Week 1 Challenge Homework

Rotational Kinematics

Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Please use the Gradescope interface to associate each page of your submission with the corresponding question number! It makes grading much easier.

Every page should be labeled on the top left with the question number and there should be only be one solution per page. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution. 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 some 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**.

Question 1:

So far in your life, you may have assumed that as you are sitting in your chair right now, you are not accelerating. However, this picture is not quite complete! You are on the surface of the Earth, which is rotating. Which means you are in Uniform* Circular Motion about the North-South axis of the Earth!

(a) What is the linear acceleration of a person sitting in a chair on the equator?

(b) If you were sitting at the equator, would your mass times the gravitational acceleration of the Earth (mg) be greater than, less than, or equal to the normal force exerted on you by the chair you are sitting on? Explain.

(c) A classmate of yours asks you why we have ignored this acceleration for the whole first term of physics. "Is everything we've learned a lie?" they ask. Assuming you are at the equator, use order of magnitude sensemaking arguments comparing the normal force from your chair with your weight to assuage their fears.

(d) The latitude of Corvallis is 44.4°. If you were sitting in a chair in Corvallis, what would be your linear acceleration?

*actually the rotational speed of the Earth is decreasing with time at a rate of about 1.7 milliseconds per century! This means, as we will discover in the conserved rotational quantities lectures, that because angular momentum must be conserved, the moon is moving slowly away from us! We can safely ignore these facts for this problem.