Fluid Mechanics Questions (Venturi and Hydraulic Loss)

In the energy balance equation shown below, identify the term which represents energy losses due to friction

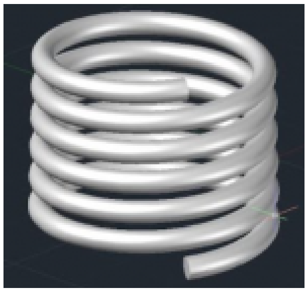
$$\frac{P_1}{\rho}+\frac{\bar{v}_1^2}{2}+g_zH_1+\eta W_p=\frac{P_2}{\rho}+\frac{\bar{v}_2^2}{2}+g_zH_2+h_f$$

- $\frac{P_1}{\rho}$, $\frac{P_2}{\rho}$
- $\frac{\bar{v}_1^2}{2}$, $\frac{\bar{v}_2^2}{2}$
- g_zH_1 , g_zH_2
- ηW_p
- h_f

Excessive head losses are observed in a section of piping with constant diameter. Select the option that could be explored to reduce the head losses in the piping section, assuming turbulent flow

- Increase the fluid velocity
- Decrease the pipe diameter
- Increase the pipe diameter
- Use a piping material with a higher relative roughness to decrease the friction factor

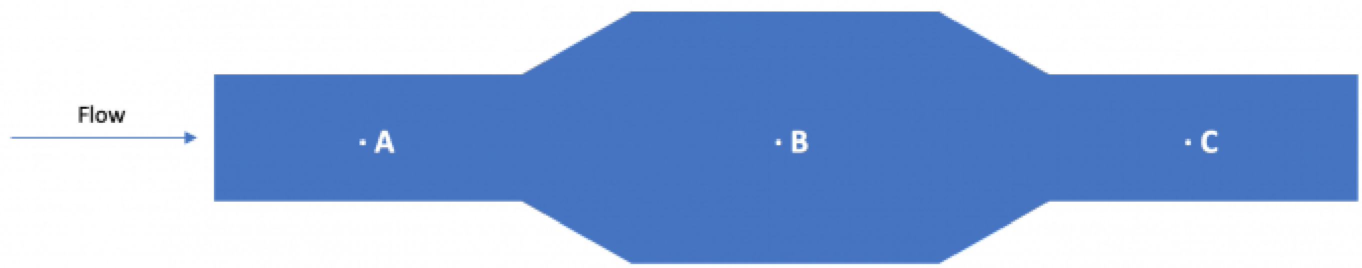
Imagine fluid flowing inside the coil shown below. Assuming the coil has a constant diameter, what would happen to the fluid velocity as the fluid flows from the top to the bottom of the coil?



- ○ The velocity will increase because the fluid is flowing downwards and is driven by gravity
- ○ The velocity will remain constant because the pipe has a constant diameter and mass must be conserved
- ○ The velocity will decrease because of friction on the pipe walls
- ○ The velocity will remain constant because the increase in velocity due to gravitational forces is counterbalanced by the decrease due to friction

---

Describe the energy transformation in the fluid between points A and B.

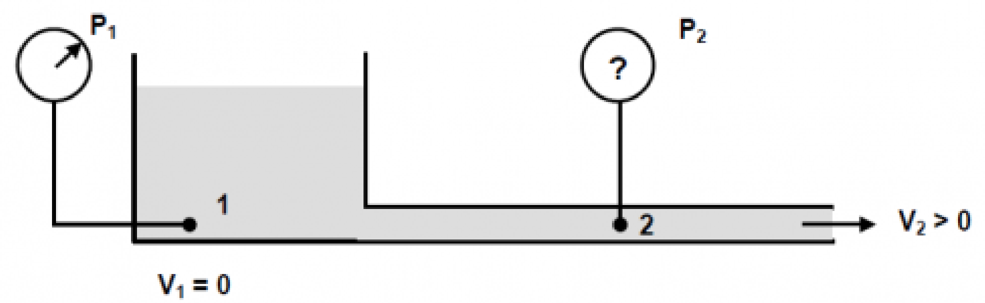


- ○ Kinetic energy is being converted to flow work.
- ○ Flow work is being converted to kinetic energy.
- ○ Kinetic energy is being converted to potential energy.
- ○ Potential energy is being converted to kinetic energy.
- ○ Not enough information.

