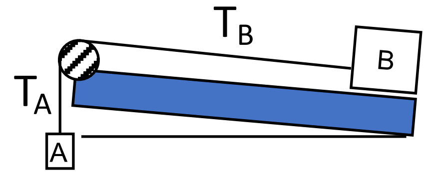
You will be graded on your *COMMUNICATION* of physics understanding

#1 You devise a way to lift a large block (B) on low friction wheels, up a 4 m incline, increasing height by 50 cm. The string is run over a pulley wheel (The wheel has *considerable mass)* that turns freely on its axel with the rope stretched over it. That is, the rope does not slip over the wheel's surface. I release the system from rest and it moves until mass *B* hits the pulley wheel.



a) Assume we allow this low friction system to go from rest. Knowing what we do about the measurements of the system and the masses of blocks A and B, how would we determine which way it would accelerate? Explain briefly and clearly. It is true that if the system is accelerating to the left, $T_A < F_{gA}$. However, T_A has to be calculated from the acceleration, so T_A is still undetermined. Even though the masses of the blocks is not given, these values determine the problem. These are *knowns,* along with the heights. If you use dynamics here, you have to compare external forces… but gravity on B is almost perpendicular to the surface. You need to just take the parallel component of gravity. You best use an energy lens. When looking at a potential energy graph, which way do forces push the system?... to lower potential energy… of the system – that means both masses. Can $m_B > m_A$ and still have the system accelerate to the left? by what factor can $m_B > m_A$? This is really what the question should have asked.

b) As block B slides (and block *A* falls), how does T_A compare to the force of gravity on A, *AND*.. Most people correctly used dynamics to get this one right.

c) How does T_A compare to T_B? Briefly and clearly explain how you know this to be true. Most people skipped this or got it wrong, or didn't explain it right. These two tension converge on the wheel…. The wheel is accelerating, rotationally. So, there must be a net torque on it. How do these tensions provide the torque?

d) You need to calculate everything about the system: the final speed when B hits the pulley wheel, the acceleration of block B, the angular acceleration of the wheel, and T_A. Explain how you would go about this. Be brief but clear, and a diagram is always good. Try to convince yourself that you *could* use a dynamics lens here… but you'd have to figure out how the wheel comes into play. However, if you use an energy lens you can just include rotational kinetic energy.

#2 You step onto the edge of a spinning carousel at the park. Your mass is 50 kg, and the carousel is a flat uniform disk of mass 100 kg and radius 2 m. The carousel is initially rotating at a rate of 1 revolution per second.

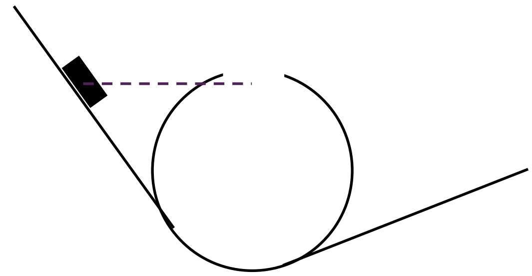
a) What is the final rotation rate after I step onto the carousel and hold on?
b) Was kinetic energy conserved in this process? If not, where did it come from/go?
c) Then you walk into the very center of the carousel and stand twirling in the middle. What is the final rotation rate? You may need to make some estimations here.
d) Was kinetic energy conserved as you walked into the center? If not, where did it come from/go?

Students did pretty good with this, but expended much writing, effort and time. If we really trust the concepts, we can step away from the formulas, no? If you've determined that you will conserve angular momentum, then just do it: $\vec{L} = I\vec{\omega}$, this doesn't change… by what *factor* does the moment of inertia change?... how should this affect $\vec{\omega}$? How would this change rotational kinetic energy? You can solve these 4 questions with a total of 4 lines of math!

It's important to note that some people used the wrong lens and did a whole bunch of work getting no credit for it. It is better to spend a bunch of time picking the right lens and not having time to do the work to get an answer.

It may be worth pointing out (and this is only a detail that you can ignore), that even in the exact center, you still have a tiny, nonzero moment of inertia because your body is rotating around in a circle about your center axis. So, to be more exact, and especially if the radius of your body was close to the radius of the carousel (which in this case it isn't), you'd use the parallel axis theorem and somehow have to calculate the moment of inertia of your body about your center of rotation.

#3 You are standing in a waiting line for a (radius = 10 m) loop-de-loop carnival ride and you are somewhat concerned when the top chunck of the track drops off. The line thins rapidly and it is your turn to go on the ride. Your 100 kg friend says that there's no problem: He's going to request that they start the cart from the same height as the top of the track so that the cart will clear the track.



a) Is your friend's idea correct? Please explain clearly. What will happen if he goes on the ride as described.

b) Your friend goes on the ride while sitting on a scale. What does the scale read at the very bottom of the loop? Very few students followed a reasonable dynamics protocol. I understand there was excessive time pressure. Sorry. However, making a FBD and a vector sum of the forces drawing results in a higher grade than a correct numerical answer. Very few people picked a positive direction.

#4 Two identical planets, planet A and planet B orbit two different suns. However, planet B is *twice* as far from the sun as planet A, and the mass of B's sun is *half* the mass as the sun that planet A orbits. ***<u>You must explain your answers to receive credit.</u>***

a) How do the planets' attractions to the sun compare? $F_B =$ __F_A.
b) How do the accelerations of two planets compare? $a_B =$ __a_A.
c) How do the speeds of the two planets compare? $v_B =$ __v_A.
d) What difference (if any) would there be if the masses of the planets were not the same? Explain.
e) We assumed that the $m_{planet} << m_{sun}$. Would it be different if the mass of the planets were *<u>not</u>* much less than that of the suns? Explain. What fundamentally changes when the mass of the planet is close to the mass of the sun?

Those who got to this did OK. A drawing is important. In doing b) and d) it is important to understand which "m" is in the F = ma. That was a source of mistakes.

Name ____