Lab 6: Rotational Motion

The Project:
Center of mass and angular momentum conservation of non-symmetric objects

A physicist has recently developed a new theory which suggests that the fundamental laws of nature may be slightly different in other parts of the universe. In order to test this theory, Company X astronauts will be visiting a far-away planet and performing experiments to verify whether or not certain non-symmetrical objects obey the law of conservation of angular momentum on this new planet.

Prior to the mission, another Company X team has devised a set of procedures that the astronauts can perform to test whether or not angular momentum is conserved on the new planet. These procedures need to be tested in a terrestrial lab where the normal laws of physics are known to hold.

Your team has been hired to work through the experiment and determine its usefulness in testing the law of conservation of angular momentum.

Equipment:

- Camera
- CNC
- Tracking stickers
- Various shape wooden boards
- Small (20 g) mass

The Requirements:

We ask that you work through the following experiment:

1. Determine the center-of-mass of the shape by hanging it from various fixed points and finding the spot where vertical lines drawn through those axes intersect. Do this for all the provided wooden boards.
2. Independently verify this center-of-mass location by tracking the rotational and translational motion of a few boards as they move freely on your frictionless air table.
3. Verify angular momentum conservation by rotating the L-shaped wooden board on the air table about a fixed axis at the center of mass and then carefully dropping a small (20 g) mass on the board at some distance from its center of mass. The L-shaped board has a moment of Inertia around its center of mass of $I_{shape,cm}=(9.7\pm0.7)\ 10^{-4}\ kg\ m^2$. The moment of inertia of pasco's 20g mass around its center of mass is $I_{weight,cm} = (2.34\pm0.05)\ 10^{-6}\ kg\ m^2$
4. Using conservation of angular momentum find the moment of inertia of another board (different than the L-shaped one) around one of it axis. As before you can spin the board and quickly drop the 20g mass on the shape at some distance from the rotation axis.

VISUAL CORTEX INSTRUMENTS

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Presentation of the solution:

Your team must prepare 2-3 page written report (including figures) summarizing the results of the project. The report must include the following:

- Description of the procedure used to find the center of mass (c.o.m) with the vertical lines method, including at least one still photo illustrating the technique.
- A brief explanation of how the c.o.m. of an object should move when no external forces are acting on it. Track the c.o.m. with a sticker as the board moves and rotates, and show a plot of the x and y components of the c.o.m.'s position and velocity as a function of time to verify it is moving as c.o.m should move.
- A description of the procedure used to test conservation of angular momentum, including relevant equations, numerical results, and sources of uncertainties.
- A description of the procedure used to measure the moment of inertia of a board around some axis, including numerical results, and their uncertainties.