newton's third motion*
➢ Define and apply the moment of a force and torque of a couple
➢ State and apply the principle of moments
➢ State and apply the conditions necessary for a particle to be in equilibrium
➢ State and explain the laws of solid friction
➢ *Show the coefficient of friction is equal to the tangent of the angle of repose and use the concept to solve problems.*
➢ Solve the numerical problem and conceptual question on dynamics

Dynamics:

The branch of mechanics that deals with the study of the motion of the body along with the cause of motion is known as dynamics.

Force: Force is an external agent that changes or tends to change the state of a body.

Momentum or Linear Momentum:

Momentum of a body is defined as the total quantity of motion contained in the body. It is the property of moving body which is produced due to the combined effect of mass and velocity.

Let $'m'$ be the mass of body moving with velocity $'v\,'$ then,

Mathematically, $momentum\ (p) = mass\ (m) \times velocity\ (v)$

In vector form, $\qquad \vec{\boldsymbol{p}} = \boldsymbol{m}\vec{\boldsymbol{v}},$ $\qquad$ *The direction of momentum is along the direction of velocity.*

Hence, momentum of a body is defined as the product of its mass and its velocity.

- Momentum is a product of mass (scalar) and velocity (vector) so it is a vector quantity.
- Its SI unit is kgm/s. And dimensional formula is: $[M^1L^1T^{-1}]$
- Larger the momentum, larger will be the effect of motion (momentum).
- If velocity $'v'$ is constant, $p \propto m$, it means, two objects moving with same velocity, then greater mass will have greater momentum.
- If mass $'m'$ is constant, $p \propto v$, it means, two objects having same mass, then object moving with greater velocity will have greater momentum.
- Two bodies of same mass and moving with same speed can have different momenta unless their direction of motion is same. This is because momentum is a vector.
- We know, $E_k = \frac{1}{2}mv^2$ and $E_k = \frac{1}{2}m^2v^2/m = \frac{p^2}{2m} \rightarrow p = \sqrt{2mE_k}$
- **The plural of momentum is 'momenta'**

Questions:

1. *It is easier to catch a moving ball but it is almost impossible to catch a bullet fired from a gun, even the mass of bullet is much smaller than that of ball, why?*
2. *Is momentum a vector quantity? Explain.*
3. *It is easier to catch a tennis ball then a cricket ball, though both are moving with same velocity. Why?*