

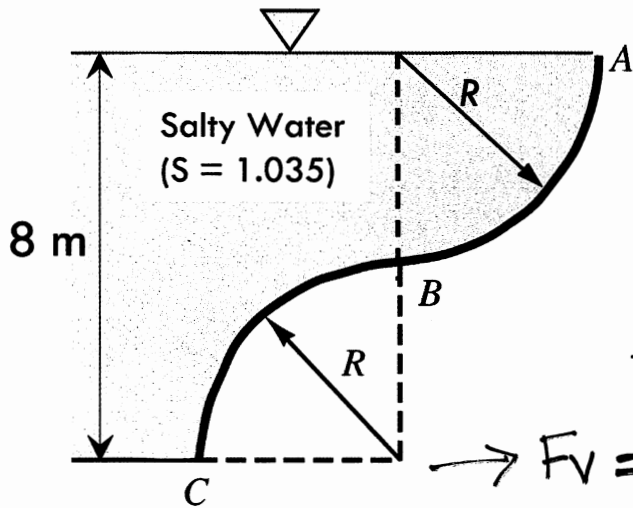
Florida International University
CWR 3201 Fluid Mechanics, Fall 2023
Mid-term # 1

Instructor: Arturo S. Leon, Ph.D., P.E., D.WRE

Student Name: Arturo Leon **Panther ID:** _____

- ✓ You will have 1 h 15 minutes to complete the exam. The exam is closed book and closed notes.
- Only one page (front and back) with handwritten equations are allowed

1. (40 points). Determine the **horizontal** and **vertical** forces of the liquid (salty water) acting on the curved gate ABC . The radius R is 4 m and the curved gate width, measured perpendicular to the figure below, is 5 m.

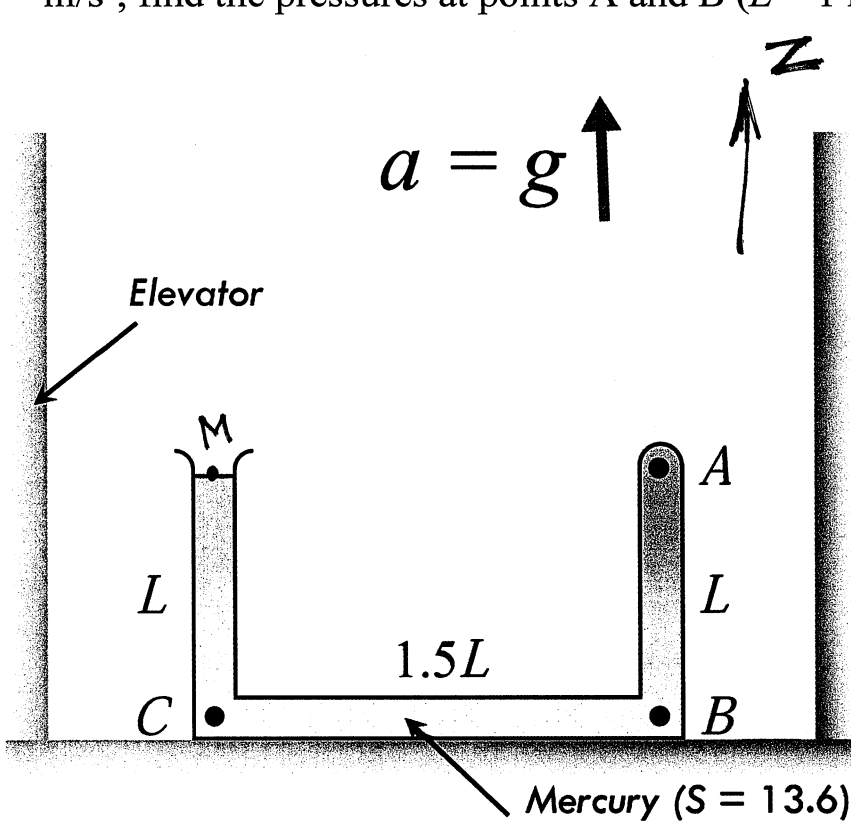


$\rightarrow F_H = \gamma \bar{h} A$ $\bar{h} = \frac{8}{2} = 4\text{m}$
 $A = 8 \times 5 = 40\text{m}^2$

$F_H = 1.035 \times 9800 \times 4 \times 40$
 $F_H = 1,622,880\text{ N}$
 $F_H = 1,622\text{ kN}$

$\rightarrow F_V = \gamma \text{Volume}$ $\text{Vol} = 4 \times 8 \times 5 = 160$
 $F_V = 1.035 \times 9800 \times 160$
 $F_V = 1,622\text{ kN}$

2. (30 points) In the figure below, a U-tube contains mercury and is placed inside an elevator. If the elevator is accelerated vertically upward with an acceleration of 9.8 m/s^2 , find the pressures at points A and B ($L = 1 \text{ m}$).



$$dp = -\rho a_x dx - \rho(a_z + g) dz$$

$$a_z = +g$$

$$dp = -\rho(9+9) dz$$

$$dp = -2g\rho dz$$

Between A and M

$$P_A - P_M = -2g(13.6 \times 1000)(z_A - z_M)$$

$$P_A = P_M = 0$$

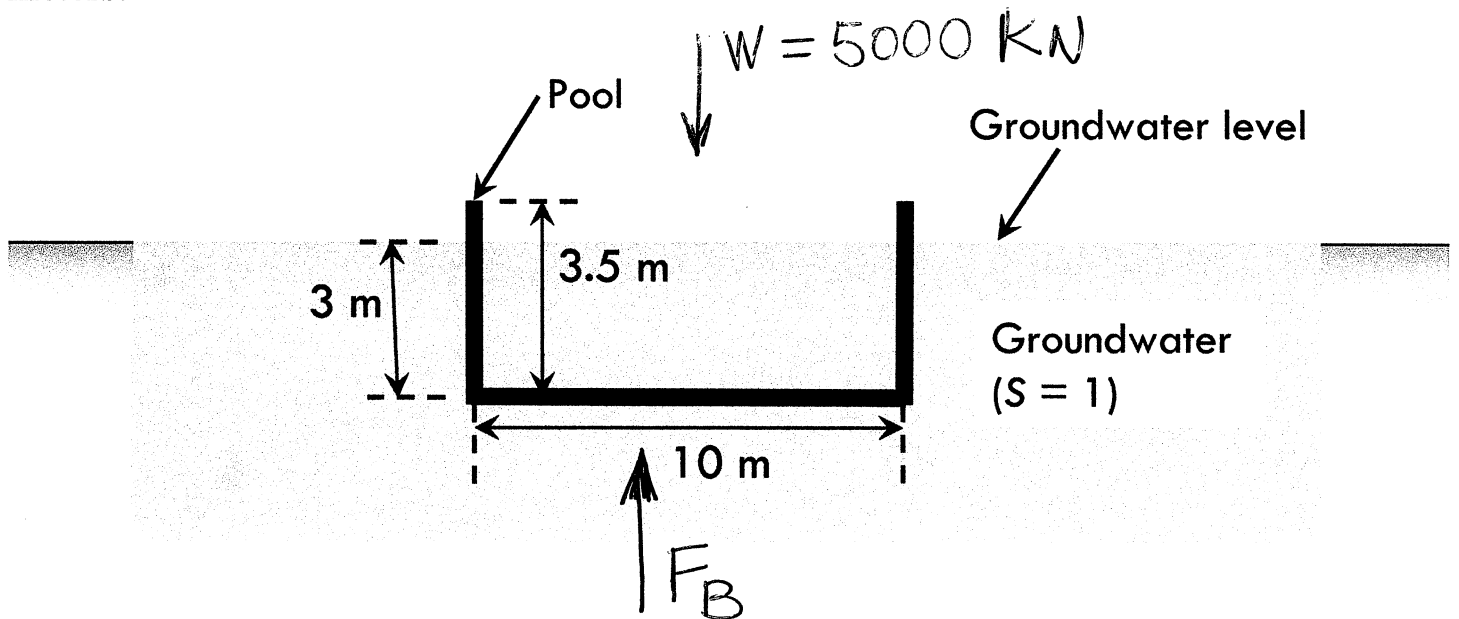
Between A and B

$$P_B - P_A = -2g(13.6 \times 1000)(z_B - z_A)$$

$$P_B = -2 \times 9.8 \times 13600 \times (0 - 1)$$

$$P_B = 266,560 \text{ Pa}$$

3. (30 points) The pool, depicted in the cross-section below, has been constructed using a combination of concrete and recyclable plastic materials. The total weight of the pool empty is 5000 kN. If the pool is empty, will the groundwater cause the pool to lift out of the ground? Justify your answer with calculations. The groundwater density is 1000 kg/m³ ($S = 1.0$). The width of the pool, measured perpendicular to the illustration, is 20 meters.



$$F_B = \gamma_{\text{submerged}} = 9800 \times 3 \times 10 \times 20$$

$$F_B = \underline{5,880 \text{ kN}}$$

$$W = \underline{5000 \text{ kN}}$$

$F_B > W$ [Thus, the groundwater will cause the ^{empty} pool to lift out of the ground.]