Physics 24a - Section —
Non-Inertial Systems and Fictitious Forces
Monday, April 25, 2016

$9.\{4,5,6,12\}$

Reading Chapter 9 on non-inertial sytems and fictitious forces. I will be leaving for Minnesota on Wednesday afternoon, so there will be no class on Thursday.

Weight on a car's wheels - KK 9.4 The center of mass of a 1600kg car is midway between the wheels and 0.7m above the ground. The wheels are 2.6m apart.

a) What is the minimum acceleration A of the car so that the front wheel just begin to lift off the ground?

b) If the car decelerates at rate g, what is the normal force on the front wheels and on the rear wheels?

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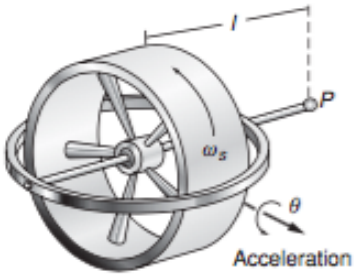
Gyroscope and acceleration - KK 9.5 Gyroscopes can be used to detect acceleration and measure speed. Consider a gyroscope spinning at high speed ω_s. The gyroscope is attached to a vehicle by a universal pivot P. If the vehicle accelerates in the direction perpendicular to the spin axis at rate a, then the gyroscope will precess about the acceleration axis, as shown in the sketch. The total angle of precession, θ, is measured. Show that if the system starts from rest, the velocity of the vehicle is given by

$$v = \frac{I_s \omega_s}{Ml}\theta$$

where $I_s\omega_s$ is the gyroscope's spin angular momentum, M is the total mass of the pivoted portion of the gyroscope, and l is the distance from the pivot to the center of mass. (Such a system is called an integrating gyro, since it automatically integrates the acceleration to give the velocity.)



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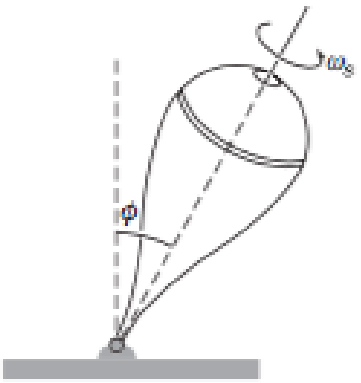
Spinning top in an elevator - KK 9.6 A top of mass M spins with angular speed ω_s about its axis, as shown. The moment of inertia of the top about the spin axis is I_0, and the center of mass of the top is a distance l from the point. The axis is inclined at angle ϕ with respect to the vertical, and the top is undergoing uniform precession. Gravity is directed downward.
The top is in an elevator, with its tip held to the elevator floor by a frictionless pivot. Find the rate of precession, Ω, clearly indicating its direction, in each of the following cases:

a) The elevator at rest.

b) The elevator accelerating down at rate $2g$.



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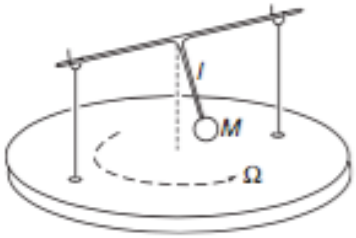
Pendulum on rotating platform - KK 9.12 A pendulum is rigidly fixed to an axle held by two supports so that it can swing only in a plane perpendicular to the axle. The pendulum consists of a mass M attached to a massless rod of length l. The supports are mounted on a platform that rotates with constant angular velocity Ω. Find the pendulum's frequency assuming that the amplitude is small.



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