PHY140Y

Spring Term – Week 6 Discussion

8 February, 1999

1. For a system to remain in equilibrium, the net force on the system, $\vec{F}_{net}$, **and** the net torque, $\vec{\tau}_{net}$, must equal zero. In this problem, we now use our understanding of torque to determine the equlibrium condition.

   Suppose we have a ladder of mass m and length L leaning up against a wall, so that ϕ is the angle between the base of the ladder and the ground. The wall is frictionless, whereas the coefficient of static friction between the ladder and the ground is μ.

   (a) Identify and sketch the forces that act on the ladder. Note that point about which each force acts.

   (b) Write down the net forces in each dimension (there are two equations as this is a 2-dimensional problem).

   (c) Write down an expression for the net torque on the ladder. Chose the most convenient pivot point about which to make this calculation. Why is the point you have chosen the most convenient?

   (d) Using the results of the last two parts, find a relationship between the angle ϕ and the coefficient of friction μ.

2. The wheels of a bicycle and motorcycle are often thought to act as gyroscopes and assist in maintaining the balance of a rider.

   (a) If a bicycle has a wheel of mass $m_b = 2.0$ kg and a radius $r_b = 40$ cm, what is the moment of inertia of the wheel about the axis of the wheel? Assume all the mass is concentrated at the rim.

   (b) Calculate the moment of inertia about the axle of a motorcycle wheel of mass $m_m = 20.0$ kg and radius of $r_m = 35$ cm.

   (c) What is the angular momentum associated with each wheel of the bike travelling at a speed of 30 km/h? Calculate the angular momentum of the wheel of a motorcycle travelling at 130 km/h. Compare these two numbers.

   (d) Argue why the angular momentum of the spinning bicyle wheels cannot play a key role in our understanind of how a bicycle works.

   (e) The fastest way to initiate a high speed turn on a motorcycle is to push on the handlebar in the direction opposite to the intended turn. Why is this?