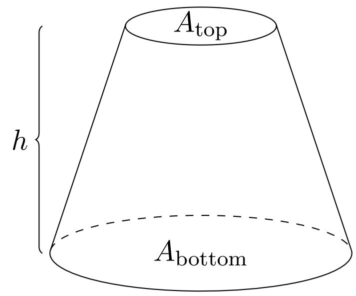
Quiz 1 (compiled : 2026/04/11 at 22:08; version 1)

Name: ______________________ **Student ID:** ______________________

Problem 1: A section of a vertical pipe of height h with resistance R has a cross-sectional area that changes. The top area (A_{top}) is smaller than the bottom area (A_{bottom}). For a particular flow direction and flow rate I_0, it is observed that the pressure at the top (P_{top}) is equal to the pressure at the bottom (P_{bottom}).



(a) For this part, suppose the top and bottom areas are actually equal. With the pipe's flow set up to have equal pressures at the top and bottom, and given $h = 2$ m, $R = 5 \times 10^4$ Js/m^6, and $\rho = 1000$ kg/m^3, determine the magnitude and direction of I_0. (Round to two decimal places.)

$I_0 =$ ____________ m^3/s

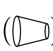
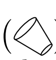
○ flowing down ○ flowing up ○ cannot be determined

(b) Suppose the pipe is set up with the flow direction and flow rate that made the top and bottom pressures equal. Then, one of the following changes are made. For which changes does P_{bottom} end up larger than P_{top}?

(Changing the height h does not change the resistance R.)

☐ increasing A_{bottom} ☐ increasing h ☐ increasing I_0 ☐ increasing R ☐ reversing the direction of I_0

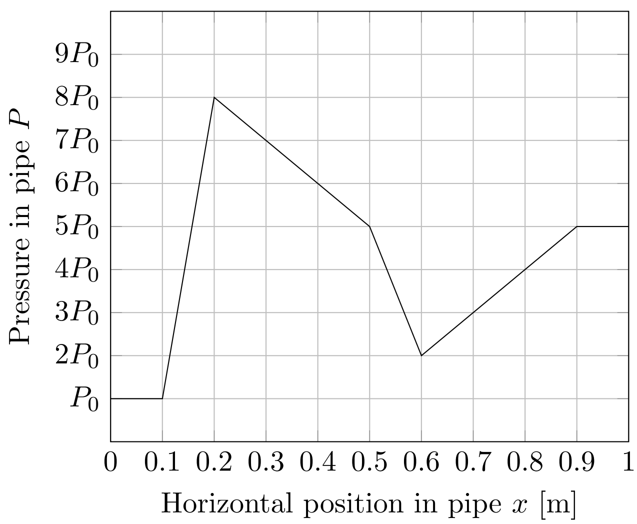
(c) In each of the following cases, the pipe has been rotated in some way. If possible, determine the direction that the fluid must flow to keep the pressures on the two ends equal:

- Rotated 90 degrees clockwise ():
  ○ flowing left ○ flowing right ○ flowing down ○ flowing up ○ cannot be determined
- Flipped over ():
  ○ flowing left ○ flowing right ○ flowing down ○ flowing up ○ cannot be determined
- Rotated 45 degrees counter-clockwise ():
  ○ flowing down-left ○ flowing down-right ○ flowing up-left ○ flowing up-right ○ cannot be determined
- Rotated 135 degrees clockwise ():
  ○ flowing down-left ○ flowing down-right ○ flowing up-left ○ flowing up-right ○ cannot be determined

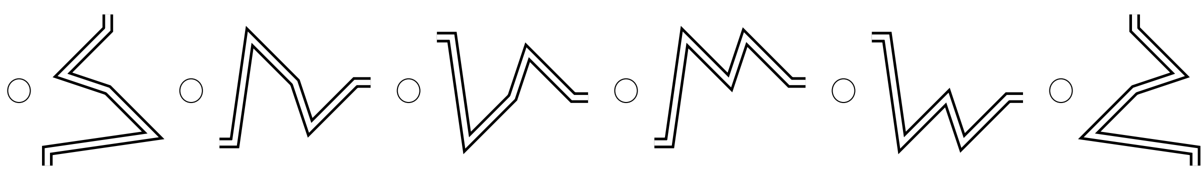
Energy Density Equation	**Continuity Equation**	**Constants**
$\Delta P + \frac{\Delta PE}{\text{vol.}} + \frac{\Delta KE}{\text{vol.}} = \frac{E_{\text{pump}}}{\text{vol.}} - \frac{\Delta E_{\text{th}}}{\text{vol.}}$	$I = Av$	$\rho_{\text{water}} = 1000$ kg/m^3
$\Delta P + \rho g \Delta h + \frac{1}{2}\rho\Delta(v^2) = E_{\text{pump}}/\text{vol.} - IR$	$I_{\text{in}} = I_{\text{out}}$	$g = 10$ m/s^2
		$P_{\text{atm}} = 1$ atm $= 10^5$ Pa OR J/m^3 OR kg/(m $\cdot$ s^2)

Problem 2: A section of pipe traverses 1 meter horizontally, with water flowing from left to right inside of it. The pipe can change heights and/or areas, but has no pumps or resistance. The left end of the pipe (at $x = 0$ m) has a fixed pressure P_0. The pressures elsewhere in the pipe for a flow rate of 1 m^3/s are plotted below.

Pressure measurements for $I = 1\ m^3/s$



(a) Suppose the area of the pipe is constant. Which of the following could be the shape of the pipe:



(b) Suppose the height of the pipe is constant, the initial area at $x = 0$ is $A_0 = 0.15\ m^2$, and the initial pressure is $P_0 = 1.2$ kPa. Determine the location of the maximum area of the pipe. (Round to two decimal places.)

$x_{\text{where } A_{\max}} =$ ______ m

Determine the maximum area. (Round to three decimal places.)
(You may find $\Delta(v^2) = v_f^2 - v_i^2 = I^2/A_f^2 - I^2/A_i^2 = I^2\Delta(1/A^2)$ helpful.)

$A_{\max} =$ ______ m^2

(c) Determine whether the following are true, false, or not possible to determine with the given information:

- If the height of the pipe is constant, the areas at $x = 0.5$ m and $x = 0.9$ m are the same.
  ○ True ○ False ○ Not possible to determine
- If the height of the pipe is constant, the areas at $x = 0$ m and $x = 1$ m are the same.
  ○ True ○ False ○ Not possible to determine
- If the height of the pipe is constant, then increasing the flow rate would increase the pressure differences.
  ○ True ○ False ○ Not possible to determine
- If the area of the pipe is constant, then increasing the flow rate would increase the pressure differences.
  ○ True ○ False ○ Not possible to determine

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$\Delta P + \rho g \Delta h + \frac{1}{2}\rho\Delta(v^2) = E_{\text{pump}}/\text{vol.} - IR$	$I_{\text{in}} = I_{\text{out}}$	$g = 10\ m/s^2$
		$P_{\text{atm}} = 1\ \text{atm} = 10^5$ Pa OR J/m^3 OR $kg/(m \cdot s^2)$