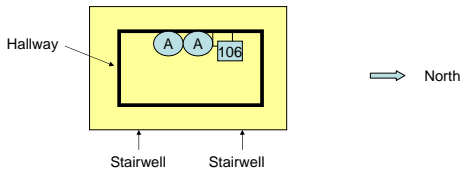


Temporary Class Room Change

- Starting Jan 14 thru Jan 23 (W,F,W,F)
- B106 JFSB (Joseph F. Smith Bldg.)
 - Northwest corner
- New sound system in 254 CB



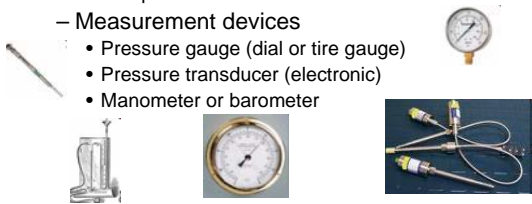
Class 4

1. Definitions
2. Gauge Pressure
3. Pressure and Height of Liquid Column (Head)
4. Pressure Measurement and Manometers

1. Definitions

Pressure: Force per area

- Units of N/m^2 , lb_f/in^2 (i.e., psi), etc.
- Force usually caused by a fluid (gas or liquid)
 - Gravity
 - Change in temperature (constant volume)
 - Pump
- Measurement devices
 - Pressure gauge (dial or tire gauge)
 - Pressure transducer (electronic)
 - Manometer or barometer



Atmospheric Pressure

Definition: The local pressure of the atmosphere or the pressure of the surrounding air

- Can be thought of as the pressure at the base of a column of air
- Decreases with increase in elevation
- Ambient pressure is the same as atmospheric pressure (used interchangeably)
- **Atmospheric or Ambient Pressure is not necessarily 1 atm!** (only true at sea level)
 - In Provo, $P_{amb} \approx 12.6$ psia

What Does the Weatherman Report as Atmospheric Pressure?

- Normalized to remove effect of altitude!

$$P_{sea} (in. Hg) = P_z (in. Hg) + \frac{z(ft)}{1000}$$

↑ reported ↑ actual

- The Clyde Building is at 4657 feet above sea level
 - Provo Airport is at 4495 feet
- Correction factor = $4657/1000 = 4.657$ in. Hg
- Current reading on weather.com = 30.51 in. Hg

Work Example

2. Gauge vs. Absolute Pressure

- **Absolute pressure**- the pressure relative to a perfect vacuum (no molecules present)
- **Gauge pressure**- the pressure relative to the ambient or atmospheric pressure at the measurement point

$$P_{gauge} = P_{absolute} - P_{ambient}$$

- psig = lb_f/in^2 gauge pressure
- psia = lb_f/in^2 absolute pressure

Gauge vs. Absolute Pressure

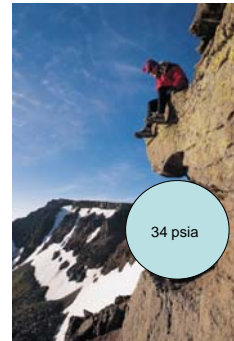
$P_{\text{amb}} = ?$



What is the gauge pressure of the spherical container?

Gauge vs. Absolute Pressure

$P_{\text{ambient}} = 11 \text{ psia}$



What is the gauge pressure of the spherical container?

Gauge vs. Absolute Pressure

- How can the gauge pressure change when the absolute pressure remains the same?
- What does a tire pressure gauge read when the bike tire is totally flat?
- What is the absolute pressure inside of a flat tire?
- In a pressurized gas bottle, what does the gauge read when it is empty?

Gauge vs. Absolute Pressure

- This type of pressure gauge only measures a pressure difference! (usually)

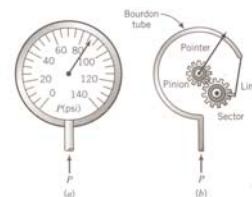


FIGURE 3.4-3 Bourdon gauge.

3. Pressure Head



$$P = P_0 + \rho gh$$

- Weight of the fluid produces a force (pressure is highest at the bottom- Why?)
- Force/Area provides the pressure
- The pressure at the bottom does not depend on the diameter of the column (height only) Why?
- Any pressure can be expressed as an equivalent height of a liquid (called a Pressure Head, P_h) with units of length

Pressure Head

- Use Eq. 3.4-2 to calculate P_h for a column of Hg (SG = 13.6) that is equivalent to 1 atm.
- Repeat the above calculation for H₂O.

This is why we can have units such as mm Hg or ft H₂O for a pressure, even though this is not strictly a force per unit area!

Table in front of book

Pressure | 1 atm = $1.01325 \times 10^5 \text{ N/m}^2 \text{ (Pa)}$ = 101.325 kPa = 1.01325 bar
 = $1.01325 \times 10^6 \text{ dynes/cm}^2$
 = 760 mm Hg at 0°C (torr) = 10.333 m H₂O at 4°C
 = 14.696 lb_f/in.² (psi) = 33.9 ft H₂O at 4°C
 = 29.921 in. Hg at 0°C

4. Pressure Measurement- Manometers

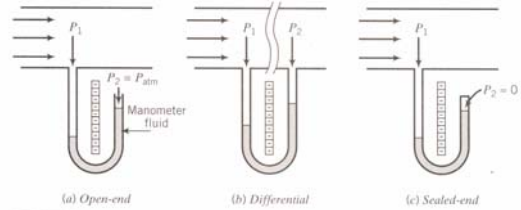
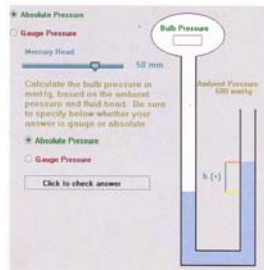


FIGURE 3.4-4 Manometers.

(Barometer)

Pressure Measurement- Manometers

- **Principle:** Any two points at the same height in a static continuous fluid must be at the same pressure.
- Otherwise, the column height would move!
- Where does this apply?



Pressure Measurement- Manometers

- **Procedure**
 - Draw a horizontal line at the level where the same type of fluid exists in both arms of the tube (i.e., points a and b in Fig. 3.4-5)
 - Add up the pressures on the left
 - Add up the pressures on the right
 - Set the two equal and rearrange to solve for the unknown pressure

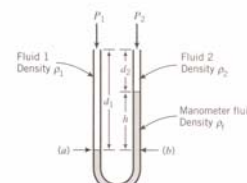


FIGURE 3.4-5 Manometer variables.

Note: forces must be used if the area isn't constant

Manometer Practice Problems

- See Eqns. 3.4-5, 6, & 7
- Example: Problem 3.40
- Practice: Problem 3.42 (if time permits)

Pressure Measurement- Manometers

Practice on the Web!! Interactive Applications are available.

