1 Background

The rotational motion of rigid bodies is discussed in Chapter 10, which should be read before attempting these problems.

It is often easier to describe the motion of a rotating body from a reference frame attached to the body. This is a non-inertial system, and Newton’s equations are not valid unless fictitious forces are introduced, which for a rotating reference frame are the coriolis and centrifugal force. These topics are usually explained in the introductory physics class, but if you need to review them, Chapter 9 provides a thorough discussion. For our purposes understanding Eq. (9.30), and Section 9.5 suffice. (If you can follow Section 9.9 on the Foucault pendulum, you should be able to move on to the dynamics of rigid bodies).

2 Problems

2.1 From the book.

Exercises 10.10, 10.25, 10.36, 10.52.

2.2 Additional Problem

i) Calculate the principal moments of inertia of a uniform, solid cone of vertical height $h$, and base radius $a$, about its vertex. For what value of the ratio $h/a$ is every axis through the vertex a principal axis? For this case, find the position of the centre of mass, and the principal moments of inertia about it.

ii) A gyroscope consisting of a uniform solid sphere of radius 0.1 m is spinning at 3000 r.p.m. about a horizontal axis. Due to faulty construction, the fixed point is not precisely at the centre, but 20 $\mu$m away from it along the axis. Find the time taken for the axis to move through $1^\circ$. 