Water Pressure & Pressure Forces

Chapter 2 - STUDENT OUTCOMES

1. Understand the difference between **absolute pressure** and **gage pressure**.
2. Recognize **surfaces of equal pressure** and their use in determining **manometry pressure**.
3. Explain how **hydrostatic forces** on flat and curved surfaces are obtained.
4. Define the concept of **buoyancy**.
5. Describe the concept of **flotation stability**.
6. **Calculate solutions to various problems that involve these pressure concepts.**

Pressure Concepts and Definitions

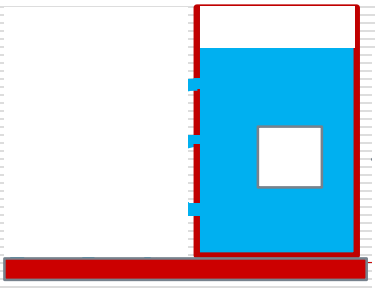
Atmospheric Pressure: The weight of the atmospheric column of gases divided by the area upon which it acts.
(At sea level and normal conditions: 1.014 x 10^5 N/m^2 (Pa) = 1 bar)

Free Surface of Water: Water placed in a container seeks a horizontal surface minimizing its position (potential) energy. ("Water seeks its own level!")

Pressure Variation in a Static Fluid

Three holes are drilled in the container below. Will water shoot out the same distance? Why or why not?

Concept: All surfaces in a static fluid are subject to normal (pressure) forces, but not shear forces since there is no fluid motion. Recall that $\tau = \mu(dV/dy)$, but $(dV/dy) = 0$.



Note: Pressure varies with depth!

Pressure Variation in a Static Fluid

Sum forces along the x-axis:

But L(sinθ) = h, thus simplifying

If A and B are at the same elevation?

What if A is at the water surface?

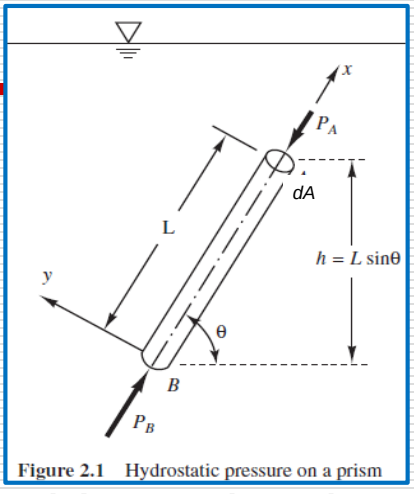


Figure 2.1 Hydrostatic pressure on a prism

Pressure gages measure pressure above or below atmospheric. Thus,

Surfaces of Equal Pressure

Identify equal pressure surfaces (ES) in the figure below.

Equal pressure surfaces must: **1)** ____ **2)** ____ **3)** ____

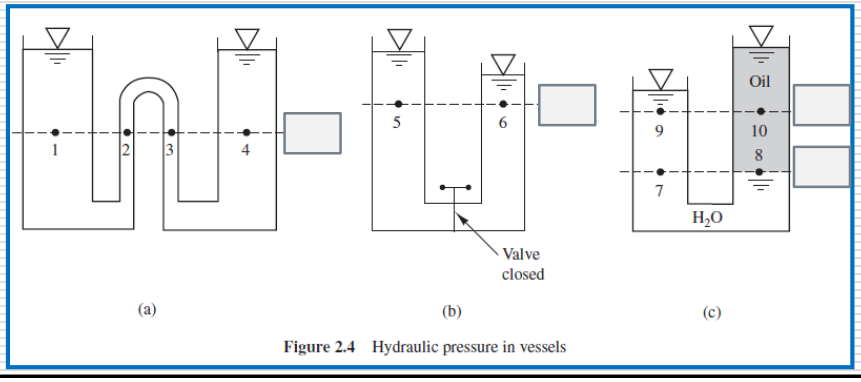
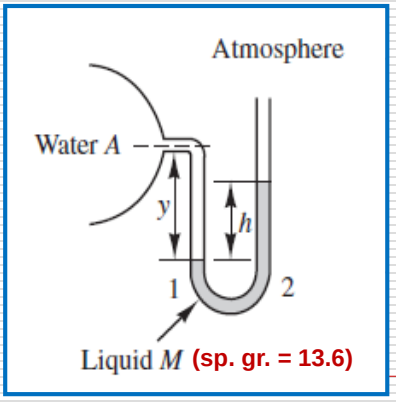


Figure 2.4 Hydraulic pressure in vessels

Manometer Applications

(Example Problem – Solve on White Board)

Find the pressure in the water pipe (P_A) if y = 8cm, h = 6cm, and M is mercury.

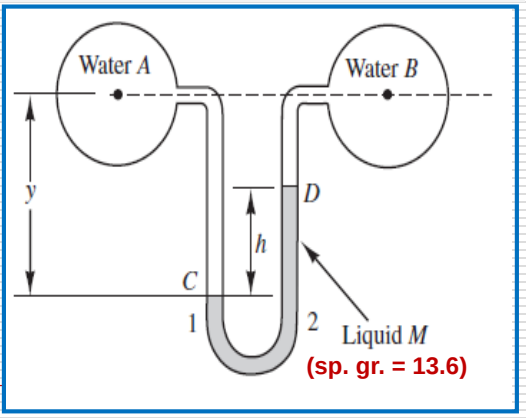


Note: Some people prefer the "swim-through" technique over the technique in the book.

Differential Manometers

(Example Problem – Solve on White Board)

Find the pressure in pipe A (P_A) if P_b = 30 kPa, y = 20cm, h = 10cm, and M is mercury. Note: 1 kPa = 1,000 N/m^2



Note: Some people prefer the "swim-through" technique over the technique in the book.

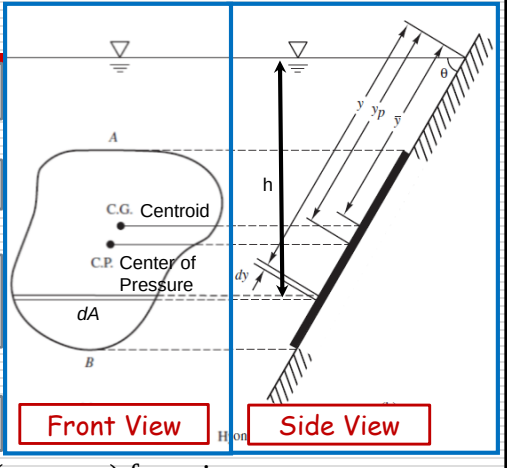
Hydrostatic Forces on Flat Surfaces

Find pressure on strip *dA* :

Pressure force on strip *dA*?

Pressure Force on area AB?

$\int_A y\, dA = \bar{y}A$ (first moment of area)



The location of this hydrostatic (pressure) force is:

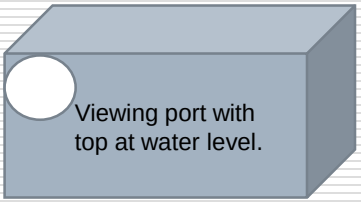
Purpose (of finding hydrostatic forces): **Moment Calculations**

Hydrostatic Force Example Problems

1) A swimming pool is 75 ft long, 30 ft wide, and 5 ft deep. Find the hydrostatic force on the bottom of pool.
2) Find the force on the 30-ft-wide wall and its location.

Hydrostatic Force Example Problems

3) Find the force (and its location) on a 2-ft-diameter coach's viewing port on the side of the pool.



Homework Problems: