CE 100 Midterm #1

Version C

September 25, 2024

UC Berkeley

Time: 50 minutes

Total Points: 100

99/100

Name Kyle Wong

Read all of the instructions below before starting the exam

1. Work in pencil (exams worked in pen will not be graded)
2. Show all of your work for the workout problems! It's much easier for me to give you partial credit if you clearly document all of your steps when solving a problem.
3. Remember to write your units in your answer!
4. Box your answers!
5. Be sure to read the instructions for each problem carefully.
6. Extra paper is available to show your work. Staple this paper to the back of your test.

Sign the honor statement below after finishing the quiz

As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others. I have neither given nor received help on this work, nor am I aware of any other student giving or receiving help on this work.

Signature Kyle Wong

Question 1 - True/False (10 points, 1 point each)

9 $Y_R = \frac{I_{xxc}}{Y_c A} + Y_c$

True The depth of the center of pressure of a panel (y_R) is always greater than the depth of the centroid of the panel (y_c)

False The x-coordinate of the center of pressure of a panel (x_R) is always located at the centroid of the panel (x_c)

True The center of buoyancy is always located at the center of mass of the submerged part of the body

False The fluid pressure on a panel is always uniform over the panel

False The total force due to fluid pressure acting on a panel always acts through the centroid of that surface

$P_{abs} = P_{gage} + P_{atm}$

True The gage pressure at a point is always less than the absolute pressure at the same point

True Forces due to pressure act perpendicular to surfaces in contact with the fluid

False The total force due to pressure on a curved surface is equal to the horizontal force due to pressure on the projection of the curved surface

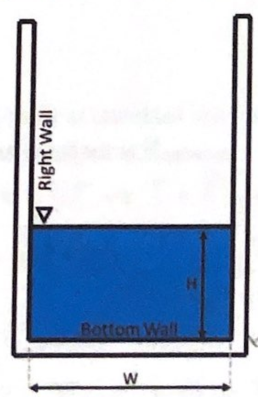
True In a closed system, a pressure change produced at one point in the system will be transmitted throughout the entire system

False Pressure is constant in the horizontal for a hydrostatic fluid of constant density -1

varies linearly with depth

Question 2 (5 points) 5

A container has width W and length L into page. It is filled with water to depth H. Select ALL of the true statements regarding force due to water pressure acting on parts of the well.



Doubling H → A
A right wall = H·L or H·W
→ A = 2HL or 2HW
P = γh → P = γ2H
Bottom Area always same →
Pressure at bottom doubles
L
Side Area double → P = 4x P_i

A. Doubling H doubles the force due to water pressure on each of the container's four walls
B. Doubling H doubles the force due to water pressure on the bottom of the container
C. Doubling H quadruples the force due to water pressure on each of the containers four walls
D. Doubling H quadruples the force due to water pressure on the bottom of the container

Question 3 (5 points)

5

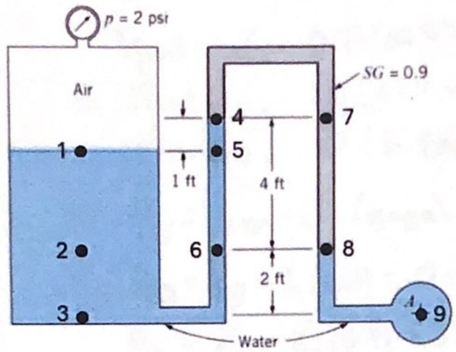
An inverted U-tube manometer containing a fluid with SG = 0.9 is located between a tank and a pipe, both containing water. The tank on the left is closed and pressurized to 2psi.

