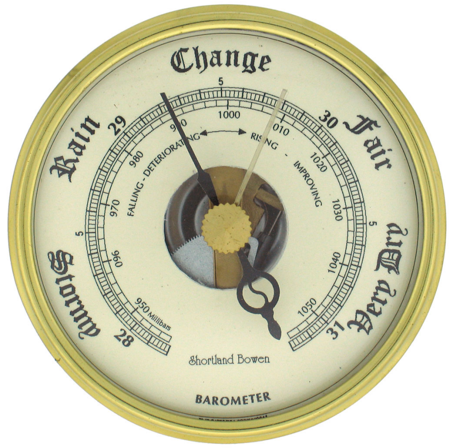


Specific Volume, Pressure, Temperature

Density and Specific Volume

$[\rho] = M/L^3$ units: kg/m^3, lb_m/ft^3, $slugs/ft^3$

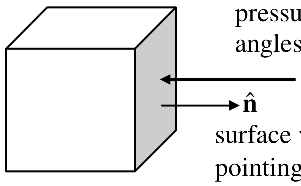
$[v] = L^3/M$ units: m^3/kg, ft^3/lb_m, $ft^3/slug$

$v = 1/\rho$

$\bar{v} = vM$ units: $m^3/kmol$ (M is molecular weight with units kg/kmol or g/mol)

Pressure

$[p] = F/L^2$ units: Pa = N/m^2, lb_f/in^2 (psi), lb_f/ft^2 (psf), bar (= 10^5 Pa), inHg, mmHg



pressure force is normal (at right angles) to the surface

$$d\mathbf{F}_n = -p\,dA\,\hat{\mathbf{n}}$$

surface with small area, dA, and outward pointing unit normal vector, $\hat{\mathbf{n}}$

"d" means very small, e.g., dA is a very small area and $d\mathbf{F}$ is a very small force. We use small quantities since over a large area, the pressure could vary from location to location. However, over a very small area the pressure is essentially constant. To get the total force over a large area, we can sum up all the small forces, i.e., integrate over the area: $\boldsymbol{F}_N = \int_A d\boldsymbol{F}_N = \int_A p\,dA(-\hat{\boldsymbol{n}})$.

<u>absolute pressure</u>: pressure referenced to a vacuum, e.g., $p_{\text{vacuum}} = 0$ (abs)
<u>gage pressure</u>: pressure referenced to the atmosphere, e.g., $p_{\text{atm}} = 0$ (gage)

$$p_{\text{gage}} = p_{\text{abs}} - p_{\text{atm,abs}}$$

Always use absolute pressure when using the ideal gas law and any equation derived using the ideal gas law.

p_{atm} = 101 kPa (abs) = 14.7 psia = 0 psig

Temperature
Temperature is a measure of the random kinetic energy of the molecules comprising a substance.

$[\theta] = \theta$ units: °C, K, °F, °R

Always use absolute temperature when using the ideal gas law and any equation derived using the ideal gas law.

Some helpful conversions (the "θ" refers to temperature):

$\theta(K) = 1.8\ \theta(°R)$ (1.8 = 9/5)
$\theta(°C) = [\theta(°F)-32]/1.8$
$\theta(°C) = \theta(K) – 273.15$
$\theta(°F) = \theta(°R) – 459.67$

Another convenient conversion formula for casual usage (not scientific usage):

10 °C = 50 °F (for every 5 °C increase, add 9 °F)

Another very approximate approach,

$\theta(°F) \approx 2*\theta(°C) + 30$ (will give a few degrees error over the range of typical weather temps)
$\theta(°C) \approx (\theta(°F) – 30)/2$