Week 4 Challenge Homework

2-D 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:

At the Ice Capades two ice skaters pass right by each other while doing a routine where they are wearing directional jet packs. At this moment the skater in the red suit is traveling at a speed of 5 m/s in a direction 30º from the positive *x* axis towards the negative *y* axis and the skater in the blue suit is traveling at 4 m/s in the positive *y* direction. As they pass each other their jet packs turn on, shooting flames for effect and providing each of them a constant acceleration. The acceleration of the skater in the blue suit is in the positive *x* direction and has a magnitude of 4 m/s^2, while the acceleration of the skater in the red suit is in the positive *y* direction. With their jet packs turned on the entire time, they eventually meet again and pass right by each other.

(a) How much time elapses between the two times they are side-by-side?
(b) What was the magnitude of the acceleration of red skater to achieve this feat?
(c) What is their change in position during this time?
(d) What is the final velocity of each skater?
(e) Use the *Order of Magnitude* sense-making technique to determine if your answers to part (d) seem safe.