$SG = \gamma/\gamma_w \rightarrow \gamma = 0.9\gamma_w$

ASSUME: $\rho_w = 1000\ kg/m^3$

$\gamma_w = \rho_w g = 9810\ N/m^3$

$\gamma_w = 62.4\ lb/ft^3$



$P_1 = 2psi$

$P_2 = P_1 + \gamma_w (3ft)$

$P_3 = 2psi + \gamma_w (5ft)$

$P_1 = P_5 = 2psi$

$P_5 = P_4 + \gamma_w (1ft) \rightarrow P_4 = P_5 - \gamma_w$

$P_4 = P_7 = P_5 - \gamma_w (1ft)$

$P_8 = P_7 + 0.9\gamma_w (4ft)$

$P_9 = P_8 + \gamma_w (2ft)$

$P_9 = P_7 + 3.6\gamma_w + 2\gamma_w$

$P_9 = P_5 - \gamma_w (1ft) + 5.6\gamma_w$

$P_9 = 2psi - 4.6\gamma_w$

$P_9 \neq P_3$

Select ALL of the true statements below

A. $P_3 = P_9$
B. $P_4 = P_7$
C. $P_7 > P_8$
D. $P_6 > P_5 > P_4$
E. $P_1 = 0$
F. $P_3 > P_2 > P_1$
G. $P_1 = P_5$
H. $P_2 = P_6$
I. $P_6 = P_8$

Question 4 (5 points)

5

Air (Molar mass = 29 g/mol = 0.029 kg/mol) at standard sea level pressure (p = 101.3 kN/m^2) has a density of 1.00 kg/m^3. The universal gas constant is $R_{universal}$ = 8.31 m^3·Pa·mol^{-1}·K^{-1}. What is the temperature?

$PV = nRT \rightarrow T = PV/nR$

$\frac{n}{V} = 1.00\ kg/m^3 \left(\frac{1000 g}{1 kg}\right)\left(\frac{1 mol}{29 g}\right)$

$\frac{n}{V} = 34.483\ mol/m^3$

$\frac{V}{n} = 0.029\ m^3/mol$

(a) 0 °C
(b) 22 °C
(c) 81 °C
(d) 354 °C

$T = \frac{101.3 \cdot 10^3\ Pa\ (0.029\ m^3/mol)}{(8.31\ m^3 \cdot Pa \cdot mol^{-1} \cdot K^{-1})}$

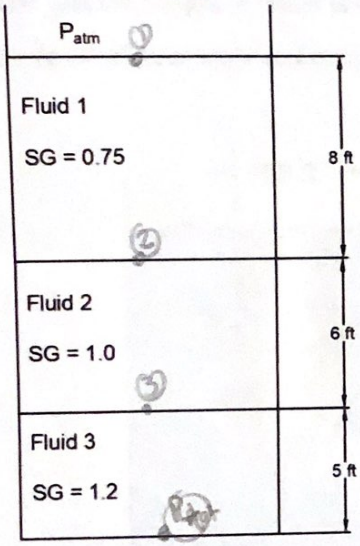
$T = 353.514\ K$

$T°C = T - 273.15 = 80.36°C \approx 81°C$

Question 5 (5 points) (5)

A tank is open to the atmosphere and contains three layers of fluid as shown. Calculate the gage pressure at the bottom of the tank

(a) 7.8 psi
(b) 18.0 psi
(c) 32.7 psi
(d) 56.1 psi



$\gamma_w = 62.4\ lb/ft^3$

Fluid 1: $\gamma_1 = 0.75(62.4\ lb/ft^3) = 46.8\ pcf$

Fluid 2: $\gamma_2 = 1.0(62.4\ pcf) = 62.4\ pcf$

Fluid 3: $\gamma_3 = 1.2(62.4\ pcf) = 74.88\ pcf$

$P_1 = P_{atm} = 0$ (gage)

$P_2 = P_1 + \gamma_1(8ft) = 0 + 46.8\ pcf(8ft) = 374.4\ psf$

$P_3 = P_2 + \gamma_2(6ft) = 374.4\ psf + 62.4\ pcf(6ft) = 748.8\ psf$

$P_4 = P_3 + \gamma_3(5ft) = 748.8\ psf + 74.88\ pcf(5ft) = 1123.2\ psf$

$P_4 = 1123.2\ \frac{lb}{ft^2}\left(\frac{1ft}{12in}\right)^2 = 7.8\ psi$

Question 6 (30 points) (30)

A 1-ft diameter, 2-ft long cylinder floats in an open tank containing a liquid with an unknown specific weight. A U-tube manometer is connected to the tank as shown in the figure below. When the pressure in pipe A is 0.1 psi below atmospheric pressure (-0.1 psi gage pressure), the various fluid levels are as shown.

