

KARACHI EDU COACHING CENTER

Comprehensive Master Notes: Chapter 05

Detailed Theoretical Breakdown, Core Derivations, Conceptual Diagrams &
Exam-Focused Numericals for Sindh Board.

Chapter Outline & Core Objectives

01. Fundamental Theory

Rigorous conceptual definitions, physical significance, and governing laws.

02. Mathematical Derivations

Step-by-step formula proofs, vector analysis, and dimensional verification.

03. Diagrammatic Analysis

Schematic vector representations, free-body diagrams, and graphical plots.

Section 5.1: Fundamental Concepts

Angular Displacement (θ)

Angle swept out by position vector in radians; dimensionless vector quantity.

Angular Velocity (ω)

Rate of change of angular displacement; measured in radians per second.

Centripetal Acceleration (a_c)

Directed towards center of circular path maintaining constant speed.



Vector Kinematics Model

Tangential velocity $v = r\omega$ links linear and rotational motion frameworks.

Section 5.2: Mathematical Derivations

Derivation of Centripetal Force Formula

Step 1: Consider uniform circular motion of radius r and speed v .

Step 2: Acceleration magnitude is derived from velocity vector triangle similarity:

$$a_c = \frac{v^2}{r}$$

Step 3: Apply Newton's Second Law ($F_c = ma_c$):

$$F_c = \frac{mv^2}{r} = mr\omega^2$$

Essential requirement for maintaining stable orbital or curved trajectories.

Section 5.3: Schematic Diagram Analysis

A Tangential Vector ($\vec{v}$)

Always acts tangent to circular path at any given point, representing instantaneous linear velocity direction.

B Radial Vector ($\vec{r}$)

Points radially outward from center of rotation to object position, defining orbital radius length.

C Force Vector ($\vec{F}_c$)

Acts perpendicularly inward toward center, continuously changing velocity direction without changing speed.

Section 5.4: Exam Numerical Problem

Problem Statement & Solution Breakdown

Question: A 0.5 kg ball is tied to a 2.0 m string and rotated in a horizontal circle at 4 m/s. Find the centripetal force.

Given Data:

Mass (m) = 0.5 kg

Radius (r) = 2.0 m

Velocity (v) = 4 m/s

Calculation:

$$F_c = \frac{0.5 \times 4^2}{2.0}$$

Result: $F_c = 4.0 \text{ N}$

Section 5.5: Board Exam Quick Review

Top Short Questions

- Define centripetal acceleration and state its direction.
- Why does an object in circular motion experience acceleration despite constant speed?
- Distinguish between angular velocity and linear velocity.

Key MCQ Highlights

- Centripetal force does zero work on the moving object.
- Dimension of angular velocity is $[T^{-1}]$.
- Banking of roads prevents skidding by providing necessary centripetal force.

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Chapter 05 Mastery Achieved

Review complete. Prepare your queries for the upcoming doubt-clearing session.

Contact: Karachi Edu Academic Office | **Support:** Active 24/7