

VO.L1.4 | Vector Operations | 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 sensemaking in most problems. Use the list below as a reference to the different sense-making techniques. More information about sensemaking can be found on the BoxSand menu under Math Tools => [Sensemaking](#).

- *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**.

VO.L1.4-01

This question practices vector operations in the context of **Average Quantities | Position and Displacement**. Use the diagram to answer the following questions.

- Find the position vector, as a function of the radius (variable r), for points **A**, **B**, and **C**, using origin **O**.
- Find the change in position vector from **A** to **B** and **B** to **C** using origin **O**.
- Repeat parts (a) and (b) using origin **O'**.
- Do the position vectors depend on the choice of origin? Explain.
- Do the change in position vectors depend on the choice of origin? Explain using the *Self-Consistency* sensemaking technique.

