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

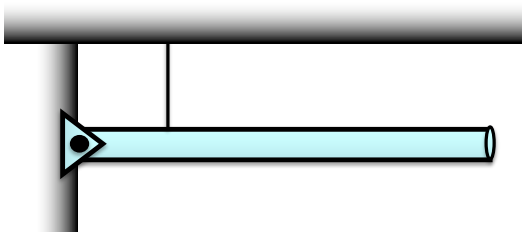
#1 You know a road with a round hump of radius 40 m as shown. You drive over it at a constant speed of 10 m/s. Your 50-kg body is sitting on a scale. As you go over the very top of the bump, what should the scale be reading? Your process is more important than your answer. We should notice that we are not moving in a straight line, so there is centripetal acceleration… must be caused by forces. So, I know it's dynamics, I write the vector sum of the forces equals mass times acceleration, and I recognize one of the forces is the normal force of the scale. I draw a FBD remembering to identify the direction of acceleration and also pick a positive direction. I'm able to make a vector sum diagram.

#2 True Story: I know a carousel at a playground. I wish I knew the moment of inertia of it,. While I can measure dimensions, I know nothing about its mass distribution or even what the mass is. How could I measure the moment of inertia? You know what I have in the Physics "toy room"… I have all kinds of force scales, I have masses and wheels and all kinds of other things. I can take a video with my cell phone. Please figure out a way for me to measure the moment of inertia with a complete lens explanation, and set up the correct equations. I can think of several ways…likely the class will find even more ways. I can see using any of three lenses to solve this:

- Rotational Dynamics, because torque causes angular acceleration.
- Angular momentum, because angular momentum is conserved inside of a closed system… or when outside torques = 0.
- Energy lens because I can do work which is converted to rotational energy.

Do we understand what moment of inertia is? It's kind of how hard it is to get something rotating, or how hard it is to get something to change its rotational velocity, or how much kinetic energy there is in a spinning object.

#3 You see at right a uniform, 10 m long, 200 kg steel "I" beam that is attached to the wall with a rotating hinge. A vertical cable, attached 2 m from the wall prevents the beam from rotating downward on the hinge, holding it in place as shown.



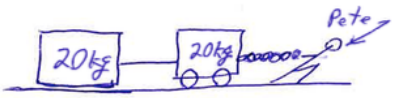
a) Find the tension in the cable
b) Is there any force on the hinge attached to the wall? If not, explain why you know. If so, find the force on the wall (include direction)

Have we seen problems like this? What lens do we need? Did you label the forces? How many are there? What body are we looking at? Where is the force of gravity working on this?

#4 I pull with a force of 100 N on a chain, towing two 20-kg toy railroad cars in a row attached to each other with string. The car in front has low-friction wheels, but the car at the back has no wheels and slides on the rails with a coefficient of friction of 0.1. I pull it for 10 meters.

a) Is the system in equilibrium? How do you know?

b) Please find whatever you can, but ideally, I'd like to know the tension in the string between the two cars.



Do we know what equilibrium means? There's two ways to look at it… when all accelerations are zero, including rotational acceleration. This would mean that the vector sum of all the forces in any direction = 0. Because we aren't given any explicit kinematic information about the acceleration, or speed, we might look at forces. Do all forces add to zero in the y direction?... in the x direction? What are these forces? Did we draw a good FBD and label the forces we know?

Did we recognize how to treat this as a system? Is tension a force on the system itself, or is it an internal force… how do we find it then?

In order to find the final speed, it is reasonable to use an energy lens, because my work is changed to kinetic energy and heat. We know heat results from the work of friction. You could also then ask yourself what tension you would need to give the appropriate kinetic energy to either of the cars… however, using a dynamics lens is a little more straight forward. But you have to use both bodies independently, or first recognize that I'm pulling a system of 40 kg.

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