

Boyle's Law

<http://www.grc.nasa.gov/WWW/K-12/airplane/Animation/gaslab/Images/chprmt.gif>



$$P V = K$$

Charles' Law

<http://www.grc.nasa.gov/WWW/K-12/airplane/aglussac.html>



specific volume

<http://www.grc.nasa.gov/WWW/K-12/airplane/specvol.html>



Temp. conversion:

$$\text{C to F} \quad F = 9/5C + 32$$

$$\text{F to C} \quad C = (F - 32)5/9$$

Zeroth Law:

$$A = B = C$$

important because "B" could be a thermometer and "A" and "C" substances. Temp. is measured indirectly you have a third variable when doing thermal interaction

$$\text{Boyles: } PV = K$$

$$\text{Charles: } \frac{V}{T} = K$$

$$\text{G-L } \frac{P}{T} = K$$

$$PV \sim T$$

$$\frac{PV}{T} = K$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

An air bubble in your blood is @ $2.1 \times 10^{-4} \text{ cm}^3$ in size. What change in V does the bubble undergo if you go from 55 m at 6 degrees C to the surface at 17 degrees C.

$$V_2 = ? \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$T_1 = 6^\circ \text{C}$$

$$T_2 = 17^\circ \text{C}$$

$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$$

$$V_2 = \frac{6.32 \text{ atm} (2.1 \times 10^{-4} \text{ cm}^3) 290 \text{ K}}{279 \text{ K} (1 \text{ atm})}$$

$$V_2 = 1.38 \times 10^{-3} \text{ cm}^3$$

6.6 x greater

$$P_1 = \rho d g = 1000 \text{ kg/m}^3 (55 \text{ m}) 9.8 \text{ m/s}^2$$

$$P_1 = 5.39 \times 10^5 \text{ Pa} + 1.013 \times 10^5 \text{ Pa}$$

$$P_1 = 6.403 \times 10^5 \text{ Pa} \sim 6.32 \text{ atm}$$

$$\frac{PV}{T} = R$$

$$\frac{1.013 \times 10^5 \text{ Pa} (0.0224 \text{ m}^3)}{273 \text{ K}} = R$$

$$R = 8.315 \text{ J/mol K}$$

$$\frac{1 \text{ atm} (22.4 \text{ L})}{273 \text{ K}} = R$$

$$R = 0.0821 \text{ L} \cdot \text{atm} / \text{mol} \cdot \text{K}$$

mole: amount of a substance

$$n = \frac{m}{M} = \frac{\text{mass (g)}}{\text{molecular mass}}$$

CO₂

$$1 \text{ mole} = \frac{m}{C+O+O} = \frac{m}{12+16+16} = \frac{44g}{44}$$

ex. 2 mol of CO₂

m = ?

$$n = \frac{m}{M}$$

$$m = nM$$

$$m = 2 \text{ moles} (44)$$

$$m = 8.8g$$

*# of moles
of the gas*

$$n = \frac{N}{N_A}$$

of molecules in gas

**# of molecules/mole
(Avogadro's #)**

$$n = \frac{m}{M}$$

$$\frac{PV}{T} = R$$

$$\frac{PV}{T} = nR$$

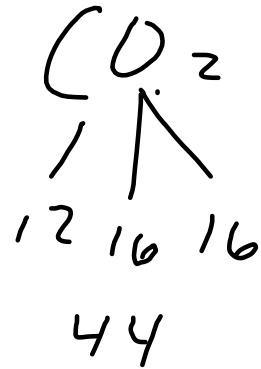
$$V = \frac{nRT}{P}$$

$$PV = nRT$$

$$V = \frac{1 \text{ mol} (8.315 \text{ J/mol} \cdot \text{K}) (273 \text{ K})}{1.013 \times 10^5 \text{ Pa}}$$

$$V = 0.0224 \text{ m}^3$$

equalities



$$\textcircled{1} \quad n = \frac{m}{M} = \frac{44\text{g}}{44} = 1 \text{ mole}$$