To describe the concept of continuity at steady state for an incompressible fluid, classify the following statements as true or false

	True	False
Mass flow rate in equals mass flow rate out	○	○
Volumetric flow rate in equals volumetric flow rate out	○	○
As diameter increases, velocity increases	○	○

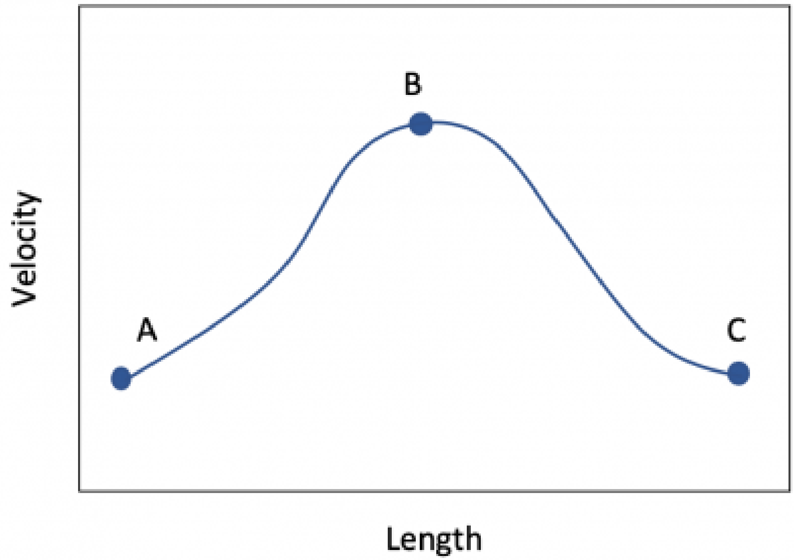
Water flows from a tank through a pipe section as shown below. Points 1 and 2 are located at the same vertical height and the pressure gauges are mounted at the same vertical position.



If the water velocity at point 1 is negligible, frictional losses are essentially zero, and there are no entrance/exit effects in the tank and pipe, how is the pressure at points 1 and 2 related?

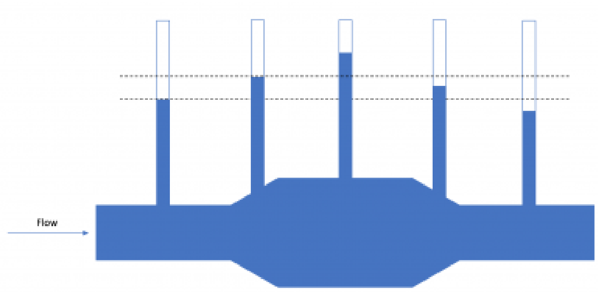
- ○ P1 = P2 because friction is negligible in the flowing fluid
- ○ P1 < P2 because of the force required to push fluid into the pipe
- ○ Can't determine without knowing the fluid density and viscosity
- ○ P1 > P2 because pressure decreases as velocity increases according to the Bernoulli principle

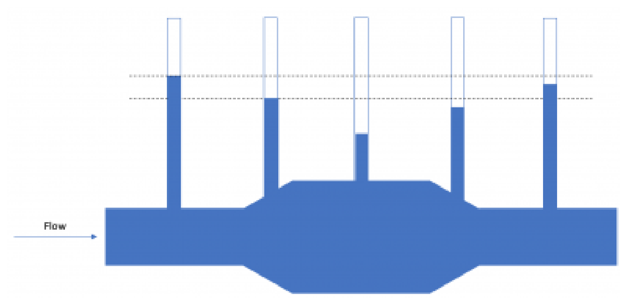
In a horizontal pipe of changing diameter, the following velocity profile was measured at points A, B, and C. Choose the best description for the pressure profile, assuming $v_A = v_C$.

