RC.L1.4 | Angular Momentum and Rotational Energy | Challenge Homework

Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Every page should be labeled on the top left with the question code (e.g. GR.L1.4-01) and there should be only be one solution per page. The questions should be in order. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution (e.g. GR.L1.4-01 continued). One question will be randomly selected and graded. Challenge homework for a given week are due the following week by Tuesday at midnight. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. See the course website for further details.

You will be asked to apply sense-making in most problems. Use the list below as a reference to the different sense-making techniques. More information about sense-making can be found on the BoxSand menu under Math Tools => Sense-making.

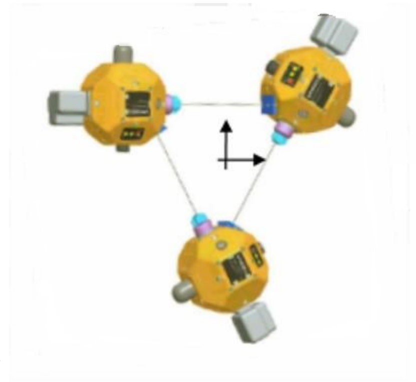
- *Sign:* Check the **sign** of each quantity makes sense.
- *Dimensionality:* Check the **dimensionality** and units of each quantity makes sense.
- *Order of Magnitude:* Check the **order of magnitude** of the final answer and other important quantities is within a a factor of 10 of what you think it should be.
- *Graphical Analysis:* Use a **graph** to see if the behavior of a solution makes sense.
- *Proportionality:* Using a symbolic solution, check the behavior of the answer when you change a given quantity on which it is dependent. Does the answer vary **proportionally** to what you expect?
- *Special Cases:* Check the behavior of a derived equation in limiting (**special**) cases makes sense, e.g. as x goes to 90 degrees in sin(x).
- *Self-consistency:* Check derived equations, functions, or values, are **self-consistent**, e.g. check that the slope of a derived position plot matches the values of the given velocity plot
- *Known Values:* Compare given or derived quantities with common well **known values**.
- *Related Quantities:* Compare the relative magnitude of two **related quantities**.

RC.L1.4-01

A solid disk and a hollow hoop are released from rest on the top of a hill of height 10 m. Both objects weigh 10 N and have a radius of 0.5 m. Assume they both roll without slipping and their translational velocity is equal to their angular velocity multiplied by their radius.

(a) At the bottom of the hill which one do you expect to be traveling faster translationally? Explain.
(b) What is the ratio of the translational speed of the hoop divided by the translational speed of the disk at the bottom of the hill?
(c) Use the *Proportionality* sense-making technique to analyze your answer to part (b). Specifically look at how the moments of inertia of the two objects are proportional and how that propagates to your final answer.

RC.L1.4-02



A space station consists of three modules, connected to form an equilateral triangle of side length 82.0 m. Suppose 100 people, with an average mass of 75.0 kg each, live in each capsule and the mass of the modules is negligible compared to the mass of the people. At the current rotational rate the effective acceleration of gravity is g/2.

(a) What angular momentum of the system?
(b) If the modules are pulled closer what should happen to the rotational rate? Explain.
(c) What distance between the modules would give an effective acceleration of gravity equal to g?