

AQ.L2.4 | Average Velocity and Acceleration | 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). If there are more than one question, they 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 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**.

AQ.L2.4-01

During the middle of a family picnic, Barry Allen received a message that his friends Bruce and Hal needed to be saved. Barry promised his wife Iris that he would be back in exactly 5 minutes. From that picnic location, Barry runs at a speed of 600 m/s for 2 minutes at a heading of 35° north of west to save Bruce. He then changed his heading to 30° west of north, slows down to 400 m/s and runs for 1 minute to save Hal. (The changes in speed are essentially instantaneous and not part of solving this problem).

- (a) Draw a physical representation of the displacement during Barry's full trip.
- (b) Use the *Related Quantities* sense-making technique to compare Barry's total distance traveled to the magnitude of his displacement.
- (c) What average velocity (magnitude and direction) does Barry need to return back to the picnic in order to keep his promise to Iris?