Physics I

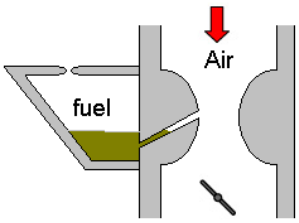
Bernoulli

Definition of pressure: $P = \dfrac{\text{Force}}{\text{Area}}$

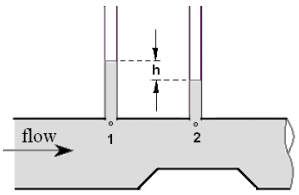
Hydrostatics equation: $P_B - P_A = \rho g h$

Bernoulli's equation: $P_1 + \frac{1}{2}\rho v_1^{\,2} + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^{\,2} + \rho g h_2$

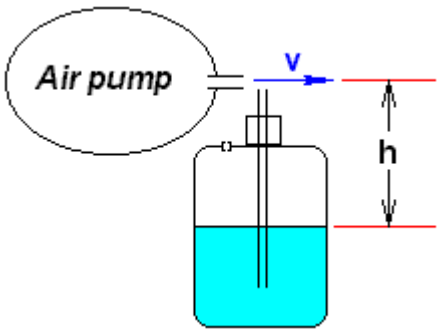
Problem 1.- In a carburetor (schematically shown in the figure) calculate the minimum speed of the air at the nozzle so the difference in pressure with the fuel reservoir is at least 1,500 pascals. [Take the density of air as 1.29 kg/m^3]



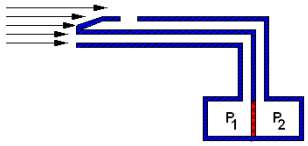
Problem 2.- The pipe in the figure is transporting oil (density 850 kg/m^3). The velocity at point 1 is 5m/s, but at point 2 it is 10m/s. Calculate the difference in height in the two open thin tubes



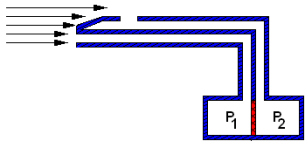
Problem 3.- Perfume in a bottle has a density of 955 kg/m^3 and its level is h=0.025m below the nozzle as shown in the figure. Calculate the minimum speed of the air, so the liquid will reach the nozzle. [For the density of air use $\rho_{air} = 1.29 \text{kg/m}^3$]



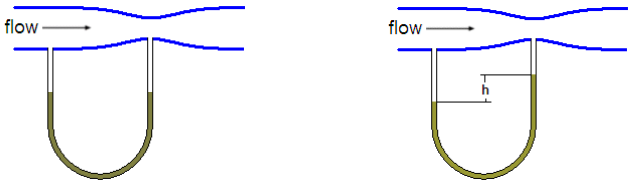
Problem 4.- A Pitot tube is an instrument used to measure airspeed of an aircraft. Calculate the change in pressure read by the instrument if the airspeed is 105 m/s. [take the density of air at these conditions as 0.95kg/m^3]



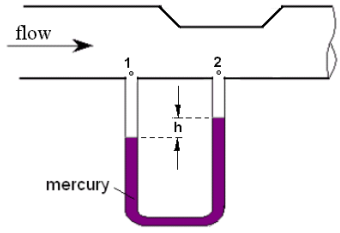
Problem 4a.- A Pitot tube is an instrument used to measure airspeed of an aircraft. Calculate the speed if the pressure difference read by the instrument is 7,500 pascals. Take the density of air at these conditions as 0.95kg/m^3.



Problem 5.- The figure shows a so called "Venturi tube" which is used to measure gas flow. The U-shaped tube section contains mercury, and the levels are equal because there is no flow right now. Use your knowledge of Bernoulli's principle to predict what will happen to the mercury levels when the gas flow starts.



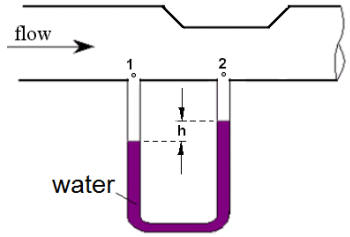
Problem 5a: The Venturi tube shown in the figure has a restriction in the cross section, so the speed of the air flow at point "2" is 20 m/s, while the speed at point "1" is 10 m/s.
Calculate the difference in the level of mercury under these conditions.
[Take the density of air=1.29kg/m^3] [1 torr = 133 pascals]



Problem 5b.- The Venturi tube shown in the figure has a restriction in the cross section, so the speed of the air flow at point "2" is 15 m/s, while the speed at point "1" is 10 m/s.

Calculate the difference in the level of water in the U-tube under these conditions.