$$\textcircled{2} \quad \rho = \frac{m}{V} \quad m = \rho V$$
$$m = 1.98 \frac{\text{g}}{\text{m}^3} (.0224 \text{ m}^3)$$
$$m = .044 \text{ kg} \rightarrow 44\text{g}$$

$$\textcircled{3} \quad 1 \text{ mole} = 6.02 \times 10^{23} \text{ molecules}$$

$$6.02 \times 10^{23} \text{ molecules} (44 \text{ part/mole})$$

$$\therefore 2.65 \times 10^{25} \text{ part} (N+P)$$

$$2.65 \times 10^{25} \text{ part} \cdot N (1.67 \times 10^{-27} \text{ kg/part})$$

$$\therefore .044 \text{ kg} \rightarrow 44\text{g}$$

ex:

100 mL of CO_2

$$m = ? \quad \rho = m/V$$

$$m = \rho V$$

$$m = 1.98 \frac{\text{kg}}{\text{m}^3} (1 \times 10^{-4} \text{m}^3)$$

$$m = 1.98 \times 10^{-4} \text{kg}$$

moles?

$$n = \frac{m}{M} = \frac{1.98 \times 10^{-4} \text{kg}}{.44} = .0045 \text{ moles}$$

set up proportion

$$\sigma \frac{n_1}{V_1} = \frac{n_2}{V_2} \quad \frac{1 \text{ mole}}{.0224 \text{m}^3} = \frac{n_2}{1 \times 10^{-4} \text{m}^3} \quad n_2 = \underline{\underline{.0045 \text{ mole}}}$$

$$N = n N_A = .0045 \text{ moles} (6.02 \times 10^{23} \text{ mol}^{-1})$$

$$N = 2.71 \times 10^{21} \text{ molecules}$$

$$2.71 \times 10^{21} \text{ molecu} \left(\frac{44 \text{ part}}{\text{mole}} \right) \left(1.67 \times 10^{-27} \text{ kg/part} \right) = \underline{\underline{1.99 \times 10^{-4} \text{ kg}}}$$

$$\sigma \frac{n_1}{m_1} = \frac{n_2}{m_2}$$

$$\frac{1 \text{ mole}}{44 \text{g}} = \frac{.0045 \text{ moles}}{m_2} \quad m_2 = .178 \text{g}$$
$$\sigma 1.98 \times 10^{-4} \text{kg}$$

$$P V = n R T$$

moles

$$N = n N_A$$

of molecules

$$n = \frac{N}{N_A}$$

molecules per mole
 6.02×10^{23} molecules

$$n = N/N_A$$

$$P V = \frac{N}{N_A} (R T)$$

$$\frac{R}{N_A} = K$$

Boltzmann's constant

$$\frac{8.315 \text{ J/molK}}{6.02 \times 10^{23} / \text{mol}} = K$$

$$1.38 \times 10^{-23} \text{ J/K} = K$$

$$\therefore P V = N K T$$

Energy in a gas

most translational

$$K \bar{E} = \frac{1}{2} m v^2 = \underline{\underline{\frac{3}{2} K T}}$$

$$K = 1.38 \times 10^{-23} \text{ J/K}$$

$$N = n N_A$$

$$N_A = \frac{N}{n}$$

and

$$pV = nRT$$

$$pV = \frac{N}{N_A} RT$$

$$\frac{R}{N_A} = k$$

$$k = \frac{R}{N_A/n}$$

$$k = \frac{Rn}{N}$$

$$k \bar{\epsilon} = \frac{1}{2} m \bar{v}^2 = \frac{3}{2} kT$$

$$U = N \left(\frac{1}{2} m \bar{v}^2 \right)$$

$$U = N \left(\frac{3}{2} kT \right)$$

$$U = N \frac{3}{2} \left(\frac{Rn}{N} \right) T$$

$$U = \frac{3}{2} RnT$$