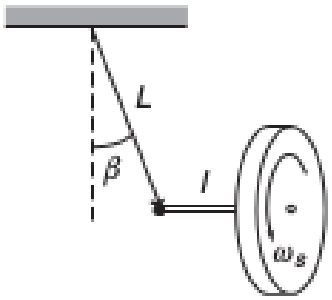
Physics 24a - Section —
Precession and Rigid Body Motion
Monday, April 18 2016

8.{3,4,6,7}

Reading: Chapter 8, section 1–5

Suspended gyroscope - KK 8.3 A gyroscope wheel is at one end of an axle of length l_a. The other end of the axle is suspended from a string of length l_b. The wheel is set into motion so that it executes uniform precession in the horizontal plane. The wheel has mass M and moment of inertia about its center of mass I_0. Its spin angular velocity is ω_s. Neglect the masses of the shaft and string. Find the angle β that the string makes with the vertical. Assume that β is so small that approximations like $\sin\beta \approx \beta$ are justified.



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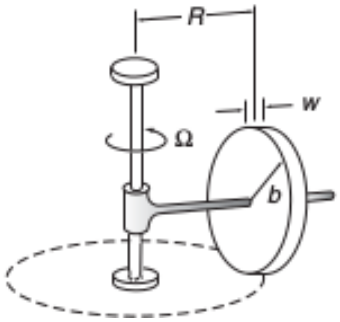
Grain mill* - KK 8.4 In an old-fashioned rolling mill, grain is ground by a disk-shaped millstone that rolls in a circle on a flat surface, driven by a vertical shaft. Because of the stone's angular momentum, the contact force with the surface is greater than the weight of the wheel.
Assume that the millstone is a uniform disk of mass M, radius b, and width w, and that it rolls without slipping in a circle of radius R with angular speed Ω. Find the ratio of the contact force with respect to the surface to the weight of the stone.



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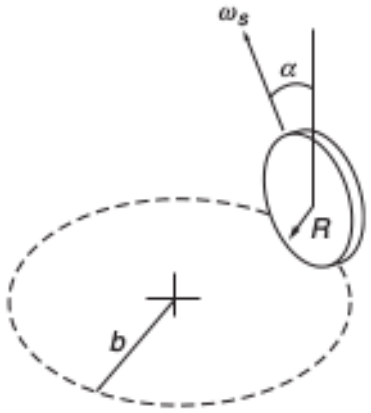
Rolling coin* - KK 8.6 A coin of radius b and mass M rolls on a horizontal surface at speed V. If the plane of the coin is vertical the coin rolls in a straight line. If the plane is tilted, the path of the coin is a circle of radius R. Find an expression for the tilt angle of the coin α in terms of the given quantities. (Because of the tilt of the coin the circle traced by its center of mass is slightly smaller than R but you can ignore the difference.)



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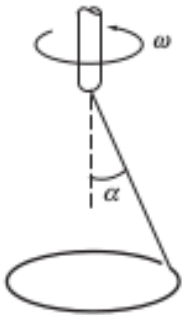
Suspended hoop - KK 8.7 A thin hoop of mass M and radius R is suspended from a string through a point on the rim of the hoop. If the support is turned with high angular velocity ω, the hoop will spin as shown, with its plane nearly horizontal and its center nearly on the axis of the support. The string makes angle α with the vertical.

(a) Find, approximately, the small angle β between the plane of the hoop and the horizontal. Assume that the center of mass is at rest.

(b) Find, approximately, the radius of the small circle traced out by the center of mass about the vertical axis.

(c) Find a criterion for the validity of the assumption that motion of the center of mass can be neglected. (With skill you can demonstrate this with a rope. It is a favorite cowboy lariat trick.)



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