

K1.L1.4 | 1-D Kinematics | 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). 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**.

K1.L1.4-01

Two bacteria are next to each other moving in the same direction. One moves with an initial velocity of $20 \mu\text{m/s}$, accelerating at a rate of $5 \mu\text{m/s}^2$. The other starts with a velocity of $60 \mu\text{m/s}$ and is decelerating at a rate of $2 \mu\text{m/s}^2$. $1 \mu\text{m}=10^{-6} \text{ m}$.

- (a) Find the time and position at which the bacteria meet again for an epic battle.
- (b) Use the *Related Quantities* sense-making technique to compare the position found in part (a) for both bacteria. How do you expect these positions to compare?
- (c) Sketch a plot of the position as a function of time for the two bacteria. Any important feature of the motion should be scaled to the time at which it happened.