Rotational Inertia aka Moment of Inertia

* Rotational inertia, or Moment of inertia, is the rotational counterpart to inertia (or mass).
  + It is the measure of the resistance of an object to change its state of rotation.
  + Newton’s Bizarro 1st Law: An object rotating will continue to rotate at a constant angular speed, an object at rest will stay at rest unless an outside unbalanced torque acts on it.
* It is defined as: (This is a summation, it means: )
* If a particle of mass *m* is a distance *R* from an axis of rotation the moment of inertia about the axis is *mR*2.
* If there is an additional blob of mass m a distance 2*R* from the axis of rotation its moment of inertia is 4*mR*2 and the total is 5*mR*2.
* Work on Sample Question 1 either them or in front of the class.

The Results

* Let’s relate regular inertia to rotational inertia.
* Suppose you have two masses, one is 10 kg and the other is 0.5 kg. It is more difficult to get the 10 kg to change its state of motion, while it is easier to get the 0.5 kg to change. Everyone already knows that. But just consider the numbers. 10 is more than 0.5. So it is more difficult to get the 10 to change its motion.
* It is the same thing for rotational inertia. Let’s look at the results. The rotational inertia through the center of mass is 12 kg∙m2. Mass 1: 36 kg∙m2; Mass 2: 18 kg∙m2. The rotational inertia is the smallest through the center of mass and greatest around mass 1. That means that it is easiest to rotate the system around the center of mass and most difficult to rotate it around mass 1.

Parallel Axis Theorem

* We have the parallel axis theorem. This is for any time you are rotating a system around a point that is NOT the center of mass.
* It is: , where *I* is the rotational inertia of the system around the point it is rotating around. *I*cm is the rotational inertia of the system around the center of mass. *M* is the total mass of the system. *D* is the distance between the center of mass and the point the system is rotating around.
* Let’s take it for a test drive. We already know that the rotational inertia is 36 kg∙m2. But let’s use the parallel axis theorem to confirm it.
  + We know that *I*cm = 12 kg∙m2, the total mass is 6 kg. The distance between the center of mass and mass 1 is 2 m.
  + . It works!
  + Try it out for around mass 2
* Try it question 2.
* Only do question 3 if there’s time and there probably won’t be time.

Discuss Shapes

* Talk about each of the shapes and equations on the sheet.
* We can combine these shapes into one system and still find the rotational inertia. To do so, just find the rotational inertia of each shape and add them together.
* Work on question 4
* More parallel axis theorem… It works for shapes too. Usually for this there will only be one shape at a time, but you never know what the College Board will come up with.
* Question 5 either as demo or have them work on it.

Net Torque

* We have already discussed net torque. Now we are adding the other part of net torque.
* Recall Newton’s Second Law of Motion: *F*net *= ma*.  
  If we translate this into the Bizarro world we get: *τ*net *= Iα*
* Questions 6 and 7.