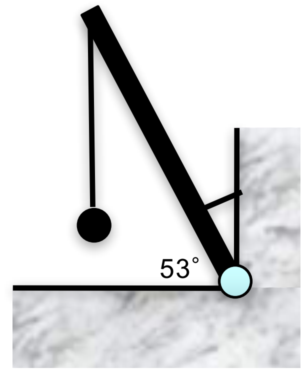
PS#10 Due in Class Monday, Nov. 27. Please pay good attention to describe the lens you are using and explain your method.

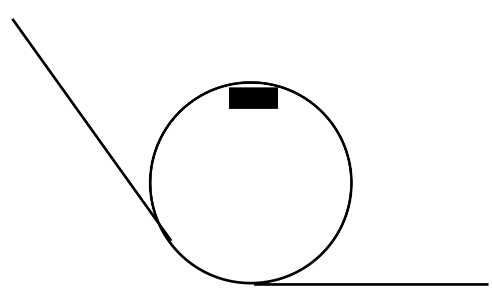
1. 7.5 Exercise 1
2. 7.5 Exercise 3
3. 7.6 Exercise 1 and 2. These are covered in the videos, and you don't have to hand them in, but it's a good exercise to do them in order to know where the formulas come from.
4. 7.6 Exercise 3
5. 7.6 Exercise 4
6. 7.6 Exercises 5 – 7. On the final exam, you will not have to use a calculator to do trigonometry; you are welcome to estimate angles and components using drawings. Take a look at these three problems and make sure you can solve them. You can decide if you want to use trig or not.



7. In the diagram at right, a post of some length supports a 100 kg ball. From the drawing at right (make your own better drawing), estimate the tension on the string and the reactive force at the pivot.
8. According to the hydrodynamic flow equations you'll learn in PHYS-132, the speed of water coming from a 200 PSI fire house is about 45 m/s (~100 mph!). Wikipedia claims these hoses are 25 mm in diameter. Imagine if you were hit with water by one of these hoses, like if you were protesting the Dakota Access Pipeline, and the fire department was called to clear the area (please see some drama: https://www.youtube.com/watch?v=K3Iv9okL4QU). I'd like to know the force that this water puts on someone's body. Let's model the water as a moving column that hits you and disperses in all directions perpendicular to its original direction of travel, as in the figure of the demonstrator at right.

a) Clearly map out why this problem should be solved with conservation of momentum.
b) What is the volume, mass and momentum of a 1-meter column of water *before* it hits your body?
c) What is the momentum of water *after* it hits your body?
d) How long did it take the water to change momentum?
e) Find the force that this water puts on your body. Could it knock you over?

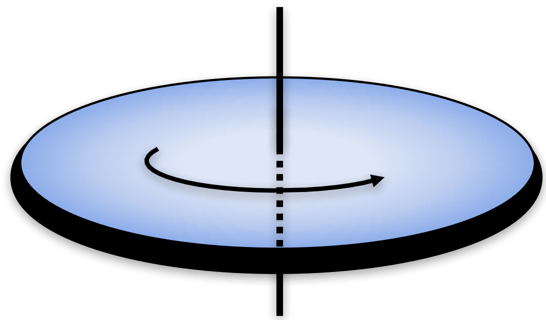
9. *If you think you've already done this problem before, just skip down to part d*. You go on a R = 10 m, loop-de-loop ride at the carnival, but you have to choose how high to start the cart. Say you have a mass of 70 kg, like your instructor and you are sitting on a scale that reads in kg. You likely already solved a) and c). Please just do b) and c)



a) If you start from a vertical height of 40 m, what does the scale under you read as you are at the top of the loop? What does it read at the bottom of the loop as you enter the loop? Is this a good ride for pregnant women? How does it feel as you round the bottom of the loop?
b) <u>What would happen if you decide to start the cart at the same height as the top of the loop? Why would this happen?</u>

c) Please find the minimum vertical height, above the ground that you must start the ride.

d) Let's say that the object is instead a hollow sphere that is rolling without slipping. How would this change the problem? Can you do part a) and c) above for this scenario? Essentially, this is what we're asking: for a) would the rolling sphere be going faster than the frictionless cart or slower – how much faster or slower – is the acceleration greater or less?; and for b) in order to make it around the loop without falling, would the hollow sphere need to start from higher or lower than the frictionless cart?



10. At right is shown a spinning solid disk on a vertical axis 80 cm long (40 cm above and 40 cm below) spinning in space in front of you, balanced on its axes. It has a mass of 2 kg and a radius of 0.5 m and is spinning around 10 times per second!
a) Show that the angular momentum of this disk is about 15 Js, and define the direction of the angular momentum vector.
b) Then, looking at the paper, you grab the top of the axel with one hand and the bottom of the axel with the other hand. You pull the top out toward you with 20 N and push the bottom away from you with 20 N of force. You do this for a tenth of a second (0.1 s). Calculate the torque you apply to the wheel (include direction), and the angular momentum you impart onto the wheel. Remember to include direction.
c) After you do the above act for 0.1 s, you let the wheel go again. Is the wheel tilted now? If not, why? If so, in which direction and by about how much? Draw the wheel in its new position.
d) What will the wheel do now if I let it balance on the bottom of the axel? Describe the motion as exactly as possible.