Today, we will:

- Continue Chapter 3 – Pressure and Fluid Statics
- Discuss applications of fluid statics (barometers and U-tube manometers)
- Do some example problems (manometers)

D. Applications of Fluid Statics

1. Mercury barometer

2. “Head” as a pressure measurement

3. The U-tube manometer

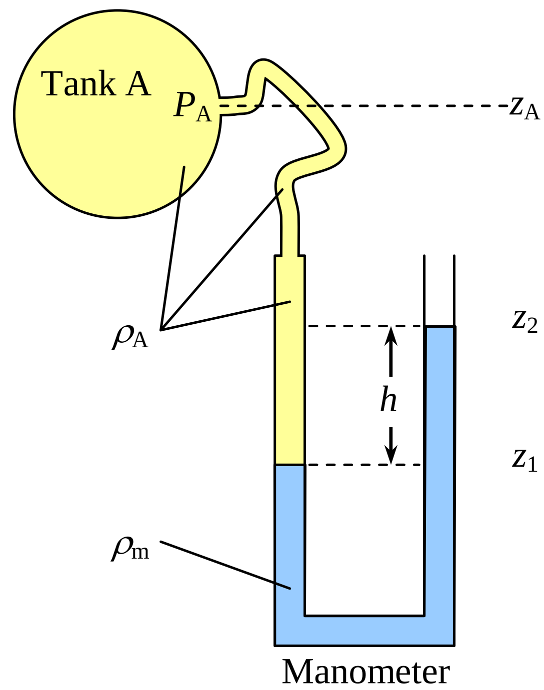
Purpose:

Example: Pressure measurement with a U-tube manometer

Given: A U-tube manometer is used as an instrument to measure the pressure in a tank. The right leg of the manometer is open to atmospheric pressure.

(*a*) To do: Calculate the absolute and gage pressure P_A and $P_{A,gage}$ for the general case in which ρ_A is not small compared to ρ_m.

(*b*) To do: Simplify for the case in which $\rho_A << \rho_m$ (e.g., A is air and m is mercury).



Solution:

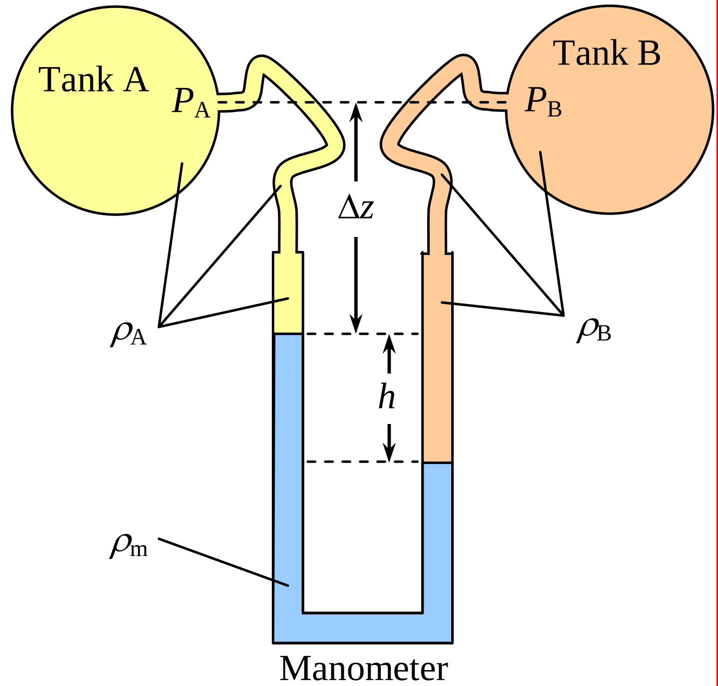
Example: Pressure measurement with a U-tube manometer

Given: A U-tube manometer is used as a differential pressure measurement instrument to measure the pressure difference between two tanks. The two tanks are at the same elevation.

(*a*) To do: Calculate the pressure difference $P_B - P_A$ for the general case in which ρ_A is not the same as ρ_B (they are different fluids.

(*b*) To do: Simplify for the case in which $\rho_A = \rho_B$ (they are the same fluid).

Solution:



