FD.L1.4 | Continuity, Bernoulli | 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) and there should be only be one solution per page. The questions 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 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**.

FD.L1.4-01

You are on a cruise ship to the Bahamas. The door to your room opens to the side of the ship. On a breezy day you notice that it is very difficult to even start to open the door to your room (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 (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.

(b) Does your door open swinging into the room, or swinging out into the walkway outside your room? Explain.

(c) 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 have to 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.

FD.L1.4-02

A water intake at a reservoir has a radius of 0.486 m. The water flows in at a speed of 0.405 m/s. At the generator building, 183 m below the intake point, the water flows out at a speed of 9.45 m/s.

(a) What is the radius of the outlet?

(b) What is the difference in pressure between the intake and outlet?