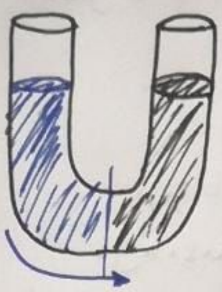
Phy 250

1.



Oil	Water
h = 25cm	h = 25cm
$\rho = 0,8$	$\rho = 1$

a) Barrier removed, what will be the height of the liquids?

$Density_w > Density_o$ so water will push oil up.

We know that:

Equilibrium $\rightarrow$ $P_w + \cancel{P_{atm}} = P_o + \cancel{P_{atm}} \rightarrow P_w = P_o$

$\Delta h \rightarrow$ $h_w - \Delta h = h_o + \Delta h$

$h_w \rightarrow 25cm$, $h_o \rightarrow 25cm$, $\Delta h \rightarrow ?$

$P_w = (25cm - \Delta h) \cdot \rho_w \cdot g$, $\rho_w \rightarrow 1$

$P_o = \Delta h \rho_w g + 25 \cdot \rho_o g$, $\rho_w \rightarrow 1$, $\rho_o \rightarrow 0'8$

$(25 - \Delta h)\rho_w g = \Delta h \rho_w g + 25 \rho_o g$

$25\rho_w \cancel{g} - \Delta h \rho_w \cancel{g} = \Delta h \rho_w \cancel{g} + 25 \rho_o \cancel{g}$

$25\rho_w - \Delta h \rho_w = \Delta h \rho_w + 25\rho_o$

$-2\Delta h \rho_w = (25 \cdot 0,8) - 25 \rightarrow 2\Delta h \rho_w = 5$

$\Delta h = \frac{5}{2\rho_w} = \frac{5}{2} = 2,5cm$

$$\boxed{\begin{array}{l} h_{oil} = 25 + 2,5 = 27,5cm \\ h_w = 25 - 2,5 = 22,5cm \end{array}}$$

b) using physical reasoning:

I) h if oil and w have same ρ?

If both had the same density the height won't change so it will be 25cm for both.

II) h if oil's ρ will be much smaller than water's

In this case the height of the watter will be bigger than the oil's, and the Δh will be obtained using the previous formula but with the $\Delta h \rho_0 g$ on the water's side.

2.

Knowing that $P = P_0 + \rho g h$ and $P = \frac{F}{A} \Rightarrow F = PA$

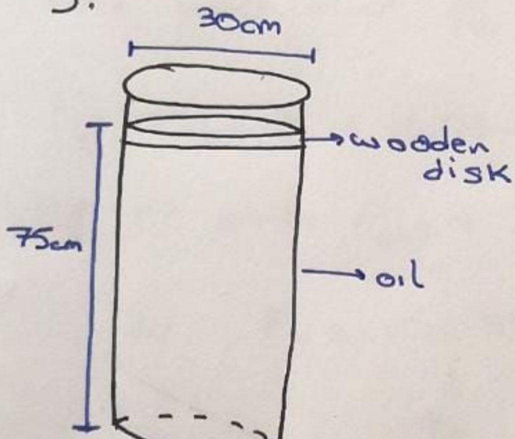
$$h = \frac{P - P_0}{\rho g h}$$

$\rho = 1{,}03 \times 10^3\ kg/m^3$

$A = \pi r^2$

$$h = \frac{\Delta F}{\rho g A} = \frac{1{,}5N}{1{,}03 \cdot 10^3 \cdot 9{,}8 m \cdot \pi \cdot (4{,}1 \cdot 10^3)} = \underline{2{,}8m \text{ of depth}}$$

3.



$\omega_{disk} = 45N \quad d = 30cm$

$\rho_{oil} = 0'850 g/cm^3 \quad h = 75cm$

a) P on the top of the column?

