

KARACHI EDU COACHING CENTER • IX PHYSICS

Unit 4: Turning Effect of Forces

Moments, Torque, Center of Mass & Equilibrium • Sindh Textbook Board



Parallel Forces



Like Parallel Forces

Forces that are parallel to each other and act in the **same direction**. Example: Apples falling down due to gravity.



Unlike Parallel Forces

Forces that are parallel to each other but act in **opposite directions**. Example: Steering wheel couple forces.

Addition of Forces: Head-to-Tail Rule

Graphical Method

A graphical technique to find the resultant of multiple forces by joining the head of one vector to the tail of the next.

The closing side from the tail of the first vector to the head of the last vector represents the **Resultant Force**.

Resolution of Forces

Component Definition

Splitting a single force vector into two mutually perpendicular components (rectangular components: F_x and F_y).

Formulas

$$F_x = F \cos \theta$$

$$F_y = F \sin \theta$$

Torque or Moment of Force

Turning Effect

The turning effect of a force is called torque or moment of force. It depends on force and moment arm.

$$\tau = F \times L$$

SI Unit: Newton-meter ($\text{N} \cdot \text{m}$).

Principle of Moments

Balanced Torques

"A body is balanced if the sum of all clockwise moments acting on the body is equal to the sum of all anticlockwise moments."

$$\text{Clockwise Moments} = \text{Anticlockwise Moments}$$

Center of Mass & Gravity

Center of Mass

A point where an applied force causes linear motion without rotation.

Center of Gravity

A point where the whole weight of the body appears to act vertically downward.

Conditions of Equilibrium

First Condition

Net force acting on the body must be zero (translational equilibrium).

$$\sum F = 0$$

Second Condition

Net torque acting on the body must be zero (rotational equilibrium).

$$\sum \tau = 0$$

States of Equilibrium

Stable Equilibrium

Body returns to its original position when slightly disturbed (e.g., loaded truck or cone resting on base).

Unstable Equilibrium

Body does not return and topples over when disturbed (e.g., pencil balanced on its tip).

Neutral Equilibrium

Body stays in its new displaced position (e.g., ball rolling on a flat table).

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Unit 4 Completed

Mastering Torque, Principle of Moments, Center of Gravity, and
Equilibrium States.

Next: Unit 5 - Gravitation
