Two core principles govern this problem: **manometry** and the definition of **absolute pressure**.

Manometry and Pascal's Principle

A U-tube manometer measures the gauge pressure of a closed reservoir by balancing it against a column of a known fluid—in this case, mercury (Hg). The fundamental hydrostatic equation dictating this balance is:

$$P_{gauge} = \gamma_{manometer}h = \left(SG \cdot \gamma_{water}\right)h$$

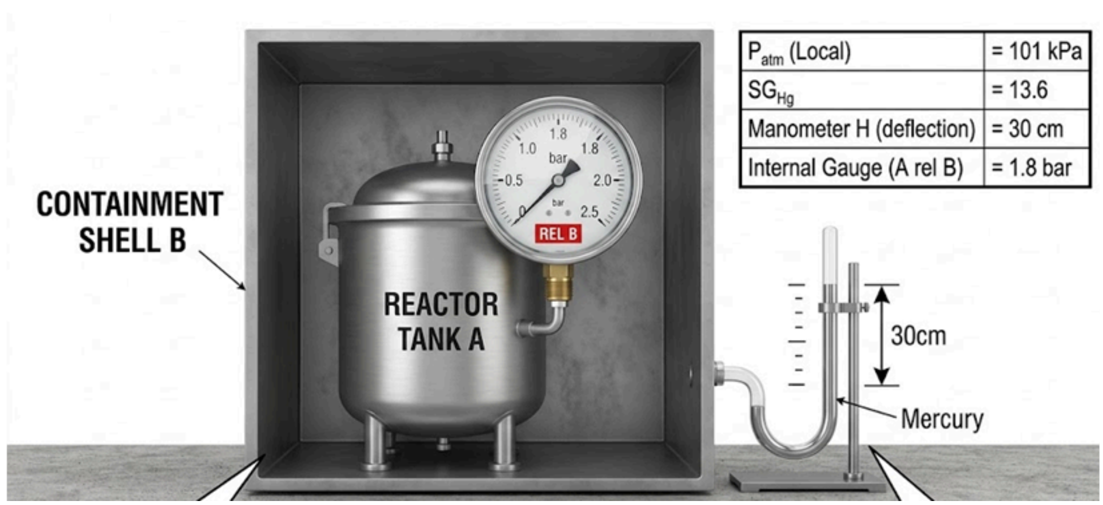
Where γ represents specific weight, SG is specific gravity, and h is the vertical deflection height. According to Pascal's law, pressure within a static gas reservoir (like Tank B) is uniform throughout its volume because the density of gas is small enough that its elevation changes have negligible hydrostatic weight effects.

Absolute vs. Gauge Pressure Relationship

Engineering problems must strictly distinguish between gauge pressure (P_{gauge}), which is measured relative to local atmospheric conditions, and absolute pressure (P_{abs}), which is referenced against a perfect vacuum. The universal thermodynamic relation is written as:

$$P_{abs} = P_{atm} + P_{gauge}$$

When tanks are nested inside one another (interconnected chambers), a pressure gauge mounted on an internal tank measures **relative pressure** (differential pressure) between the inner chamber and its immediate surrounding environment, rather than the open atmosphere.



<u>Step 1:</u> Extract and Standardize Given Data

To avoid unit mismatch errors during the calculation, all values must be translated into base SI units (meters and kilopascals):

- Atmospheric Pressure (P_{atm}) = 101 kPa
- Specific Gravity of Mercury (SG_{Hg}) = 13.6
- Specific Weight of Water (γ_{water}) = 9.81 kN/m^3
- Mercury Column Height (h) = 30 cm = 0.30 m
- Relative Pressure of Tank A ($P_{gauge,\ A\ rel\ B}$) = 1.8 bar = 180 kPa

<u>Step 2:</u> Determine Absolute Pressure of Tank B ($P_{abs,\ B}$)

Tank B is directly hooked up to the open-ended U-tube manometer. Because the mercury column is pushed *down* on the tank side and *up* on the atmospheric side, the pressure inside Tank B is greater than atmospheric pressure.

$$P_{abs,\,B} = P_{atm} + \left(SG_{Hg} \cdot \gamma_{water}\right)h$$

$$P_{abs,\,B} = 101\,kPa + \left(13.6 \cdot 9.81\,\frac{kN}{m^3}\right)(0.30\,m)$$

$$P_{abs,\,B} = 141.0248\,kPa_{abs}$$

<u>Step 3:</u> Determine Absolute Pressure of Tank A ($P_{abs,\ A}$)

Because Tank A is nested completely inside Tank B, its internal pressure gauge uses Tank B as its ambient baseline reference point. To compute the absolute pressure of the innermost tank, we must add the relative internal gauge pressure to the absolute pressure of the medium surrounding it (Tank B):

$$P_{abs,\,A} = P_{abs,\,B} + P_{gauge,\,A\,rel\,B}$$

$$P_{abs,\,A} = 141.0248\,kPa + 180\,kPa$$

$$P_{abs,\,A} = 321.0248\,kPa_{abs}$$

The core takeaway of this problem highlights **how ambient reference boundaries shift in cascaded environments**. A standard pressure gauge does not know what absolute space is; it only measures the mechanical deflection between its internal mechanism and the outside casing air.