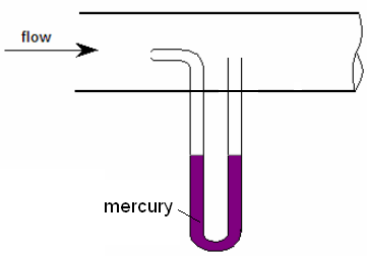
[Take the density of air=1.29kg/m^3 and water=1000kg/m^3]

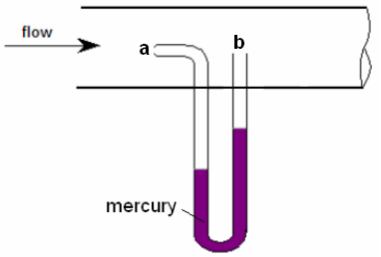


Problem 6: The airspeed on the top surface of a wing is 105m/s, but only 95m/s on the bottom surface. The wing has an area of 15m^2. Use Bernoulli's principle to calculate the net force trying to lift the wing. Ignore other mechanical effects such as viscosity drag.

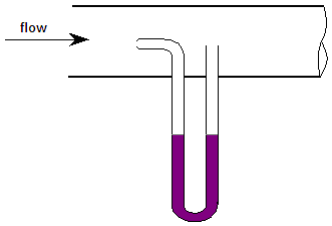
Take the density of air as 1.20kg/m^3

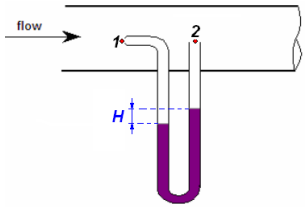
Problem 7.- A Pitot tube is an instrument used to measure airspeed of an aircraft or fluid flow in pipes. In the following schematic, the mercury is leveled because there is no flow. Indicate what will happen to the mercury when flow starts and give a short rationale of your answer.



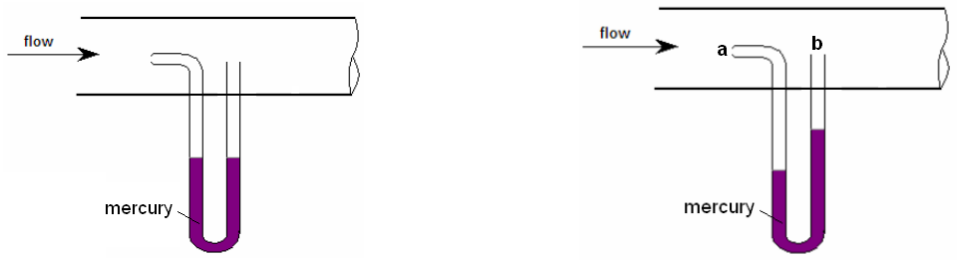


Problem 7a.- A Pitot tube is an instrument used to measure airspeed of an aircraft or fluid flow in pipes. In the following schematic, the mercury is leveled because there is no airflow. When the flow starts, the level on the right goes up 0.5mm (and the level on the left goes down 0.5 mm). Calculate the speed of the air if the density of air is 1.29kg/m^3 and the density of mercury is 13,600 kg/m^3.

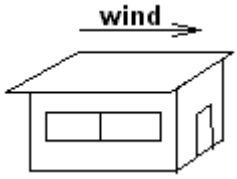




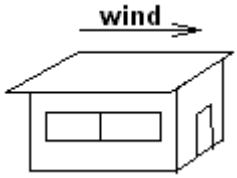
Problem 7b: A Pitot tube is an instrument used to measure airspeed of an aircraft or fluid flow in pipes. In the following schematic, the mercury is initially leveled because there is no flow. Calculate the difference in level when the speed of the flow of air is v=10.5 m/s.
[Take the density of air=1.29kg/m^3] [1 torr = 133 pascals]



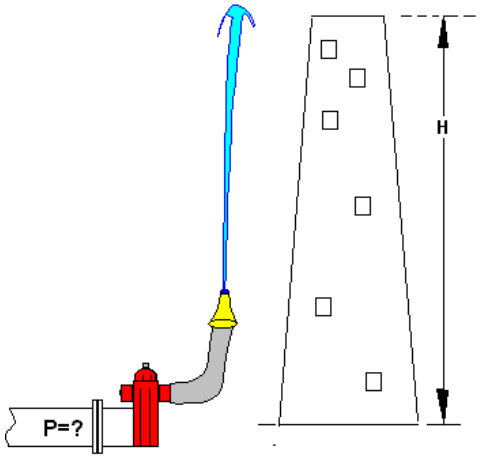
Problem 8.- How would you use Bernoulli's principle to calculate the force on a flat roof produced by wind of speed v? Write the equation(s) that you would use.



Problem 8a.- The wind is blowing at a speed of 25 miles/hour over a flat roof of area 95m^2. Use Bernoulli's principle to calculate the net force trying to lift the roof.



Problem 9.- You want water to reach a height of H=33 meters with a fire hose. Calculate the minimum gauge pressure in the mains to do this. Assume the speed of the water in the mains to be negligible and density $\rho_{water} = 1000 kg/m^3$



Problem 10.- Prairie dogs built the following architecture. Indicate in what direction air will flow in the tunnel and explain **why**.