WEEK 5

Physics of Engineer

Chapter 5: Circular Motion

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Outline

- Introduction to Circular Motion
- What is Circular Motion?
- Describing Circular Motion
- Kinematics of Circular Motion
- Dynamics of Circular Motion
- Applications of Circular Motion
- Conclusion

Introduction to Circular Motion: Exploring the Physics of Rotation

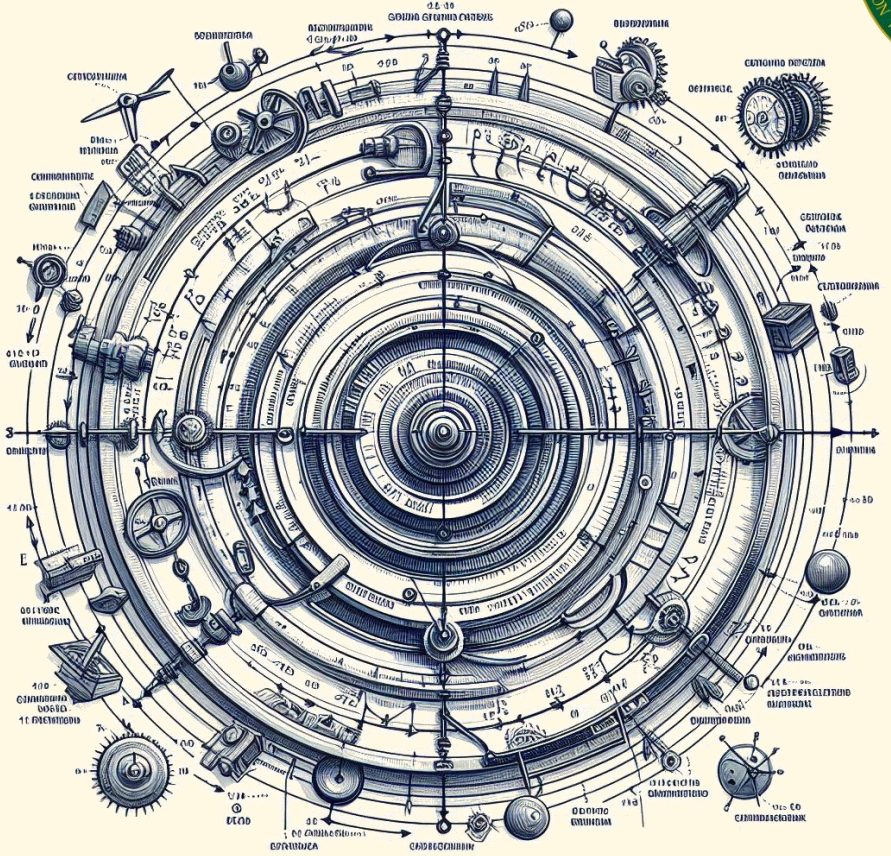
What is Circular Motion?

Definition:

Movement of an object along the circumference of a circle or rotation around an axis.

Key Characteristics:

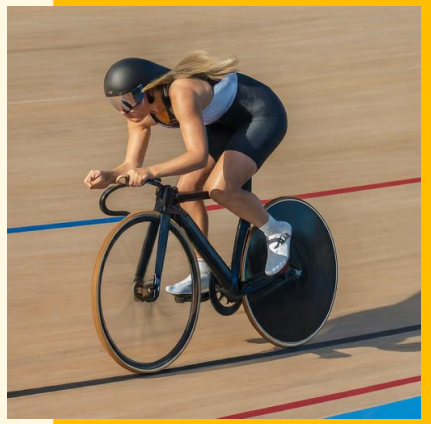
- Constant or changing distance from the center
- Continuously changing direction
- Can be uniform (constant speed) or non-uniform (changing speed)