$A = \pi r^2 = \pi \cdot (0{,}15m)^2 = 0{,}0706 \simeq 0{,}07\ m^2$

Gauge pressure $\rightarrow P = \frac{F}{A} = \frac{45}{0'07} = 637 Pa$

b) Now weigh = 83N, change of pressure at bottom of the oil and halfway

$P = P_0 + \rho \cdot g \cdot h$

$\begin{cases} \text{Midway} = \frac{75}{2} = 37'5cm = 0{,}375m \\ \text{Bottom} = 75cm = 0{,}75m \end{cases}$

$P_0' = 83 / 0'07 = 1185{,}71\ Pa$ new pressure exerted by the disk

$P'_{mid} = 1185'71 + 0'85 \cdot 9'8 \cdot 0'375 = 1188'83$ | $\Delta P_{mid} = 548'71$

$P_{mid} = 637 + 0'85 \cdot 9'8 \cdot 0'375 = 640'12$

$P'_{bot} = 1185'71 + 0'85 \cdot 9'8 \cdot 0'75 = 1191'96$ | $\Delta P_{TOP} = 548'71$

$P_{bot} = 637 + 0'85 \cdot 9'8 \cdot 0'75 = 643'25$

$\boxed{\text{The pressure varies the same at bot and mid}}$

4

a) Fish remain floating at an acuarium, what does that tell about their density?

if the fish can move freely on the water that means that it's density has to be the same as the water.

b) if a fish of 2,75kg inflates (growing 10% vol) whats the net force exerted by the water?

We know that $\rho_w = 1030 kg/m^3$ and $\rho = \frac{m}{V} \Rightarrow m = \rho V$

$F_b = m_{fish} \cdot g = 2,75 \cdot 9'8 = 26'95 N$ (Before increasing vol)

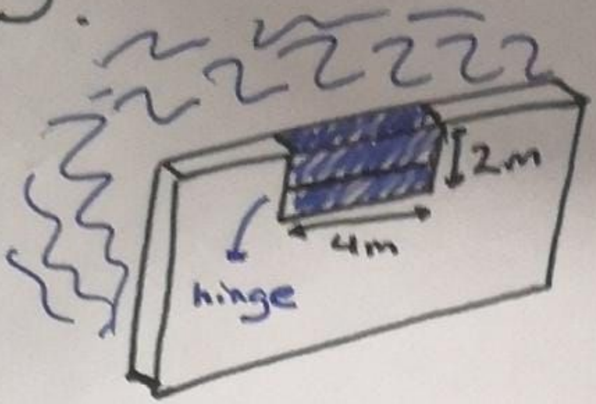
if $V\uparrow$ while $\rho_{cnt} \rightarrow$ $\Delta F_b = \rho_F g \, \Delta V = \rho_F g \, (1,1 - 1) = 0,1 \rho g$

So $F_b' = \underset{P_0}{\underset{\downarrow}{26'95}} + 0'1 \cdot 26'95 = \underline{\underline{29'645 N}}$

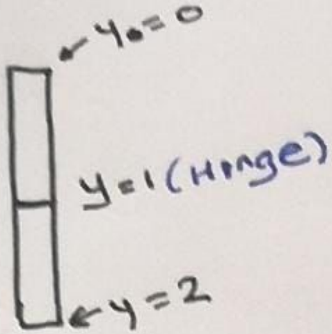
c) Net external force on it? Does the fish go down or up?

$F_{ext} = F_b - w = 29'645 - 26'95 = \underline{\underline{2'695 N}} > 0 \rightarrow$ goes up

5.



A gate hinged along the horizontal.
What's the torque due to the water?



Top part ↓ bottom part ↓

$$\text{torque} = \int_2^1 \rho g\, dy\, dA - \int_1^0 \rho g\, dy\, dA$$

$$\rho g \left[\frac{y^4}{4}\Big|_2^1 - \frac{y^4}{4}\Big|_1^0 \right]$$

$$\rho g \left[\frac{1}{4} - \frac{16}{4} + \frac{1}{4} \right] = 10 \times 1000 \times \frac{7}{82} = \underline{\underline{-35000}}$$