Set #2 - for Wednesday January 22

Read RHK Ch. 9: 9.1-9.3, 9.6, 9.7; Ch. 10: 10.1-10.4; Ch. 11: 11.7; Ch. 12: 12.4
K&K Ch. 6: 6.4, 6.5, 6.7
Feynman 18, 19

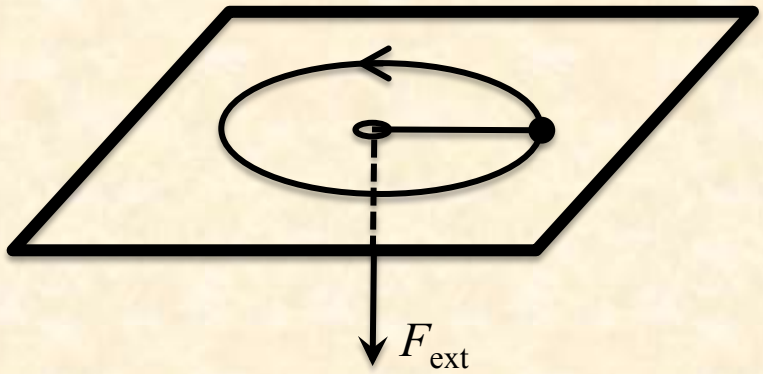
Solve

From RHK **Ch. 9** Exercises 17; Problems 16, 18, 22
Ch. 10 Exercises 6; Problems 2, 4, 11
Ch. 12 Exercises 23, 25

From K&K **Ch. 6** Problem 6.1

Problem 1. A small disc with mass m is guided by a light string to execute circular motion on a frictionless table top. The string passes through a small hole in the table, and the lower end is held by a hand. An initial observation finds the disc at radius r_0 and twirling with angular velocity ω_0. By pulling the string so that the radius is reduced at a constant rate $u(u > 0)$, a new radius $r(r < r_0)$ is reached.

a) What is the new value of ω at this new radius?
b) Find the equation $r(\theta)$ of the spiral trajectory the mass m follows as the string is being pulled.
c) Find the force $(F_{\text{ext}}(\theta))$ needed to accomplish this.



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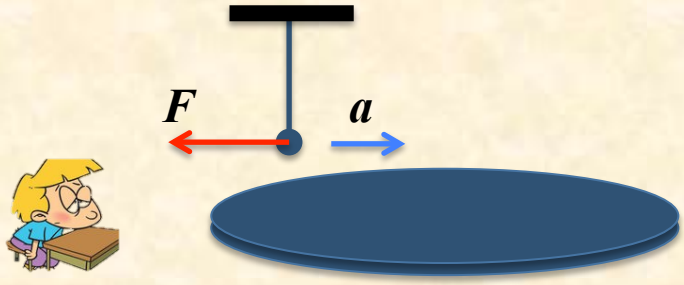
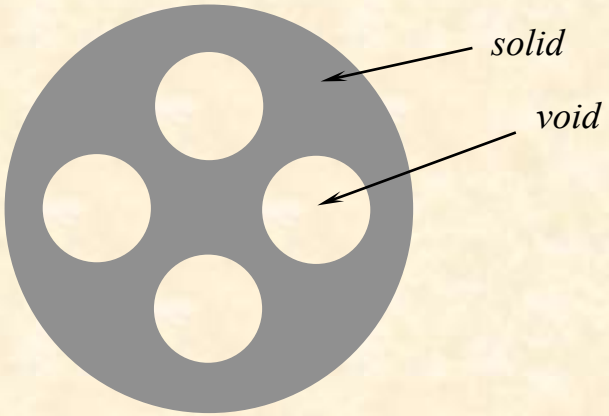
Problem 2. Calculate the moment of inertia about the central axis of the cylindrical object shown if its mass is M, radius is a, the radius of each of the four cylindrical voids is $a/3$, and the axis of each void is at a distance $a/2$ from the central axis.





Problem 3. A small hanging weight is in equilibrium above a rotating disc. A student who just learned about noninertial frames decided to look at the weight from the frame related to the disk. He said: "The weight rotates about the center of the disk, and it has normal acceleration directed toward the center of the disk. The only horizontal force exerted on the weight is centrifugal force of inertia. How could the force that is directed from the center provide the centripetal acceleration?" Help the student to answer this question.

Extra Credit. A tall chimney cracks near its base and falls over. Express (a) the radial and (b) the tangential linear acceleration of the top of the chimney as a function of the angle made by the chimney with the vertical. (c) Can the resultant acceleration exceed g? (d) The chimney cracks during the fall. Explain how this can happen.

Good Luck, Dr. B