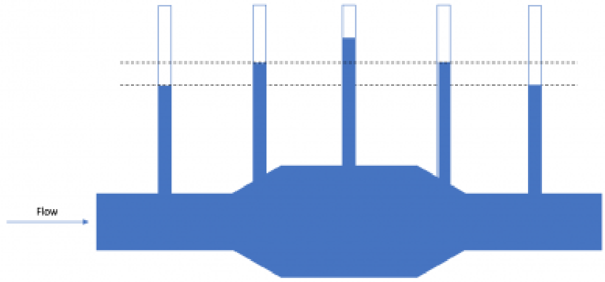


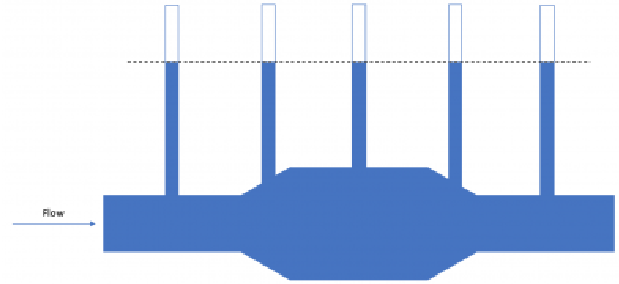
- PA > PB > PC because friction causes the pressure to decrease along the entire length of the pipe.
- PA > PC > PB because the velocity increases at Point B, leading to a decrease in pressure, and PC < PA because of frictional losses, though the velocity is the same.
- PB > PA > PC because the velocity increases at Point B, leading to an increase in pressure, and PC < PA because of frictional losses, though the velocity is the same.
- PA = PC > PB because the velocity increases at Point B, leading to a decrease in pressure, and the pressures at PA = PC because the velocities are the same .

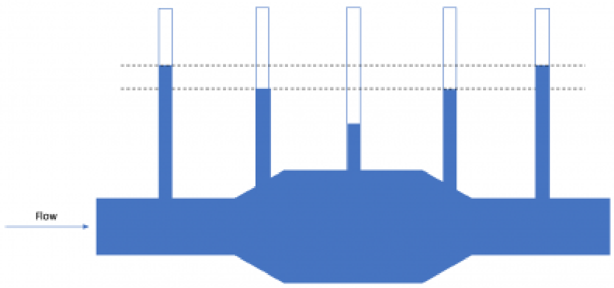
Select the figure that most closely represents reality, assuming incompressible flow and the diameters at points A and C are equal.



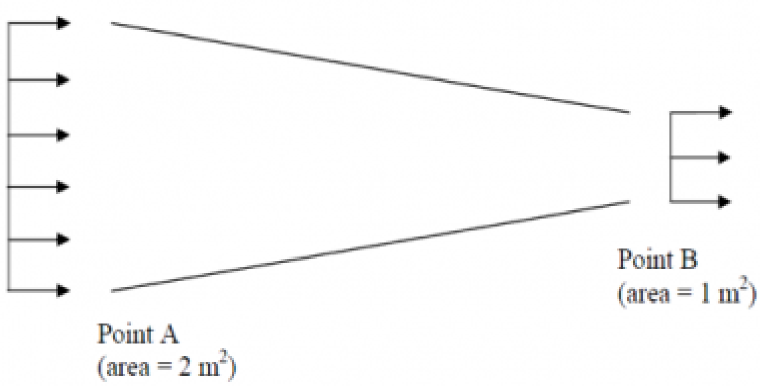






○ 

Liquid water at 25°C and 1 atm flows at steady-state through a square nozzle as shown in the figure below. At point A, the velocity is V_A and at point B, the velocity is V_B. Both velocities can be assumed constant across the nozzle cross-section.



The cross-sectional area of the nozzle at point A is 2 m^2 and the cross-sectional area of the nozzle at point B is 1 m^2.

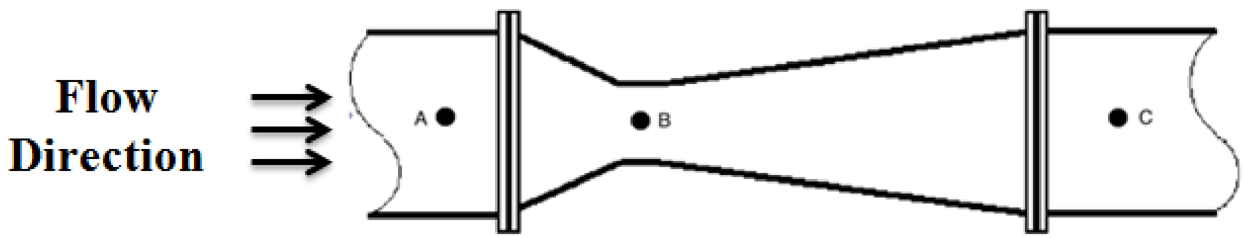
Assuming the density of water is constant, which of the following statements relating V_A and V_B is true at steady flow conditions?

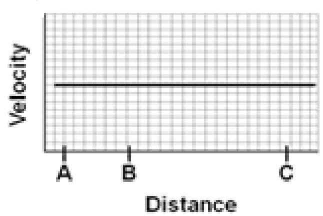
○ VB = 2VA because reducing flow area by a factor of 2 means the velocity must double to conserve mass.