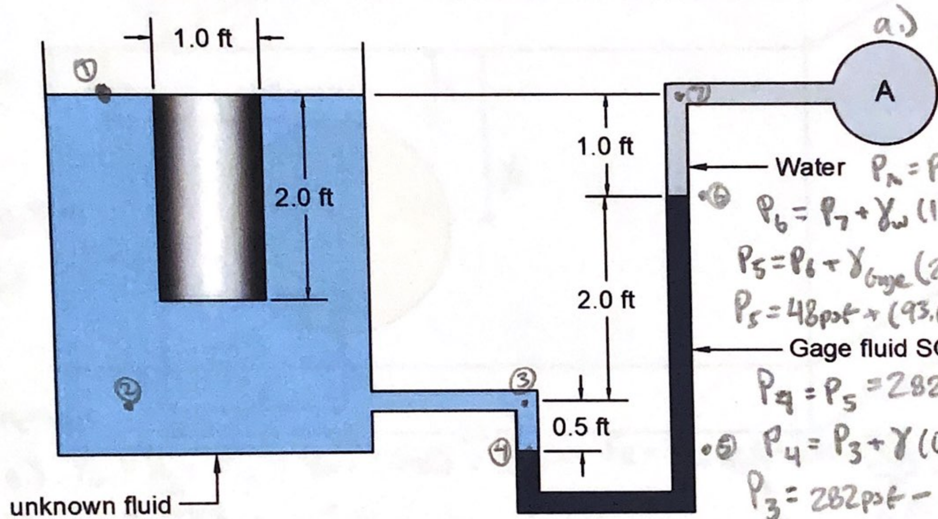
$\gamma_w = 62.4$ pcf

A. Determine the specific weight of the unknown fluid
B. Determine the weight of the cylinder

$\gamma_{Gage} = 1.5(62.4 \text{ pcf}) = 93.6$ pcf

The specific weight of water is 62.4 lb/ft³

Show all of your work and box your final answers. Pay attention to the units of the given values.



a.) $P_A = -0.1$ psi

$-0.1 \text{ lb/in}^2 \left(\frac{12 \text{ in}}{1 \text{ ft}}\right)^2 = -14.4$ psf

$P_A = P_7 = -14.4$ psf

$P_6 = P_7 + \gamma_w (1\text{ft}) = -48$ psf

$P_5 = P_6 + \gamma_{Gage}(2.5\text{ft})$

$P_5 = 48 \text{ psf} + (93.6 \text{ pcf})(2.5\text{ft}) = 282$ psf

$P_4 = P_5 = 282$ psf

$P_4 = P_3 + \gamma(0.5\text{ft})$

$P_3 = 282 \text{ psf} - \gamma(0.5\text{ft})$

$P_3 = P_2, \; P_2 = P_1 + \gamma(3\text{ft}), \; P_1 = P_{atm} = 0$

$P_2 = 0 + \gamma(3\text{ft}) = 282 \text{ psf} - \gamma(0.5\text{ft})$

$\gamma(3.5\text{ft}) = 282 \text{ psf} \rightarrow \boxed{\gamma = 80.571 \text{ pcf}}$ ✓

b.) ASSUME: Cylinder is floating → Equilibrium → $W = F_B$

$W = \gamma V_{Displaced}$ $\quad V_{Displaced} = Ah = \pi r^2 h = \frac{\pi}{4} d^2 h = \frac{\pi}{4}(1\text{ft})^2(2\text{ft}) = 1.571 \text{ ft}^3$

$W = 80.571 \text{ pcf}(1.571 \text{ ft}^3) = \boxed{126.561 \text{ lbs}}$ ✓

Question 7 (40 points) 40

A tank of water has a circular panel installed on the side, shown as a shaded region in the figure below. The diameter of the circle is 12 m and A = 10 m. The centroid of a circle is located in the middle of the circle.

