1. (20 points) An object is constructed of a material lighter than water. It weighs 50 N in air and a force of 10 N is required to hold it under water. What is its density, specific weight, and specific gravity?
2. (20 points). Find the force $P$ needed to hold the 3-m-wide rectangular gate as shown below if $l = 5$ m

$$F = \gamma \frac{1}{2} l \sin 40^\circ \times 3l \Rightarrow F \times \frac{l}{3} = (l + 2)P \sin 40^\circ.$$  
$$0.9810 \times 5^3 = 2(5 + 2)P$$
$$P = 87600 \text{ N}$$
3. **(30 points)** What force $P$ is needed to hold the 10-m-wide gate shown in the figure below closed?

![Circular gate diagram]

**Place the resultant force at the circular arc center.** $F_H$ passes thru the hinge, so $P = F_V$. Use the water that could be contained above the gate, it produces the same distribution and hence the same $F_V$.

$$ P = F_V = \gamma \text{Volume} $$

$$ P = 9810 \left( 6 \times 3 \times 10 + \frac{\pi \times 3^2 \times 10}{4} \right) $$

$$ P = 1'459,228 \text{ N} $$

$$ P = 2459.2 \text{ kN} $$
4. **(30 points)** The tank shown in the figure below is accelerated to the right at 10 m/s². If the tank is 4 meters wide, find the force acting on the wall AB.

The air volume is the same before and after:

\[
\tan \alpha = \frac{10}{9.81} \quad \alpha = 45.5°
\]

\[
\tan 45.5° = \frac{h}{b}
\]

\[
0.5 \times 8 = \frac{bh}{2} \quad \Rightarrow \quad 4 = \frac{h \times h}{\tan 45.5° \times 2}
\]

\[
h = 2.856 \text{ m}
\]

Because \( h > 2.5 \), air-water surface will look like (2):

\[
0.5 \times 8 = w \times 2.5 + \frac{2.5 \times 2.5}{2} \tan \alpha
\]

\[
w = 0.374 \text{ m}
\]

Note in the figure above that \( P_H = 0 \). To calculate the force on the wall AB, we can relate the pressures on the wall AB to point H.
\[ dp = -p_a x \, dx - p g dz \]  
\[ \alpha = 0 \]

\[ P_z - P_H = -p(10)(X_z - X_H) - p \times 9.81 \times (Z - 0) \]

\[ P_z = -10000 \left( 0 - 7.626 \right) - 9810 \, Z \]

\[ P_z = \boxed{76260 - 9810Z} \]

\[ F_{AB} = \int_0^{2.5} P_z \, dA \]

\[ dA = b \, dz \]

\[ F_{AB} = \int_0^{2.5} (76260 - 9810Z) \, 4 \, dz \]

\[ F_{AB} = 305040 \, Z - 39240 \frac{Z^2}{2} \bigg|_0^{2.5} \]

\[ F_{AB} = 639975 \, N = 640 \, kN \]