- ○ The relationship between VA and VB cannot be determined unless the pressure change from point A to point B is known.
- ○ VB = VA because velocity is constant at steady flow conditions.
- ○ VB = 2VA because volume is conserved for all fluids so that reducing flow area by a factor of 2 will double the velocity.

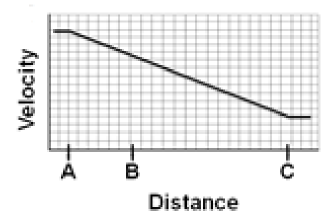
Consider the venturi meter shown below:

Select the most realistic graph for **velocity** versus distance in the venturi:

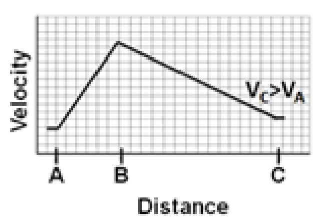


○ 

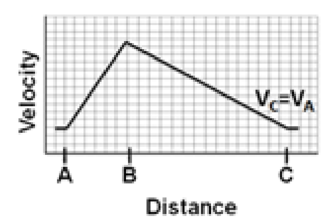
1)

○ 

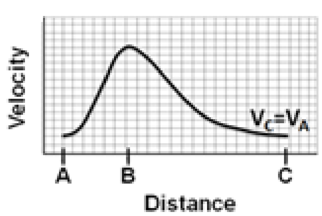
2)

○ 

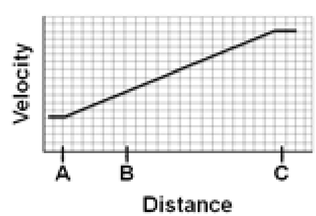
3)

○ 

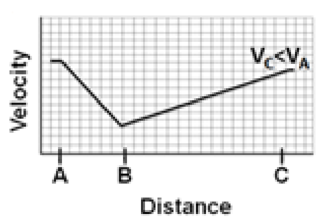
4)

○ 

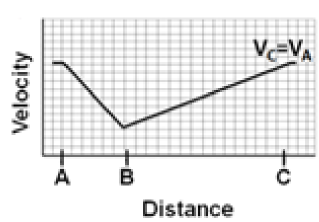
5)

○ 

6)

○ 

7)

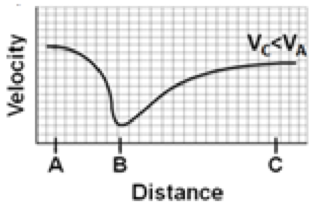
○ 

8)

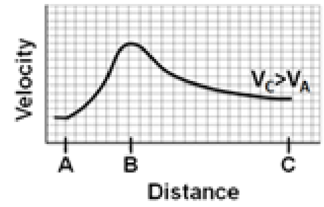
○

○

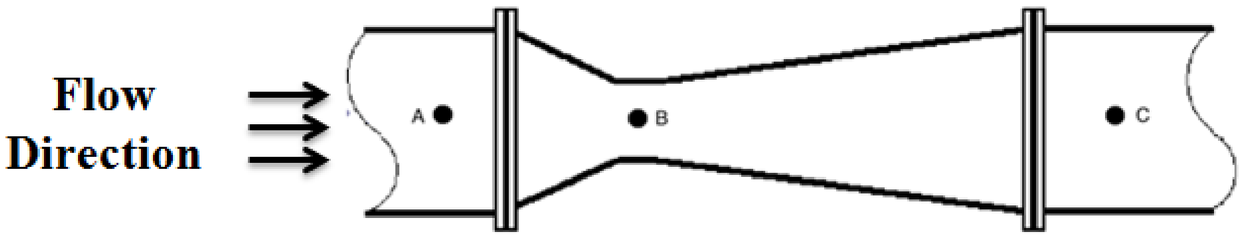
9)



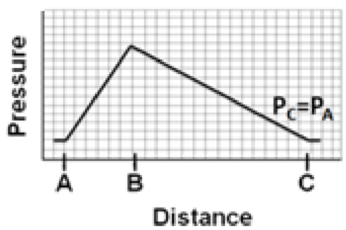
10)



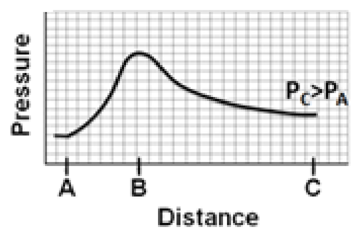
Select the most realistic graph for **pressure** versus distance in the venturi:



