**AP Physics 1**
**California Crosspoint High School**
**Mr. Darrell Yee**
**Rolling Race Lab**

## Hypothesis

1. If the small wood disk and the plastic hoop were to race, which would win and why? Explain without doing any calculations.

   I personally think the small wood disk. The hoop will have a higher moment of inertia, causing it to be harder to turn. Because of this, it will probably acceleration slower, causing it to

2. If the small wood disk and the large wood disk were to race, which would win and why? Explain without using any calculations.

   I personally think of the small wooden disk because it is lighter. The lighter the object, the easier it would be to accelerate. The two objects probably have the same density.

## Experiment

What were the results of the race?

1. Small wood disk vs. plastic hoop
   Result: Small wood disk
2. Small wood disk vs. large wood disk
   Result: Equal

## Calculations

1. Calculate the moments of inertia of all three objects.

   Small disk: $S$
   Hoop: $H$
   Large disk: $L$

   $I_S = \frac{1}{2}mr^2 = 426.657g \cdot cm^2$
   $I_H = mr^2 = 778.799g \cdot cm^2$
   $I_L = \frac{1}{2}mr^2 = 1664.2g \cdot cm^2$

2. If two objects start from rest and travel the same distance, the one with a greater final velocity must have had a greater linear acceleration and traveled that distance in a shorter amount of time. Determine a formula for the final velocity of all three objects

   Required Data: Mass, Radius, Moment of Inertia, Height

   $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

   $\omega = \frac{v}{r}$

   $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I(\frac{v^2}{r^2})$

   $v = \sqrt{\frac{2ghmr^2}{mr^2+I}}$

**Discussion**

1. Discuss what role the moments of inertia play in the race.

   The greater the moment of inertia, the less the final velocity will be. In the equation, we can see that final velocity is inversely related to the moment of inertia.

2. How could the large wood disk, with a larger moment of inertia than the small wood disk, have the same linear acceleration as the small wood disk?

   This is because both of the equations, their mass and radius cancel out, leaving only $\sqrt{2 \times 9.8}$. This is because the equation for the moment of inertia simply $\frac{1}{2}mr^2$

3. Given three objects, how could you determine which would win in a rolling race?

   Calculate the final velocity. Whichever one has the greatest final velocity (i.e greatest change in linear acceleration), that means they would win.

4. How would a block sliding down a frictionless ramp of the same dimensions do in the race compared to the other three? Explain without using equations.

   When there is no friction, the block will slide at the same speed as any other object with the same dimensions. This is because their kinetic energy's are the same, and rotational kinetic energy must equal 0 because there is no friction causing it to turn.