Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 1 – IPSP

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Exercise Sheet 10 (WS 2011/12)

Date of Issue: Dec. 9^{th} 2011

Date of Submission: Dec. 16^{th} 2011

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. Two point masses m_1 and m_2 are separated by a massless rod of length L. (a) Write an expression for the moment of inertia I about an axis perpendicular to the rod and passing through it a distance x from mass m_1. (b) Calculate dI/dx and show that I is at a minimum when the axis passes through the center of mass of the system. (6 Points)

2. Use integration to determine the moment of inertia about its axis of a uniform right circular cone of height H, base radius R, and mass M. Use Figure 1. (7 Points)

3. A uniform horizontal disk of mass M and radius R is spinning about the vertical axis through its center with an angular speed ω. When the spinning disk is dropped onto a horizontal tabletop, kinetic-frictional forces on the disk oppose its spinning motion. Let μ_k be the coefficient of kinetic friction between the disk and the tabletop. (a) Find the torque $d\tau$ exerted by the force of friction on a circular element of radius r and width dr. (b) Find the total torque exerted by friction on the disk. (c) Find the time required for the disk to stop rotating. (7 Points)

4. As the chief design engineer for a major toy company, you are in charge of designing a "loop-the-loop" toy for youngsters. The idea, as shown in Figure 2, is that a ball of mass m and radius r will roll down an inclined track and around the loop without slipping. The ball starts from rest at a height h above the tabletop that supports the whole track. The loop radius is R. Determine the minimum height h, in terms of R and r, for which the ball will remain in contact with the track during the whole of its loop-the-loop journey. (Do not neglect the size of the ball's radius when doing this calculation.)

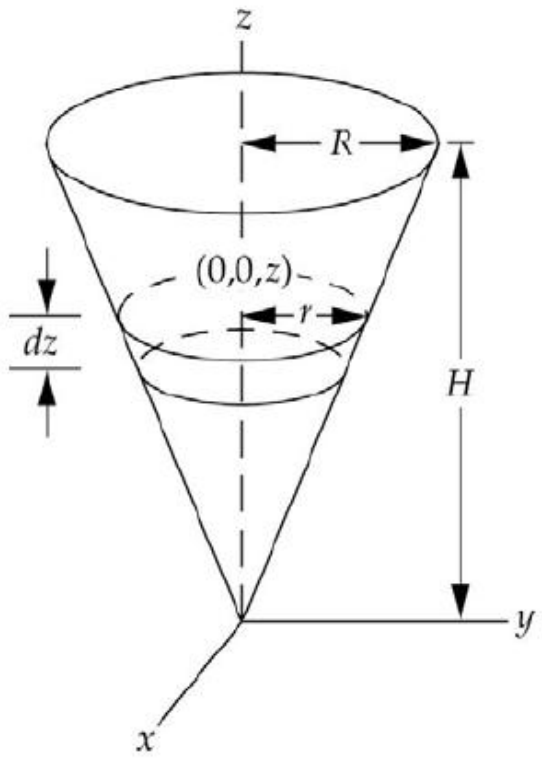

Figure 1: Exercise 2

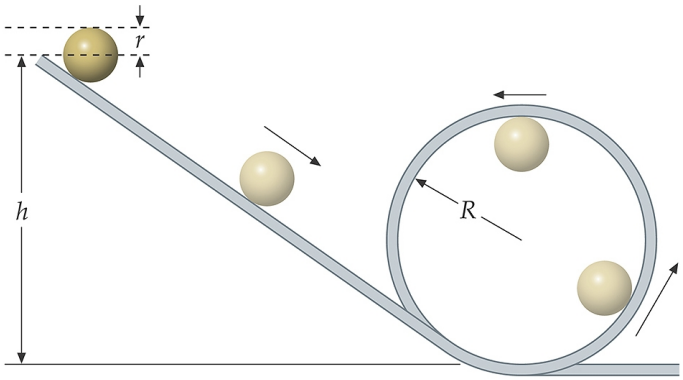

Figure 2: Exercise 4