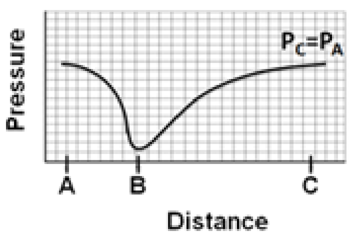
1)



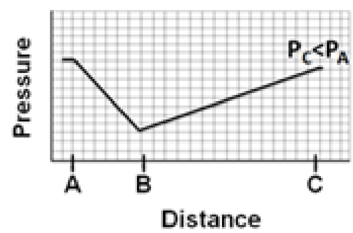
2)



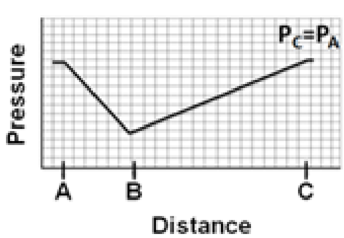
3)



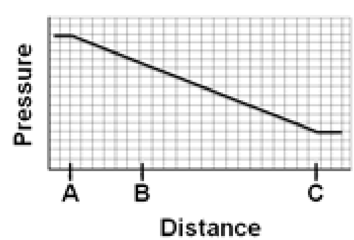
4)



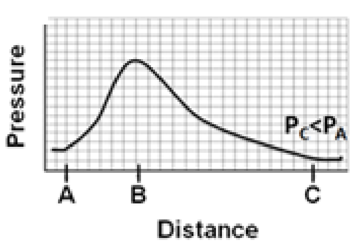
5)



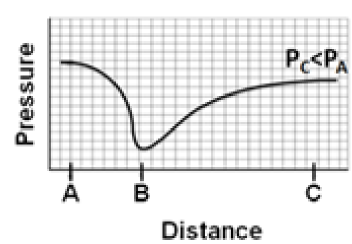
6)

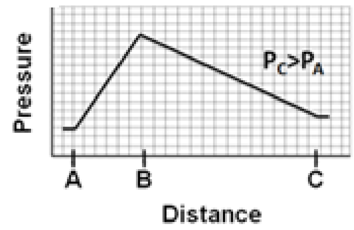


7)

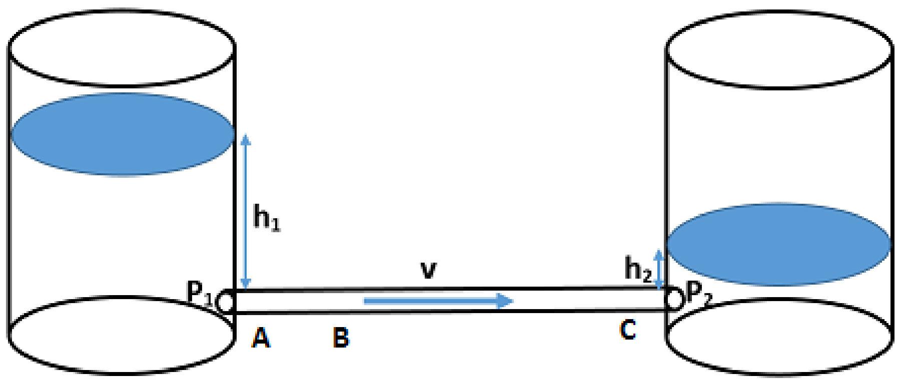


8)





9)

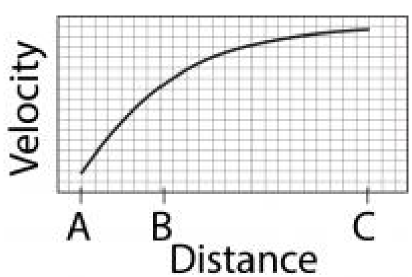


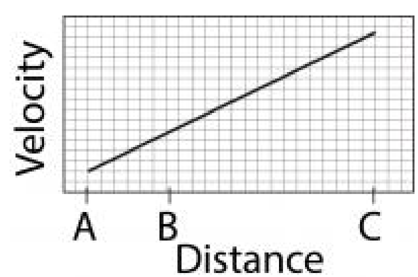
Water flows through a pipe from Tank 1 on the left to Tank 2 on the right. The water level in each tank is indicated at a point in time.

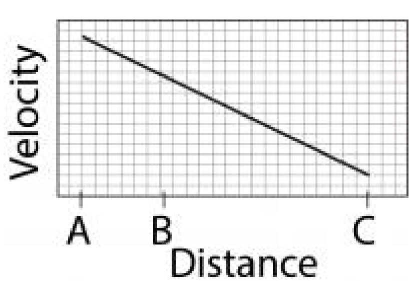
The pressure at the entrance to the pipe in Tank 1 is P1 = 20 kPa.

