Boyle's Law

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

$PV = K$

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:

C to F $F = 9/5C + 32$

F to C $C = (F - 32)5/9$

Zeroth Law:

$A = B = C$

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

Boyles: $PV = K$

Charles' $\frac{V}{T} = K$

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 @ $2.1x10^{-4}\,cm^3$ 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.

$V_2 = ?$

$t_1 = 6°C$

$t_2 = 17°C$

$$\frac{P_1 V_1}{t_1} = \frac{P_2 V_2}{t_2}$$

$$V_2 = \frac{P_1 V_1 t_2}{t_1 P_2}$$

$$V_2 = \frac{6.32\,atm\,(2.1\times10^{-4}\,cm^3)\,290K}{279K\,(1\,atm)}$$

$V_2 = 1.38\times10^{-3}\,cm^3$

6.6 x greater

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

$P_1 = 5.39\times10^5\,Pa + 1.013\times10^5\,Pa$

$P_1 = 6.403\times10^5\,Pa \sim 6.32\,atm$

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

$$\frac{1.013\times10^{5}\,Pa\,(.0224\,m^{3})}{273\,K} = R$$

$$R = 8.315\ J/mol\,K$$

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

$$R = .0821\ L\cdot atm/mol\,K$$

mole: amount of a substance

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

CO_2

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

ex .2 mol of CO_2

$m = ?$

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

$m = nM$

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

$m = 8.8g$

# of moles of the gas

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

# of molecules in gas

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

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

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

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

$$PV = nRT$$

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

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

$$V = .0224\,m^3$$

equalities

CO_2

12 16 16

44

① $n = \frac{m}{M} = \frac{44g}{44} = 1\,mole$

② $\rho = \frac{m}{V}$ $m = \rho V$

$m = 1.98\ kg/m^3\ (.0224\ m^3)$

$m = .044\ kg \rightarrow 44g$

③ 1 mole = 6.02×10^{23} molecules

6.02×10^{23} molecules (44 part/molec)

$\therefore 2.65 \times 10^{25}$ part (n + p)

2.65×10^{25} p + n (1.67×10^{-27} kg/part)

$\therefore .044\ kg \rightarrow 44g$

ex:

100 ml of CO_2

m : ? $\rho = M/V$

$m = \rho V$

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

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

moles?

$n = \frac{m}{M} = \frac{1.98 \times 10^{-4}\,kg}{.044} = .0045\,moles$

set up proportion

or $\frac{n_1}{V_1} = \frac{n_2}{V_2}$ $\frac{1\,mole}{.0224\,m^3} = \frac{n_2}{1 \times 10^{-4}\,m^3}$ $n_2 = .0045\,mole$

$N = n N_A = .0045\,moles (6.02 \times 10^{23}\,molecu)$

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

$2.71 \times 10^{21}\,molecu (44\,\frac{part}{molecul})(1.67 \times 10^{-27}\,kg/part) =$

$= 1.99 \times 10^{-4}\,kg$

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

$\frac{1\,mole}{44\,g} = \frac{.0045\,moles}{m_2}$ $m_2 = .178\,g$

or $1.98 \times 10^{-3}\,kg$

$PV = nRT$

moles

$N = nN_A$

molecules per mole 6.02×10^{23} molecules

$n = N/N_A$

# of molecules

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

$PV = \frac{N}{N_A}(RT)$

$\frac{R}{N_A} = K$ Boltzmann's constant

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

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

$\therefore PV = NKT$

Energy in a gas

most translational

$$\overline{KE} = \frac{1}{2} m v^2 = \frac{3}{2} KT$$

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

$N = nN_A$

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

and

$PV = nRt$

$PV = \frac{N}{N_A}Rt$

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

$K = \frac{R}{N/n}$

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

$KE = \frac{1}{2}mv^2 = \frac{3}{2}KT$

$U = N\left(\frac{1}{2}mv^2\right)$

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

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

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