

Physics 262: Problem Set #5

These problems are due by the end of the day on Friday, Feb. 6 in the graders' box.

NOTE: For each problem, your solution should begin with a brief statement of the problem, i.e. a description of the setup, including a list of the inputs and the goal.

1. BTM 8.3.1, pg. 215. (Use the numerical M and N given in problem 8.1.7 and verify equations 8.3.1-4 and 8.3.6.)
2. BTM 8.3.4 and 8.3.5 p. 217
3. There will be a worksheet to do and hand in from the Wednesday session.
4. Morin 8.28 (Board and cylinders) p. 339
5. Morin 9.1 (Many different ω 's) p. 415
6. Morin 9.3 (Rolling cone) p. 415
7. (K+K 7.1) A thin hoop of mass M and radius R rolls without slipping about the z -axis. It is supported by an axle also of length R through its center. The hoop circles the around the z -axis with angular speed Ω .
 - (a) What is the instantaneous angular velocity $\vec{\omega}$ of the hoop?
 - (b) What is the angular momentum \vec{L} ? Is \vec{L} parallel to $\vec{\omega}$?
8. (K+K 7.3) A gyroscope is at one end of an axle of length ℓ . The other end is suspended from a string of length L . The wheel is set in motion so that it executes uniform precession in the horizontal plane. The wheel has mass M and moment of inertia (about its CM) of I_0 . The spin rate is ω_s . Neglect the mass of the shaft and the string. Find the angle β that the string makes with the vertical, assuming that β is small enough that $\sin(\beta) \approx \beta$.
9. (K+K 7.4) In an old-fashioned rolling mill, grain is ground by a disk-shaped millstone which rolls in a circle on a flat surface driven by a vertical shaft. Because of the stone's angular momentum, the contact force with the surface can be greater than the weight of the wheel. Taking the millstone to be a uniform disk of mass M , radius b and width w , assume that it rolls in a circle of radius $R \gg w$ at an angular rate Ω and find the contact force with the ground.

10. (BONUS) Morin 9.31 (Rolling wheel) p. 421