Describing Circular Motion

- Angular Displacement (**θ**): Angle swept by the object in radians (2**π** radians in a full circle).
- Angular Velocity (**ω**): Rate of change of angular displacement, measured in radians per second (rad/s).
- Period (T): Time taken to complete one full revolution, measured in seconds (s).
- Frequency (f): Number of revolutions per second, measured in Hertz (Hz).
- Relationship:

$$T = 1/f \text{ and } \omega = 2\pi f$$



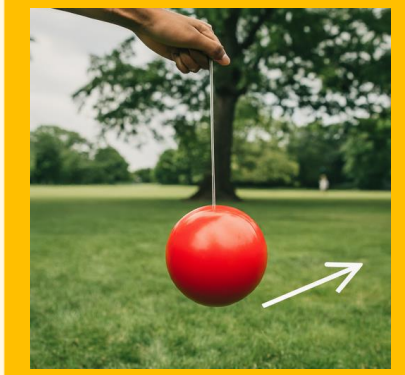
Kinematics of Circular Motion

- Tangential Velocity (v): Speed of the object along its circular path, measured in meters per second (m/s).
- Relationship between v and **ω**: v = **ω**r, where r is the radius of the circle.
- Centripetal Acceleration (ac): Acceleration directed towards the center of the circle, providing the necessary force for circular motion.
- Relationship between ac, v, and **ω**: $a_c = v^2/r$ or $a_c = \omega^2 r$

Dynamics of Circular Motion

- Centripetal Force (F_c): Force acting on the object towards the center, providing the centripetal acceleration.
- Examples of Centripetal Forces:
  - Tension in a string
  - Normal force on a banked track
  - Gravitational force in planetary motion
- Newton's Second Law:

$$F_c = ma_c$$



Applications of Circular Motion

- Amusement park rides (centrifuges, Ferris wheels)
- Satellites orbiting Earth
- Planetary motion around the sun
- Clock hands and gears
- CD players and turntables
- Washing machines and dryers
- Many other real-world examples

Conclusion

- **Key Definitions**: Reiterate the essential terms covered, such as circular motion, circumference, radius , period, frequency, linear velocity, angular velocity, centripetal force, and centripetal acceleration. Briefly explain their meaning and importance.

Conclusion

- **Core Concepts**: Summarize the main points discussed in your presentation. This could include concepts like:
  - Relationship between linear and angular velocity ($v = \omega r$)
  - Deriving centripetal acceleration from Newton's second law ($F_c = ma$)
  - Understanding the role of centripetal force in maintaining circular motion
  - Differentiating between uniform and non-uniform circular motion
  - Illustrating how circular motion principles are applied in real-world examples

Conclusion

- **Key Equations:** Highlight the main mathematical equations used in circular motion, such as:
  - $T = 1/f$ and $f = \omega/2\pi$ (relationship between period, frequency, and angular velocity)
  - $F_c = mv^2/r$ (centripetal force equation)

Conclusion

- **Concluding Remarks:** Briefly reiterate the significance of understanding circular motion and its relevance in various fields. You can also encourage students to explore real-world applications further or pose some thought-provoking questions for them to ponder.

Resources and References

❑ Websites:

- Khan Academy: https://www.khanacademy.org/science/high-school-physics/uniform-circular-motion-and-gravitation-2
- The Physics Classroom: https://www.physicsclassroom.com/Concept-Builders/Rotation-and-Balance/TorqueAndRotation
- HyperPhysics: http://hyperphysics.phy-astr.gsu.edu/

❑ Books:

- Physics for Scientists and Engineers with Modern Physics (4th Edition) by Raymond A. Serway and John W. Jewett Jr.
- Conceptual Physics (12th Edition) by Paul Hewitt
- University Physics (15th Edition) by Ronald A. Taylor and Chris D. Zafiratos

❑ Videos:

- Crash Course Physics: Circular Motion: https://www.youtube.com/watch?v=bpFK2VCRHUs
- MinutePhysics: Angular Velocity vs. Linear Velocity: https://www.youtube.com/user/minutephysics

❑ Activities and Experiments:

- Simulating planets' orbits: https://www.colorado.edu/csl/programs/phet-interactive-simulations
- Building a mini centrifuge: https://www.sciencebuddies.org/stem-activities/bottle-centrifuge
- Analyzing circular motion of a rolling ball: https://www.sjsu.edu/faculty/beyersdorf/Phys50lab/Manual/13-EXPERIMENT%2010.pdf

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