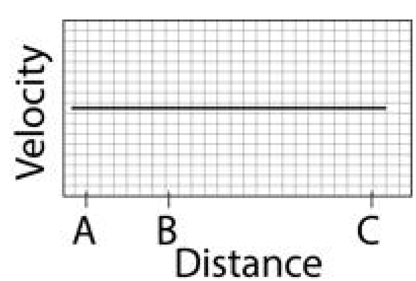
The pressure at the entrance to the pipe in Tank 2 is P2 = 12 kPa.

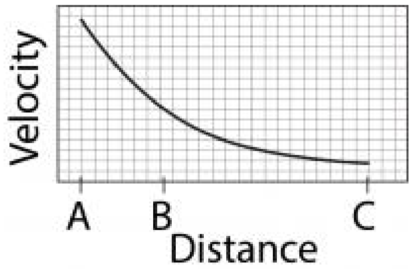
Select the correct graph of **velocity** versus distance down the pipe.





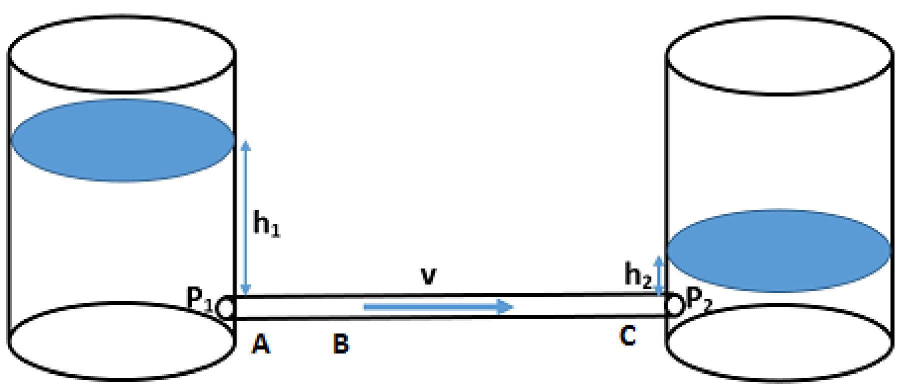


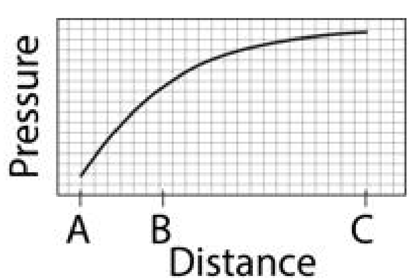


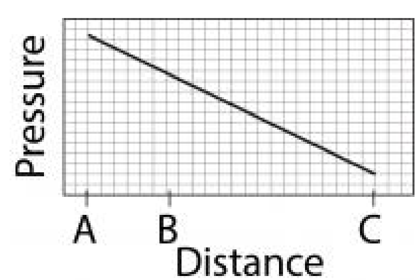


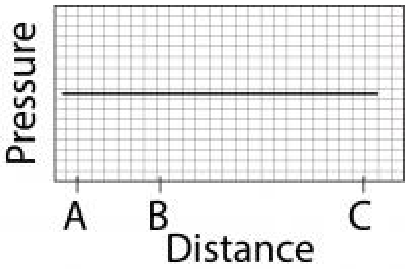
Justify your answer for the velocity vs distance.

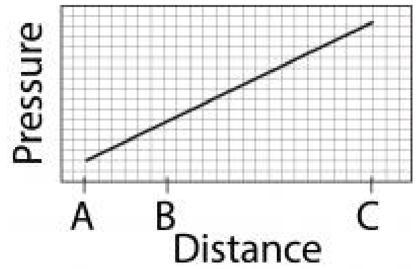
Select the correct graph of **pressure** versus distance down the pipe.

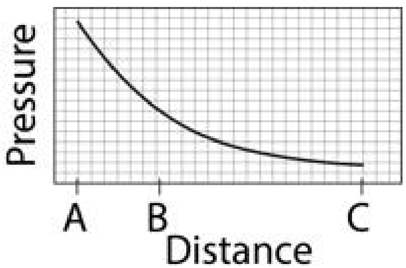







Pressure
A
B
C
Distance


Pressure
A
B
C
Distance


Pressure
A
B
C
Distance