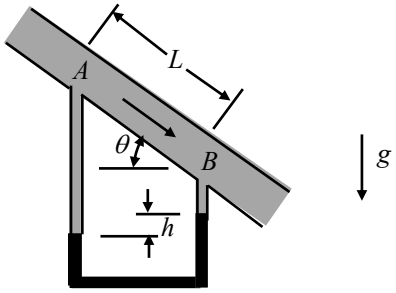
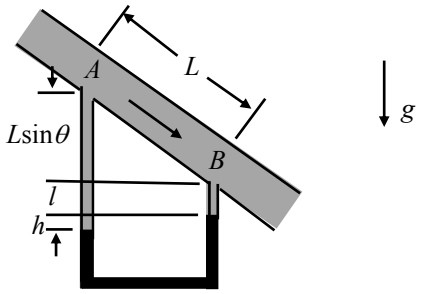
Water flows downward through a pipe inclined at a $\theta = 45°$ to the horizon as shown in the figure. The pressure difference $p_A - p_B$ is due partly to gravity and partly to viscous dissipation. Determine the pressure difference if $L$ = 5 m and $h$ = 6 cm. Mercury is the working fluid in the manometer.



SOLUTION:




The pressure at B may be written in terms of the pressure at A using,

$$p_B = p_A + \rho_{H_2O} g\left(L\sin\theta + l + h\right) - \rho_{Hg} g h - \rho_{H_2O} g l \quad (1)$$

$$p_B - p_A = \rho_{H_2O} g\left(L\sin\theta + h\right) - \rho_{H_2O} SG_{Hg} g h \quad (2)$$

$$p_A - p_B = \rho_{H_2O} g\left[SG_{Hg} h - \left(L\sin\theta + h\right)\right] \quad (3)$$

$$p_A - p_B = \rho_{H_2O} g\left[\left(SG_{Hg} - 1\right)h - L\sin\theta\right] \quad (4)$$

Using the given data,

$\rho_{H2O}$ = 1000 kg/m$^3$
$g$ = 9.81 m/s$^2$
$SG_{Hg}$ = 13.6
$h$ = 0.06 m
$L$ = 5 m
$\theta$ = 45°
$\Rightarrow$ $\boxed{p_A - p_B = -27.3 \text{ kPa}}$