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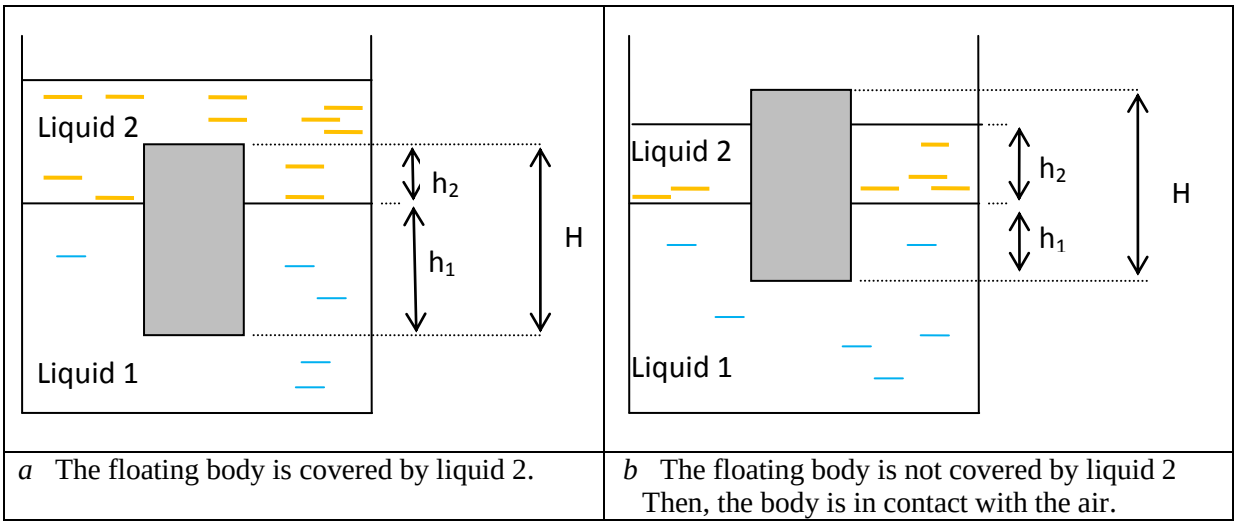
SHEET No.2[1]

Activity 2

Discussing classical solution



a The floating body is covered by liquid 2.

b The floating body is not covered by liquid 2 Then, the body is in contact with the air.

Figure 1 Two cases for a cylindrical solid at hydrostatic equilibrium "between" two liquids.

For any position of the solid, the relationship of fluid statics $\Delta p = -\rho g \Delta h$ can be used for each part of the cylinder immersed in each liquid, of respective heights h_1 and h_2. Therefore, with an upward axis, the differences in pressure between lower and upper horizontal sections of the cylinder immersed in, respectively, liquid 1 (water) and 2 (oil) are given by:

$\Delta p_1 = \rho_1 g h_1$ $\Delta p_2 = \rho_2 g h_2$

The possible contribution of the air (case b) can be neglected with respect to the two others, given that the density of the air is typically a thousand times smaller than those of the liquids.

A state of equilibrium occurs when Archimedes' up-thrusts due to each liquid and the weight of the body balance out: $(\rho_1 h_1 + \rho_2 h_2) \cdot S \cdot g - \rho_s \cdot H \cdot S \cdot g = 0$ or else:

$\rho_1 h_1 + \rho_2 h_2 = \rho_s H$

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where *S* is the cross-section of the cylinder.

Solving for, say, h_1 gives

$$h_1 = (\rho_s H - \rho_2 h_2)/\rho_1 \qquad (1)$$

h_1 and h_2 being the heights of each part of the cylinder immersed in each liquid **in case the cylinder actually floats between the liquids.**

2b. Does the relationship (1) hold for case *a* only, case *b* only or for both of them? Explain!

Holds for both

2c. Explain how relationship (1) accounts for the experimental results.

If h2 increases, h1 decreases, therefore the cylinder goes up

Note that the difference in pressure between lower and upper horizontal surfaces of the cylinder is always the same in any situation of the hydrostatic equilibrium.