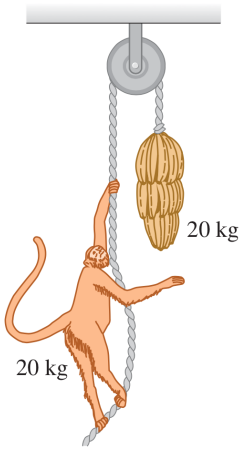
Physics 1A: Physics for Scientists and Engineers: Mechanics **Winter 2015**

Discussion 4: Week 5

Exercise 1: Monkey business. A 20-kg monkey has a firm hold on a light rope that passes over a frictionless pulley and is attached to a 20kg bunch of bananas. The monkey looks up, sees the bananas, and starts to climb the rope to get them. (a) As the monkey climbs, do the bananas move up, down or remain at rest? (b) As the monkey climbs, does the distance between the monkey and the bananas decrease, increase or remain constant? (c) The monkey releases her hold on the rope. What happens to the distance between the monkey and the bananas while she is falling? (d) Before reaching the ground, the monkey grabs the rope to stop her fall. What do the bananas do?



Exercise 2: Ulterior Motives. You are driving a classic 1954 Nash Ambassador with a friend who is sitting to your right on the passenger side of the front seat. The Ambassador has flat bench seats. You would like to be closer to your friend and decide to use physics to achieve your romantic goal by making a quick turn. (a) Which way (to the left or to the right) should you turn the car to get your friend to slide closer to you? (b) If the coefficient of static friction between your friend and the car seat is 0.35, and you keep driving at a constant speed of $20 m/s$, what is the maximum radius you could make your turn and still have your friend slide your way?

Exercise 3: Two tugboats pull a disabled supertanker. Each tug exerts a constant force of $1.80 \times 10^6 N$, one 14 degrees west of north and the other 14 degrees east of north, as they pull the tanker 0.75 km toward the north. What is the total work they do on the supertanker? [Hint: Work is defined as $W = \int \vec{\mathbf{F}}.d\vec{\mathbf{x}}$]

Challenging Problem: A transport plane takes off from a level landing field with two gliders in tow, one behind the other. The mass of each glider is 700 kg, and the total resistance (air drag plus friction with the runway) on each may be assumed constant and equal to 2500 N. The tension in the towrope between the transport plane and the first glider is not to exceed 12,000 N. (a) If a speed of 40 m/s is required for takeoff, what minimum length of runway is needed? (b) What is the tension in the towrope between the two gliders while they are accelerating for the takeoff?