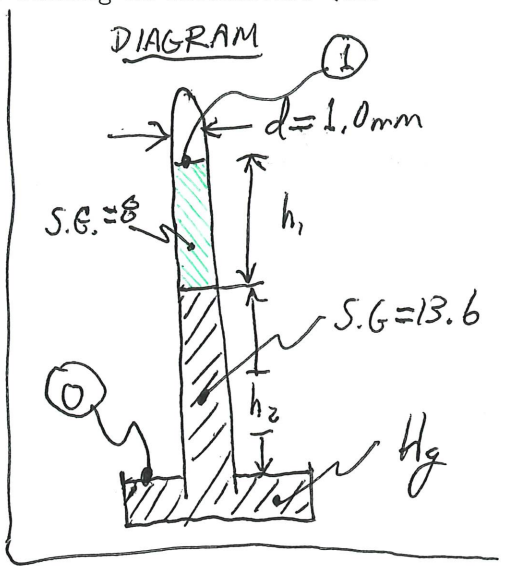
ANNOUNCED QUIZ #3 – ME 2030 –SECTION 001 – Fall 2024

SOLUTION

NAME: _____

**This is an open book quiz. A four-function calculator may be used. An unsigned honors pledge will result in a zero.**

1. Consider a barometer which utilizes two manometer fluids, mercury on the bottom, and a liquid with a specific gravity of 8 above it. The barometer tube has an internal diameter of 1.0 mm. The volume of the upper manometer fluid is 0.5 cubic centimeters. If the atmospheric pressure is one atmosphere, what is the barometer reading in centimeters (the total height of the combined manometer fluid column)?




GIVEN: d, ∀ of upper manometer fluid; S.G, $P_{atm}$

FIND: Reading in cm ($h_1 + h_2$)

ASSUME: $\rho, g$ are constant; vapor pressure of manometer fluid is zero; $\rho_{H_2O} = 1000\ kg/m^3$

ANALYSIS: $\frac{dp}{dz} = -\rho g \rightarrow \Delta p = -\rho g \Delta z$

$$P_0 = P_1 + \gamma_g h_1 + \gamma_{Hg} h_2$$

∀ of green fluid is $0.5\ cm^3$, so

$$0.5\ cm^3 = A h_1 = \frac{\pi d^2}{4} h_1 = \frac{\pi (0.1\ cm)^2}{4} h_1$$

So, $h_1 = 63.7\ cm$

$$101{,}325\ Pa = 0\ Pa + (8)(1000\ \tfrac{kg}{m^3})(9.81\ m/s^2)(0.637\ m) + (13.6)(1000\ \tfrac{kg}{m^3})(9.81\ m/s^2)(h_2)$$

Solving → $h_2 = 0.385\ m = 38.5\ cm$

$h_2 = 38.5\ cm$

So, barometer reading is $h_1 + h_2 = 63.7\ cm + 38.5\ cm = \boxed{102.2\ cm}$

Units Check

$$Pa \stackrel{?}{=} \frac{kg}{m^3}\frac{m}{s^2}m$$

$$\frac{N}{m^2} \stackrel{?}{=} \frac{kg}{m\,s^2}$$

$$\frac{kg\,m}{s^2\,m^2} \stackrel{\checkmark}{=} \frac{kg}{m\,s^2}$$

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

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SIGNATURE