Week 7 Challenge Homework

Fluid Dynamics and Simple Harmonic Oscillation

Submission Details | Submit a digital copy (PDF, jpg, etc.) to Canvas. Include solutions to the metacognitive exercise and each question. Please use the interface to associate each page of your submission with the assignment. 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. Typed work will not receive credit. 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 6 Challenge Homework. If you do not have a copy of it anymore, you can find it on Canvas or Gradescope, under the Week 6 Challenge Homework assignment. Also, review the solution which has been posted to the BoxSand solutions archive (click here for a link). Solutions are posted a few days after the assignment is due.

(a) Now that you have completed at least two (likely 5 counting PH201 last term) exams in the introductory physics sequence, what are a few things which have helped you feel more prepared? Are there preparation methods which have not helped? Are there preparation methods which you would like to try?

(b) Find a classmate or three and discuss your answer to part (a). How can you help your classmate(s) prepare for the PH202 final exam? How can your classmate(s) help you prepare for the final? **If you are in Ecampus PH 202, please find and discuss this prompt with classmates on the Canvas Discussion Boards, or in your Lab Group direct messages.** For Corvallis campus folks, LAHHH, Wormhole, lectures, and lab groups are all recommended places to find folks to talk with.

Question 1:

You are on a cruise ship to the Bahamas. **The door to your room faces the outside of the ship, and swings inwards to your room**. On a breezy day you notice that after turning the doorknob, it is very difficult to pull the door open (legend has it, this happened to the mother of a friend of your instructor's cousin's dog's grandpa's owner). The wind is blowing steadily parallel to the side of the ship. **The wind is not at all directed into the door!**

(a) What is the origin of the force preventing you from opening the door? Explain why the wind is making it difficult to open the door. Hint: if your door opened swinging outwards, it would be initially easy to open!

(b) Your door is 1.00 meters wide and 1.93 meters tall. The door handle is 87.5 cm from the door hinges. If you must exert a force of 45 lbs. to start to open the door, how fast is the wind travelling outside your door? You may assume the force discussed in part (a) acts at the center of the door. Give the speed both in m/s and m/hr.

(c) Use known value sensemaking to evaluate your answer to question (b). Make sure to state a relevant known value (which is a prediction of an acceptable value), compare with your found value, and explain whether you think your answer to part (b) is reasonable or not.

Question 2:

In an engine, a piston oscillates with simple harmonic motion so that its position varies according to the expression $x(t) = 15.0 \cos(70.0\,t)$ where x is in centimeters and t is in seconds.

(a) What is the period of the motion?

(b) What is the amplitude of the motion?

(c) At $t = 1$ s, find the position of the piston.

(d) At $t = 1$ s, find the velocity of the piston.

(e) At $t = 1$ s, find the acceleration of the piston.

(f) Sketch a plot of the acceleration as a function of time. Scale the plot properly.

(g) Apply related quantities sensemaking to your answer by

- Making a **prediction** for similarities and differences you expect to see between the position and acceleration of an oscillating object
- **Explaining** each prediction
- Finding an equation that describes the acceleration as a function of time for this piston and **comparing** this equation with the position equation in light of your predictions.