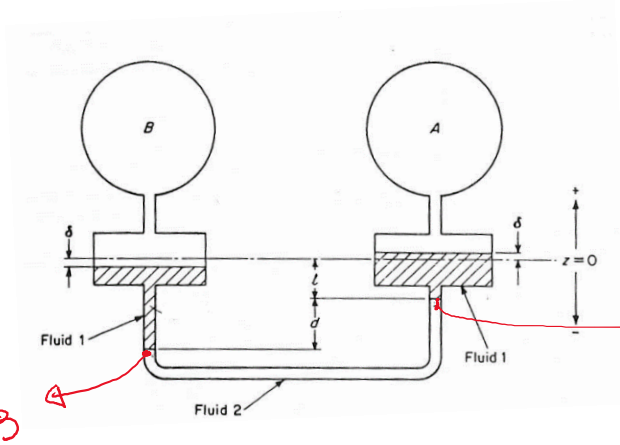
Date: Sep 1st 2017

Class Problem
ABE 307
Micro-Manometer

1. The micromanometer illustrated in figure below is a useful device for accurately measuring small pressure difference. If the densities of the two manometer fluids are nearly the same ($\rho_1 \approx \rho_2$), measurable values of the distance d can be obtained for very small values of the pressure difference, $P_B - P_A$. Letting A_1 be the cross-sectional area of the reservoirs, and A_2 be the cross-sectional area of the connecting tube, derive an expression for $P_B - P_A$ in terms of ρ_1, ρ_2, g, A_1, A_2 and d.



$$P_{2,A} = P_A + \rho_1 g (l + \delta)$$

$$P_{2,B} = P_B + \rho_1 g (l + d - \delta)$$

To eliminate $P_{2,A}$ and $P_{2,B}$, find relationship between $P_{2,A}$ & $P_{2,B}$

$$P_{2,B} = P_{2,A} + \rho_2 g d$$

$$\boxed{P_B - P_A = (\rho_2 - \rho_1) g d + 2\rho_1 g \delta}$$

↳ compared to one liquid here you have two measurable quantity. d & δ, d is easier to see.

Date:

There were two interesting questions on micromanometer in class today

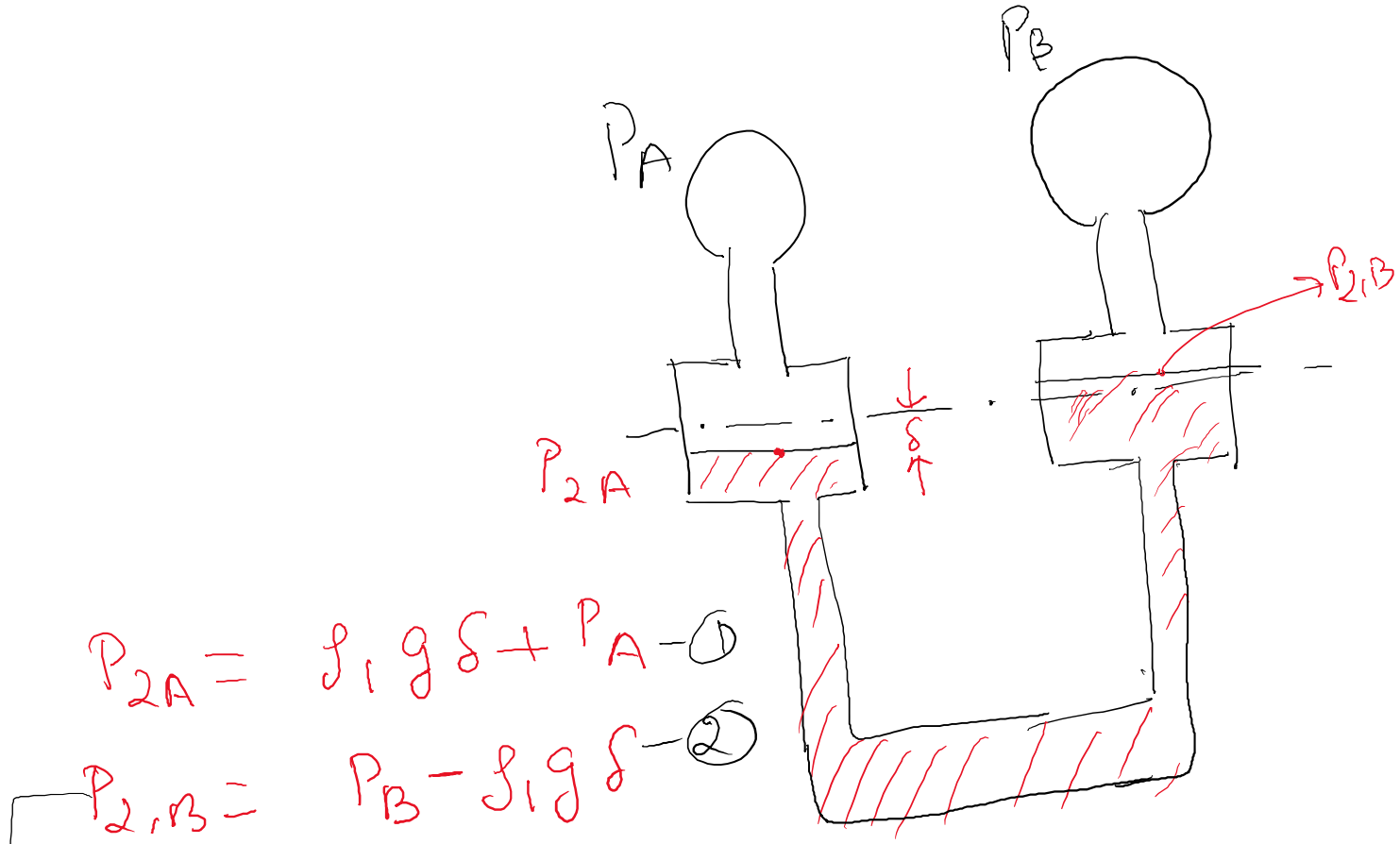
1. Why do we use two different liquids ?

2. Why should the density of two liquids be close i.e the density different is small.

Answer 1 : We use two different liquids to improve sensitivity, as you can derive the equation for using only liquid 1 and it will only be in terms of δ which will be difficult to observe while it will be easier to observe the interface of two liquids in terms of length d.

Answer 2 : The answer to this question is in the expression of P_B - P_A. for two different liquids written before. If you have liquids with large density difference, for same PB – PA you will have less d which will be difficult to observe. So keeping the density difference of liquids lower, increases the length "d" that you can easily observe for smaller pressure difference.

Hence, use of two liquids and liquids of similar density is to be able to have highly sensitive micromanometer.



$$P_{2A} = \rho_1 g \delta + P_A \quad -(1)$$

$$P_{2,B} = P_B - \rho_1 g \delta \quad -(2)$$

$$P_{2A} = P_{2B} + \rho_1 g \delta \rightarrow (3)$$

$$P_{2B} - P_{2A} - \rho_1 g \delta$$

from ① & ②

$$P_{2A} - P_{2B} = 2\rho_1 g\delta + (P_A - P_B) \quad -④$$

Date:

from ③

$$P_{2A} - P_{2B} = \rho_1 g\delta$$

Subtituting in ④

$$\rho_1 g\delta = 2\rho_1 g\delta + (P_A - P_B)$$

$$\Rightarrow \boxed{P_A - P_B = \rho_1 g\delta} \rightarrow \text{This was intuitive as well.}$$

But the equation with only one liquid only shows δ as measurable quantity

It will be difficult to read the liquid small displacement for small Pressure difference.