Week 3 Challenge Homework

1-D Kinematics

Submission Details | Submit a digital copy (PDF, jpg, etc.) to Canvas. Please use the interface to associate each page of your submission with the corresponding question number! It makes grading much easier. Please clearly indicate which question is being solved. 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.

Group Submissions | You may submit a group collaboration to Canvas. Add each group member to the submission. Each group member should contribute to the work. Clearly indicate which part of the submission is written by each member (color or labels are preferable).

Sensemaking | You will be asked to apply sensemaking in some problems. More information about sense-making can be found on the BoxSand Sensemaking page, which is linked on the Canvas homepage.

Metacognitive Exercise

Each week will feature a metacognitive exercise, followed by one or two challenge problems to solve. The metacognitive exercise will usually ask you to reflect on your solution to the previous week's challenge problems.

Review your solution to the Week 2 Challenge Homework. If you do not have a copy of it anymore, you can find it on Canvas or Gradescope, under the Week 2 Challenge Homework assignment. Also, review the solution which has been posted to the BoxSand solutions archive (click here for a link) a few days after the assignment is due.

(a) Question 1 from the Week 2 Challenge Homework involved a diagram of position vs position (the two axes were both position), while question 2 involved a graph of position vs time. Describe situations in which each type of diagram/graph might be useful. As you write, consider what the two diagrams can describe, as well as what they can help you calculate.
(b) Using the rubric for challenge homework to assess last week's solutions, for each category (click here for the link), do you feel that you performed more strongly on question 1 or question 2? Why?

Question 1:

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

(a) Evaluative sensemaking usually involves making a prediction for some aspect of your solution, explaining that prediction, then comparing your prediction with your solution. We will start our *Related Quantities* sensemaking by making a prediction. In part (b), you will find a displacement for each bacterium. Before you solve the problem numerically, what do you expect the relationship between these two displacements to be? Explain why you expect this relationship.
(b) Find the time and position at which the bacteria meet again for an epic battle.
(c) Complete your *Related Quantities* sensemaking by comparing the two displacements found in part (b), one for each bacterium. Does the found relationship match your prediction in part (a)? Explain briefly.
(d) 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.

Question 2:

A goalie kicks a soccer ball from the ground, straight up, vertically into the air. It takes 5.00 s for the ball to reach its maximum height *and* come back down to the level of the crossbar. Assume the crossbar of a soccer goal is 2.44 m above the ground.

(a) How fast was the ball originally moving when it was kicked?
(b) Evaluative sensemaking usually involves making a prediction for some aspect of your solution, explaining that prediction, then comparing your prediction with your solution. We will make the prediction here in part (b) and the comparison in part (d). Using *Sign* sensemaking, what do you predict the sign of the velocity to be? Explain using any combination of words, diagrams, algebra, examples, etc.
(c) Assuming a standard coordinate system with up as the positive y direction, what is the velocity of the soccer ball when it reaches the level of the crossbar on its way back down?
(d) Complete the *Sign* sensemaking by briefly explaining how (or how not!) the sign of your calculated answer to part (c) matches your prediction in part (b)?
(e) After the motion described in part (c), how much longer would it take the ball to reach the ground?