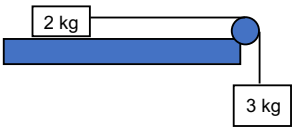
You will be graded on your *communication* of physics understanding.

#1 You let the system at right go from rest and the 3 kg mass falls 1 m to the floor below. Please find the *acceleration* and the *tension* in the string attached to the hanging 3 kg mass. The surface is *not* low friction, $\mu_f = 0.5$ between the 2 kg block and the surface.



There are several ways to approach this. The shortest way, if you can do it is address it as a system and use a dynamics lens. In this case, you need to recognize that tension of the string pulls each mass in opposite directions, so the tension has no force on the system as a whole.

You can also use an energy lens to get the final speed, or use a dynamics lens on each of the two masses leading to two linked equations of motion (the string guarantees that the two bodies have identical motions, although in perpendicular directions).

Many people showed a 20 N force of gravity is acting in the opposite direction as the 30 N force of gravity on the 3 kg mass… Does it really? What if there was no 3 kg mass, would the 2 kg mass accelerate?

A more interesting question might be, "How does the tension compare to the force of friction on the 2 kg mass, and to the force of gravity on the 3 kg mass?"

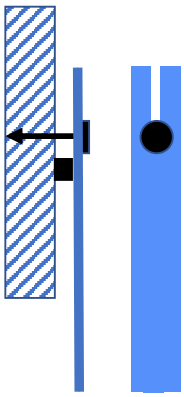
Tension should be 18 N.

#2 Possible future: You become an accomplished astronomer and find a sun-planet system similar to our own solar system! The planet orbits the sun once every 115 (earth) days at a distance of ~ 10^{11} m, corresponding to an orbital speed of ~10 km/s.

a) Is the planet accelerating? If not, how do you know? If so, how do you know, and find the acceleration.
b) Explain to someone how you could use this information to calculate the mass of the sun of this sun-planet system.

A surprising number of folks were not able to calculate the centripetal acceleration given the speed in km/s, even though they recognized the concept. Please expect a "basic math and metric" part of the final exam, where you will be expected to be able to convert units and do simple calculations. Formula for circumference, volume, how to square numbers and units, exponential notation, the metric system, and simple trig. I'll have a practice one for you for a big exam.

#3 I have a nail stuck in beam over a door. I need to pull it with 1000 N to get it to come out but I can't pull 1000 N. I get a 40 cm slotted pry bar and slide the nail all the way down the 10 cm slot. I put a small black block under the pry bar 5 cm from the nail as shown at right and 25 cm from the bottom of the pry bar. I've included two depictions of this. At left, you are looking at the arrangement from the side. At right, you see it as if you are facing the door. To pull out the nail, find the force I have to put on the pry bar (include direction and where I put the force), and also find the force that the black block puts on the beam (include direction). You will be graded by your process and explanation. The correct answer helps.



a) Please set up the problem with good reasoning.
b) What force do I need to put on the pry bar? Where do I put this force? In what direction do I apply this force? Does this seem like a reasonable force that I could apply?
c) What force does the black block put on the beam?

Many people observed that this is not truly a statics problem because we want to accelerate the nail. What makes it a statics problem? The system has a very small mass and can accelerate at a very small rate and still have the nail come out. Thus, the vector sum of the forces is very close to zero and is <<<< any of the relevant forces in the problem.

This problem was very much like one of the problems on the past midterm I provided.

The small box exerts 1200 N against the wall.

#4 A freely rotating carousel in a kid's park is a flat, uniform disk: diameter of 3 m and a mass of 70 kg (same as my body!) Standing on the outer edge of the carousel, at a radius of 1.5 m, I rotate with the carousel at a rotational speed of 2 rad/s. Then I walk to the center of the carousel and stand straight up with my hands to my side.

a) Is the carousel still rotating at the same rate? If so, explain why. If not, explain why not and find the new rotational speed.
b) Did I do any work in moving to the center of the carousel? If so, please explain how you know and how you might find how much work I did.

Strangely, many students recognized that I had to do work in order to push myself into the center while rotating, but at the same time said that energy is conserved as I move toward the center. If the system is free to rotate, then we know there is no outside torque on the system, what do we know is conserved?
You should find that the final rotation rate is 6/s, and be able to calculate the work I did using an energy lens. I get 945 J of work.

Please tell me how much information you knew about this exam before taking it.

Name _____