Answer on Question #37652 - Physics - Other

A glass tube has several different cross-sectional areas with the values indicated in the figure. A piston at the left end of the tube exerts pressure so that mercury within the tube flows from the right end with a speed of 8.0 m/s. Three points within the tube are labeled A, B, and C.
http://edugen.wileyplus.com/edugen/courses/crs3976/art/qb/qu/c11/r5-1.png
Notes: The drawing is not drawn to scale.
Atmospheric pressure is 1.01 × 105 N/m2; and the density of mercury is 13 600 kg/m3.
What is the total pressure at point B?

Solution:

First, let's find speed at which mercury flowing past point B:

$$S_c V_c = S_B V_B$$

$$V_B = \left(\frac{S_c}{S_B}\right) V_c = \left(\frac{6.0\ \text{cm}^2}{5.6\ \text{cm}^2}\right) \cdot 8\frac{\text{m}}{\text{s}} = 8.6\frac{\text{m}}{\text{s}}$$

Now, let's find the total pressure at point B (pressure equation):

$$\frac{1}{2}\rho V_B^2 + p_B = \frac{1}{2}\rho V_C^2 + p_C \qquad (1)$$

$$p_C = p_{atm} = 1.01 \times 10^5 \frac{\text{N}}{\text{m}^2} \qquad (2)$$

$(2)\text{in}(1)$:

$$p_B = \frac{1}{2}\rho(V_C^2 - V_B^2) + p_{atm} = 1.01 \times 10^5 \frac{\text{N}}{\text{m}^2} + \frac{1}{2} \cdot 13600 \frac{\text{kg}}{\text{m}^3} \cdot \left(\left(8\frac{\text{m}}{\text{s}}\right)^2 - \left(8.6\frac{\text{m}}{\text{s}}\right)^2\right)$$
$$= 3.1 \times 10^4 \text{Pa}$$

Answer: total pressure at point B is 3.1×10^4Pa.