Interesting Problem

Based on P= hdg and pressure = thrust /area

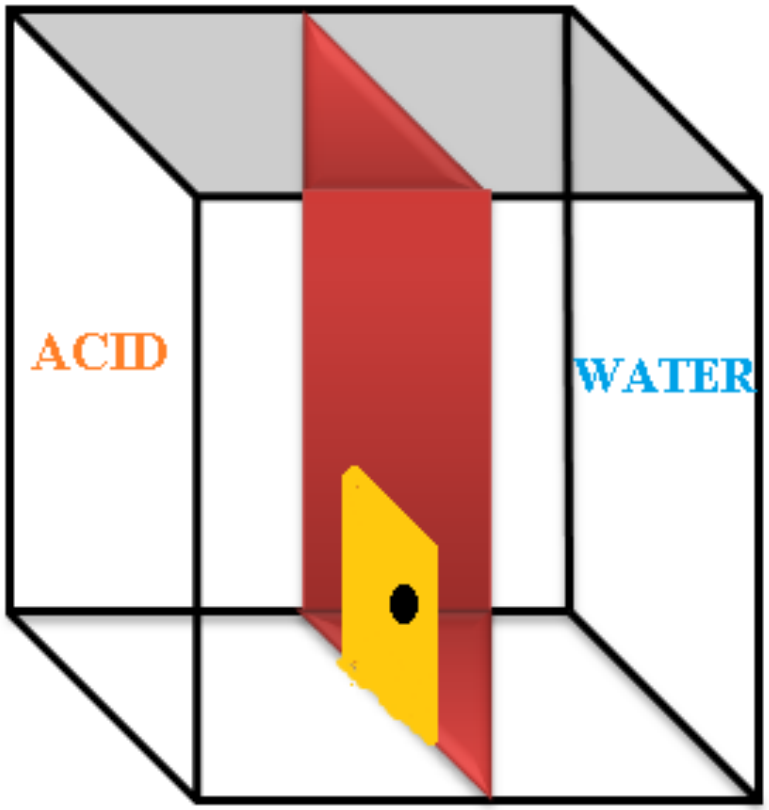
A tank with a square base of area 1.0 m^2 is divided by a vertical partition in the middle.

The bottom of the partition has a small-hinged door of area 20cm^2.

The tank is filled with water in one compartment, and an acid (of relative density 1.7) in the other, both to a height of 4.0 m.

compute the force necessary to keep the door closed.

schematic diagram



For the compartment containing water:

Height of water column, h = 4.0 m

Density of water, $\rho = 10^3 kg\ m^{-3}$

$\therefore$ Pressure due to water at the bottom of the partition,

$$P_{water} = h\rho g$$
$$= 4.0 \times 10^3 \times 9.8$$
$$= 39.2 \times 10^3\ Pa$$

For the compartment containing acid:

Height of acid column, h = 4.0 m

Density of the acid, $\rho' = 1.7 \times 10^3 kg\ m^{-3}$

$\therefore$ Pressure due to acid at the bottom of the partition,

$$P_{acid} = h\rho'\ g$$

$$= 4.0 \times 1.7 \times 10^3 \times 9.8$$

$$= 66.4 \times 10^3\ Pa$$

pressure difference causes unequal force

Now, $P_{acid} - P_{water} = 66.4 \times 10^3 - 39.2 \times 10^3$

$= 27.44 \times 10^3\ Pa$

This additional pressure must be acting on the connecting door from acid towards water

Also, area of the door, A= $20\ cm^2 = 20 \times 10^{-4} m^2$

Force on the door due to difference of their pressure on its two sides

$\therefore$ F = $(P_{acid} - P_{water}) \times A$

= $27.44 \times 10^3 \times 20 \times 10^{-4}$

= 54.88 N

Hence **the force necessary to keep the door closed =54.88N**

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