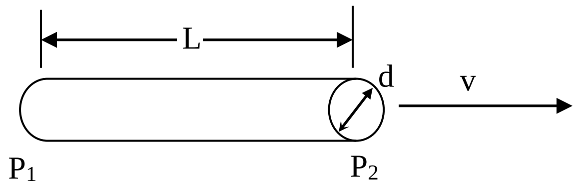
Name: ____________________

Date: _____________ Period: ___________

Fluids Worksheet 4
Dissipated Energy Density

Solar bob problem?

1. Fluid flows from left to right through the horizontal segment of tubing below, which is part of a larger, closed system. P_1 is the pressure on the left and P_2 is the pressure on the right.



Descriptions of a number of changes in this situation are presented below. Whenever a change is made to this specific tube above, the rest of the closed system is adjusted to maintain a *constant flow rate through this tube*. How does each change affect the indicated quantity? Briefly explain each answer. Possible choices are:

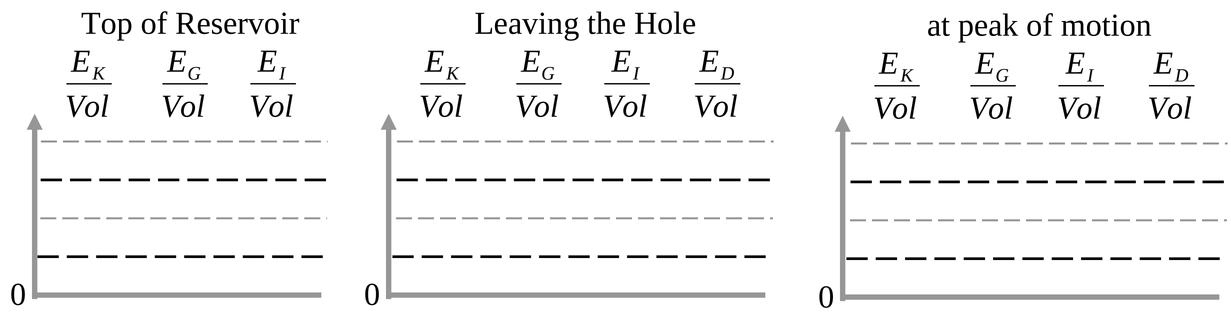
A. becomes two times greater
B. becomes four times greater
C. becomes eight times greater.
D. becomes sixteen times greater.
E. becomes half as much
F. becomes one-quarter as much
G. becomes one-eighth as much.
H. becomes one-sixteenth as much.
I. stays the same.

i. What happens to the difference in pressure, $P_2 – P_1$, if the tube becomes twice as long?
ii. What happens to the difference in pressure if the diameter of the tube becomes half as much?
iii. What happens to the difference in pressure if the diameter of the tube becomes twice as much?
iv. What happens to the difference in pressure if the tube becomes twice as long while the diameter becomes twice as much?
v. What happens to the velocity of the fluid if the tube becomes half as long?
vi. What happens to the velocity of the fluid if the tube diameter becomes twice as much?
vii. What happens to the velocity of the fluid if the tube becomes half as long while the diameter becomes half as much?

2. Because of your knowledge of fluid flow, you have been asked to advise a hospital on the proper procedure for intravenous blood infusions. If a patient's blood pressure is in the normal range, how far above the patient should the bottle of intravenous fluid be placed to insure a slow but steady trickle of fluid into the patient? You have available a 1.5m long IV tube with an inner diameter of 3.1mm. Please clearly state your assumptions along with your solution.

3. Suppose an artery is clogged with plaque so that it is ½ of its previous inner diameter. How many times greater is the pressure difference needed to obtain the same flow rate that existed when it was unclogged?

4. In worksheet 2, you were the proud member of a team designing a fountain for the quad. Thanks, in part, to your excellent technical advice, your team has won the competition and the fountain has been built to your design. However, you are displeased to learn that it does not reach its full height of 2.0m, but instead only goes up to 1.80m.
(a) Complete a new set of energy density bar graphs, reflecting more accurate information for your fountain, assuming all of the dissipation occurs inside the reservoir and tube and not in the air.



(b) How much energy is dissipated per cubic centimeter of water flowing through the fountain?

(c) Assuming all of the dissipation occurs inside the reservoir and tube and not in the air, with what velocity does the fluid now leave the hole?

(d) At what total rate (erg/s) is energy dissipated in the fountain?

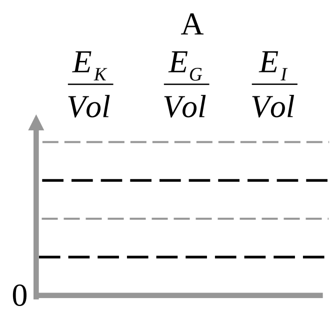
(e) In order to decrease the dissipation and make the fountain go higher, you revisit the suggestions previously offered by your teammates.
i. Increase the diameter of the reservoir so there is a larger weight of fluid pushing out.
ii. Enlarge the diameter of the pipe so the flow is not so constricted.
iii. Make the exit hole larger, so that the fluid can escape faster.
Which of these suggestions would *reduce* the dissipation the most? Explain.