4. Some Notes about Manometry [from pdf file on website]

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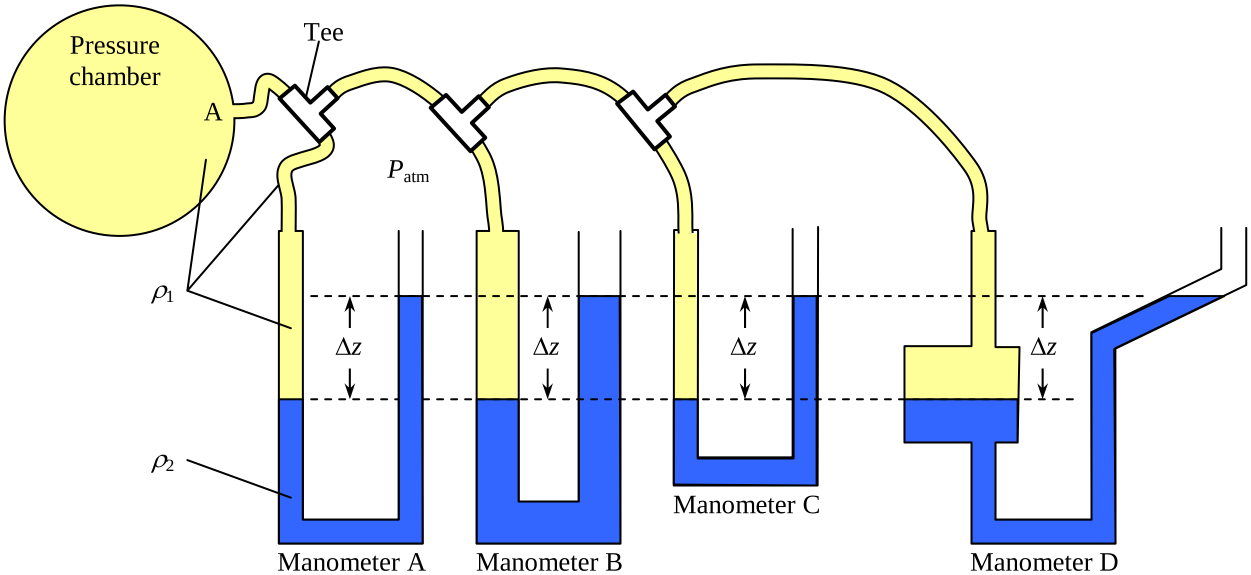
The elevation difference Δ*z* in a U-tube manometer does *not* depend on the following:

1. **U-Tube diameter** (provided that the tube diameter is large enough that capillary effects are negligible). In the sketch below, for a given pressure in the tank, Δ*z* is the same in manometers A and B, even though the tube diameter of manometer B is larger than that of manometer A. Note that the amount of manometer liquid in each of the U-tube manometers has been adjusted such that the level of the interface between fluids 1 and 2 on the left side of each manometer is at the same elevation, for direct horizontal comparison.



Why?

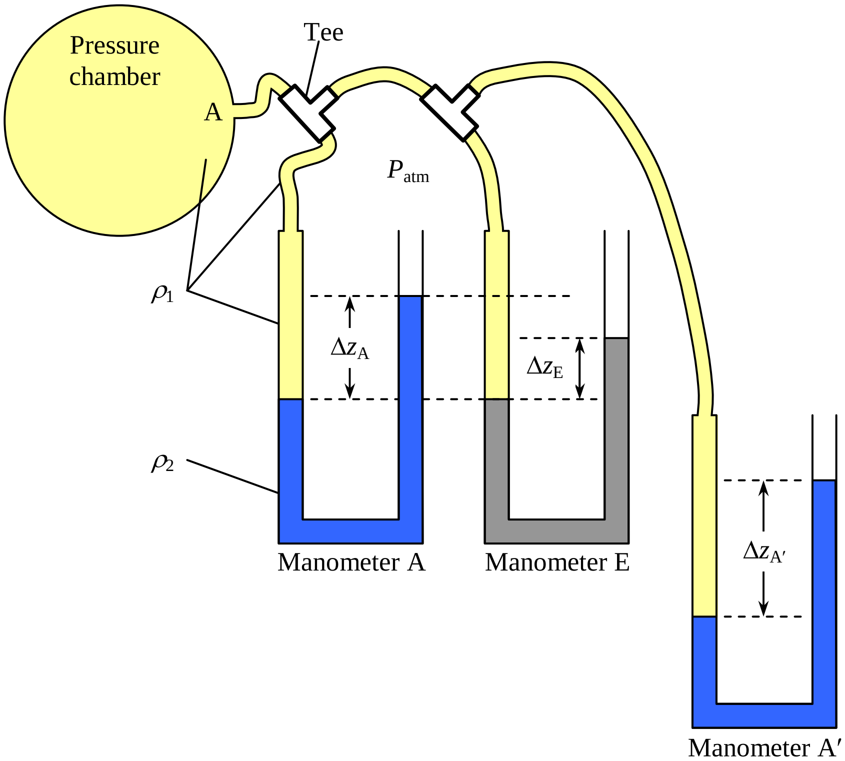
2. **U-Tube length** (provided that the tubes are long enough to include elevation difference Δ*z*). In the sketch, Δ*z* is the same in manometers A and C, even though manometer C is shorter than manometer A.

Why?

3. **U-Tube shape** (again provided that capillary effects are not important and the relative elevation is the same). In the sketch, Δ*z* is the same in manometers A and D, even though manometer D is oddly shaped. Can you think of an advantage of the "inclined manometer" configuration of manometer D?

However, the elevation difference Δz in a U-tube manometer *does* depend on the following:

1. **Manometer fluid**. For example, if we replace the blue manometer fluid in the above sketch with a *higher density* (gray colored) fluid, as in the sketch below, Δz would *decrease*. In other words, $\Delta z_E < \Delta z_A$.



Which manometer (A or E) would have better *resolution*?

2. **Vertical location of the manometer**. For example, if we move manometer A to a lower elevation, all else being the same, and ignoring changes in atmospheric pressure (manometer A′ in the above sketch), Δz would *increase*, i.e., $\Delta z_{A'} > \Delta z_A$. Why?