Equations and outline for first test

Stephen R. Addison

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$N_A = 6.022X10^{23}/mole.$
$R = 8.31\ Jmol^{-1}K^{-1}$. $k = 1.381 \times 10^{-23}\ J/K$. $pV = nRT$ $pV = NkT$
$n = N/N_A$,

$$\langle E \rangle = \frac{3}{2}NkT,$$

$$p = \frac{1}{3}\frac{N}{V}m\langle v^2 \rangle = \frac{2}{3} \times \frac{1}{2}m\langle v^2 \rangle \frac{N}{V},$$

$$pV^\gamma = constant.$$

$$dw = \frac{\partial w}{\partial x}dx + \frac{\partial w}{\partial y}dy + \frac{\partial w}{\partial z}dz.$$

$$\left(\frac{\partial x}{\partial y}\right)_z = \frac{1}{\left(\frac{\partial y}{\partial x}\right)_z}.$$

$$\left(\frac{\partial x}{\partial y}\right)_z \left(\frac{\partial y}{\partial z}\right)_x \left(\frac{\partial z}{\partial x}\right)_y = -1.$$

Consider f as a function of x, y, and z where x, y and z are related, then

$$\left(\frac{\partial x}{\partial y}\right)_f \left(\frac{\partial y}{\partial z}\right)_f \left(\frac{\partial z}{\partial x}\right)_f = 1.$$

The First Law of Thermodynamics:

$$\triangle U = (\text{Energy input by Heating}) + (\text{Work done on system }).$$

$$\triangle U = Q + W,$$

or

$$\mathrm{d}U = \text{đ}Q + \text{đ}W.$$

$$C = \frac{Q}{\triangle T}.$$

$c = C/m$, $c = C/n$, or $c = C/N$.

For an ideal gas, we can write the average kinetic energy per particle as

$$\frac{1}{2}m\langle v^2\rangle = \frac{3}{2}kT.$$

$$C_p - C_v = Nk = nR.$$

$$L = \frac{Q}{m}$$

$$H = U + pV.$$

$$C_p = \left(\frac{\partial U}{\partial T}\right)_p + p\left(\frac{\partial V}{\partial T}\right)_p = \left(\frac{\partial H}{\partial T}\right)_p.$$

$L_v = H_{vap} - H_{liq.}$ $L_f = H_{liq} - H_{sol}$,

Basic Probability

If there are several equally likely, mutually exclusive, and collectively exhaustive outcomes to an experiment, the probability of an event E is given by:

$$P(\text{E}|\text{Conditioning Information}) = \frac{\text{Number of outcomes favorable to E}}{\text{Total number of outcomes}}.$$

If the event cannot be broken down into equally likely events

$$P(\text{E}|\text{Conditioning Information}) = \frac{\text{Number of succesful occurences of E}}{\text{Number of trials}}.$$

Event not A $\Rightarrow$ A does not happen

Event A or B $\Rightarrow$ In an experiment A or B or both occur

A then B $\Rightarrow$ If in independent successive experiments A occurs in the 1^{st} and B occurs in the 2^{nd}.

A,B are disjoint events if it is impossible for both of them to occur simultaneously.

If A,B are independent successive events or experiments:

$$P(\text{A then B}) = P(A)P(B),$$

$$P(\text{not E}) = 1 - p(E),$$

and, if A,B are disjoint,

$$P(\text{A or B}) = P(A) + P(B).$$

If something can be done n_1 ways, and something else can be done in n_2 ways, then the number of ways of doing these things in succession is $n_1 n_2$. This is called *Fundamental Principle of counting.*

$$P(n,r) = \frac{n!}{(n-r)!}$$

$$C(n,r) = \frac{P(n,r)}{r!} = \frac{n!}{r!(n-r)!}$$

where

$$P(n,r) = C(n,r).P(r,r)$$

$$P(\text{Macrostate}) = \frac{\text{Number of microstates corresponding to macrostate}}{\text{Total number of microstates}}$$

$$P(\text{Microstate}) = \frac{1}{Total number of microstates} = \frac{1}{\Omega}$$

$$S = k \ln \Omega(U, V, N, \alpha).$$

$$\frac{1}{T_i} = \left(\frac{\partial S_i}{\partial U_i}\right)_{V_i, N_i}.$$

$$\frac{p_i}{T_i} = \left(\frac{\partial S_i}{\partial V_i}\right)_{U_i,N_i}.$$

$$\left(\frac{\partial S_i}{\partial N_i}\right) = -\frac{\mu_i}{T_i}.$$

$$T_i = \left(\frac{\partial U_i}{\partial S_i}\right)_{V_i,N_i}$$

$$p_i = -\left(\frac{\partial U_i}{\partial V_i}\right)_{U_i,N_i}$$

$$\mu_i = \left(\frac{\partial U_i}{\partial N_i}\right)_{S_i,V_i}$$

$$dU = TdS - pdV + \mu dN$$

$$dS = \frac{dU}{T} + \frac{p}{T}dV - \frac{\mu}{T}$$

$$dU = TdS - pdV + \sum_j \mu^j dN^j$$

$$\triangle S_{\text{system}} \geq \frac{\text{Energy transfer by heating}}{T}.$$