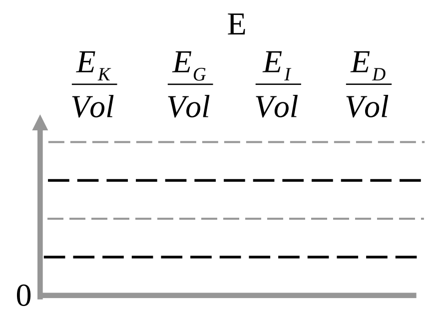
Which of these suggestions would *increase* the dissipation the most? Explain.

5. Just as Frugal Frank is about to run out the door to confront Greg the Gas Guzzler who has already siphoned almost half of Frank's gas, Frank realizes that he failed to include the effects of dissipation in his time estimate. Quickly, he re-calculates.

(a) Determine the resistance of Greg's siphon.

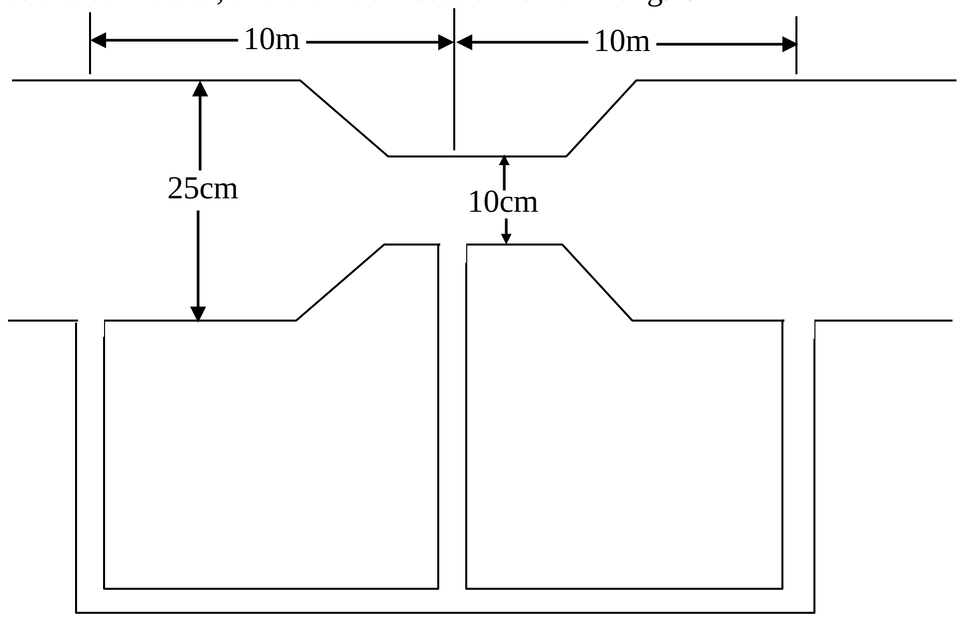
(b) Draw a set of quantitatively accurate energy density bar graphs for points A, at the surface of the gas in the tank (30cm from the ground) and E, , just after the fluid exits the siphon tube. Use them to approximate the rate at which gasoline flows into Greg's tank. Should Frank change his decision and call the police instead?





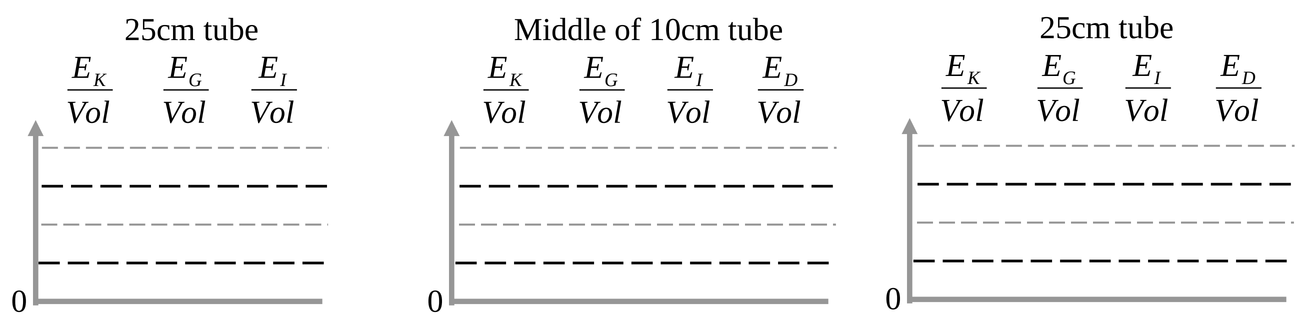
(c) At what rate (erg/s) is energy dissipated in Greg's siphon?

6. In the section of tubing below, water flows through the 25cm diameter section with a velocity of 2.0m/s. There is a distance of 10m between the places where the smaller tubes are connected, and the 10cm section is 10m long. .



(a) Determine the resistance of the 10cm diameter tube.

(b) Draw quantitatively correct energy density bar graphs for each segment of the main tube.



(c) The small tubes below the main tube are partially filled with mercury. If the height of mercury in the first vertical tube is 5.0cm, determine the height of the mercury in the second and third vertical tubes.

(e) i. For comparison, determine the resistance of a 10m long section of the 25cm long tube.

ii. At what rate (erg/s) is energy dissipated in a 10m long section of the 25cm diameter tube?

iii. At what rate (erg/s) is energy dissipated in a 10m long section of the 10cm diameter tube?

iv. Why is it a reasonable approximation to neglect any dissipation in the larger tubes?