WILLIAM & MARY
CHARTERED 1693

PHYS 303 – Classical Mechanics of Particles and Waves II

Problem Set 7

Due: Thursday, October 31 at 5:00pm

Term: Fall 2024

Instructor: Andrew W. Jackura

Readings

Read sections 10.6–10.10 of Taylor.

Problems

Please indicate the time taken to complete the problem set.

Problem 1. [5 pts.] – Moment of Inertia I

Find the moment of inertia of a uniform circular cylinder of radius R and mass M for rotation about its axis. Explain why the products of inertia are zero.

Problem 2. [10 pts.] – Moment of Inertia II

(a) Find the moment of inertia of a uniform solid sphere (mass M, radius R) for rotation about a diameter.
(b) Do the same for a uniform hollow sphere whose inner and outer radii are a and b.

Problem 3. [15 pts.] – Compound Pendulum

A thin rod (of width zero, but not necessarily uniform) is pivoted freely at one end about the horizontal z axis, being free to swing in the xy plane (x horizontal, y vertically down). Its mass is m, its CM is a distance a from the pivot, and its moment of inertia (about the z axis) is I.

(**a**) Write down the equation of motion $\dot{L}_z = \Gamma_z$, assuming the motion is confined to small angles (measured from the downward vertical), find the period of this compound pendulum.

(**b**) What is the length of the "equivalent" simple pendulum, that is, the simple pendulum with the same period?

Problem 4. [30 pts.] – The Inertia Tensor and Principle Axes I

A rigid body consists of three masses fastened as follows: m at $(a, 0, 0)$, $2m$ at $(0, a, a)$, and $3m$ at $(0, a, -a)$.

(**a**) Find the inertia tensor $\mathbf{I}$.

(**b**) Find the principal moments and a set of orthogonal principal axes.

Problem 5. [30 pts.] – The Inertia Tensor and Principle Axes II

A thin, flat, uniform metal triangle lies in the xy plane with its corners at $(1, 0, 0)$, $(0, 1, 0)$, and the origin. Its surface density (mass/area) is $\sigma = 24$ in some arbitrary units.

(**a**) Find the triangle's inertia tensor $\mathbf{I}$.

(**b**) Find the principal moments and a set of orthogonal principal axes.