PHY140Y

Spring Term – Tutorial 17 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 axis about which to make this calculation. Why is the axis 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. A 100 g yo-yo consists of two disks held together on a narrower shaft of radius r. The moment of inertia of the yo-yo about an axis through the centre of this shaft is 600 g cm^2. A string 80 cm long is wound around the narrow shaft of the yo-yo.

   With the yo-yo initially 50 cm off the ground, the string is pulled vertically upward with a force of 0.98 N until the string comes entirely free of the yo-yo. The yo-yo then falls freely. What are the rotational and translational kinetic energies of the yo-yo just as it strikes the ground?