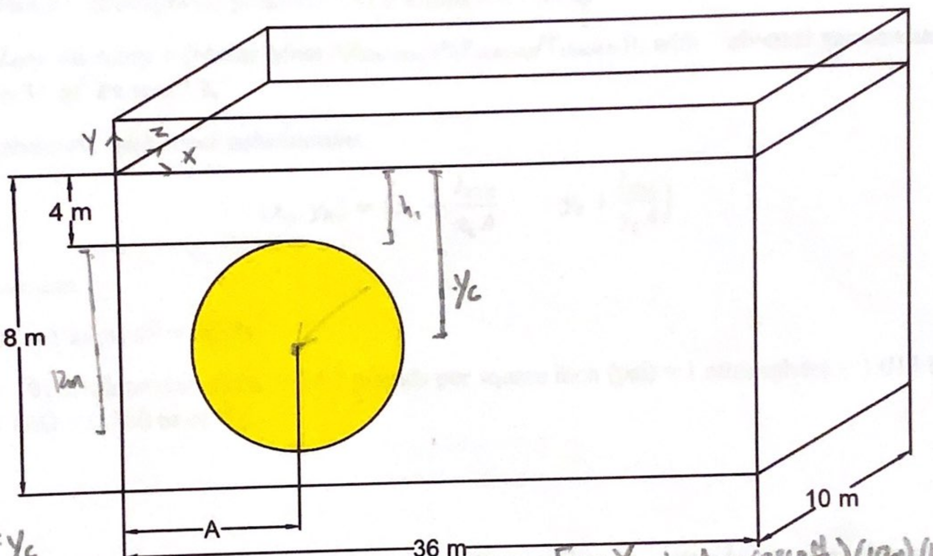
Assume: constant density ($\gamma = 9810\ N/m^3$)
Non-moving fluid

A. Determine the magnitude of the force on the panel, F_R

B. Determine the depth of the point of application on the panel, y_R

C. If the distance from the wall to the center of the circle was A = 15 m instead, how would this change your answers for A and B? Explain your answer in 1-2 sentences

Assume:
$\rho_w = 1000\ kg/m^3$
$\gamma_w = \rho_w g$
$\gamma_w = 1000\frac{kg}{m^3} \cdot 9.81\ m/s^2$
$\gamma_w = 9810\ N/m^3$



Vertical!: $h_c = y_c$

a.) $y_c = h_1 + d/2 = 4m + (12m/2) = 10m \rightarrow F_R = \gamma_w h_c A = (9810\frac{N}{m^3})(10m)(113.097m^2)$

$\boxed{F_R = 11.095\ MN}$

b.) $y_R = \frac{I_{xx_c}}{y_c \cdot A} + y_c$

Area of Circle $= \pi r^2 = \pi(12m/2)^2 = 113.097m^2$

$I_{xx_c} = \frac{\pi r^4}{4} = \frac{\pi(12m/2)^4}{4} = 1017.876m^4$

$y_R = \frac{(1017.876m^4)}{(10m)(113.097m^2)} + (10m) \Rightarrow \boxed{y_R = 10.9m}$

C.) If the horizontal distance from the wall to the center of the circle changed from A=10m to A=15m, my answers would not change for A and B. The hydrostatic pressure which gave me my resultant force and point of application are dependent on the depth of the circle in the fluid, which does not change when the horizontal distance is changed. While this would potentially affect the X-coordinate of my center of pressure (x_R), it does not alter F_R or y_R.