Physics II

Solution Set #7

Winter 2000

1. RB Chapter 13, Problem 5

The Maxwell speed distribution is given by [RB eq. (14.19) on p. 312]

\[ f(v)dv = \left( \frac{m}{2\pi kT} \right)^{3/2} e^{-m v^2 / 2kT} dv \]

The kinetic energy is given by

\[ E = \frac{1}{2} mv^2 \]

If the probability distribution for kinetic energy is given by \( P(E) \), then

\[ P(E)dE = f(v)dv \]

since the number of molecules with speed between \( v \) and \( v+dv \) is the same as the number of molecules with kinetic energy between \( E \) and \( E+dE \), assuming that \( v = \sqrt{\frac{2E}{m}} \).

Thus,

\[ P(E) = \frac{f(v)}{\frac{dv}{dE}} = \frac{f(v)}{\frac{d}{dE} \sqrt{\frac{2E}{m}}} \]

where on the right-hand side of this equation, we put \( v = \sqrt{\frac{2E}{m}} \).

Noting that \( \frac{dv}{dE} = \frac{1}{2} \sqrt{\frac{m}{2E}} e^{-\frac{3E}{2kT}} \),

\[ P(E) = \left( \frac{m}{2\pi kT} \right)^{3/2} e^{-m/2kT} \frac{1}{\sqrt{2\pi}} \frac{1}{\sqrt{m}} \sqrt{\frac{2E}{m}} e^{-\frac{3E}{2kT}} \]

Simplifying this result, we end up with:

\[ P(E) = \frac{2}{\sqrt{\pi}} \frac{1}{(kT)^{3/2}} e^{-E/kT} \frac{E^{1/2}}{2} \]

A graph of \( P(E) \) looks like:

\[ P(E) \]

The mean value of \( E \) is given by

\[ \langle E \rangle = \int_0^\infty E P(E) dE = \frac{2}{\sqrt{\pi}} \frac{1}{(kT)^{3/2}} \int_0^\infty E^{1/2} e^{-E/kT} dE \]

Substituting \( x = \frac{E}{kT} \),

\[ \langle E \rangle = \frac{2}{\sqrt{\pi}} kT \int_0^\infty x^{1/2} e^{-x} dx \]

\[ \frac{2}{\sqrt{\pi}} kT \Gamma\left( \frac{3}{2} \right) \]

Using the property of the \( \Gamma \)-function that \( \Gamma(n+1) = n \Gamma(n) \),

and recalling that \( \Gamma\left( \frac{1}{2} \right) = \sqrt{\pi} \),

\[ \Gamma\left( \frac{3}{2} \right) = \frac{3}{2} \sqrt{\pi} \]

Thus,

\[ \langle E \rangle = \frac{3}{2} kT \]
\[
\frac{\Delta}{\partial N} = \frac{\partial}{\partial (\frac{\Delta}{\partial e})} = \frac{\Delta}{\partial (\frac{\Delta}{\partial e})}
\]

Thus,
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USing the initial guess, we find
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we conclude that
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Finally,
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Since \(\Delta = \frac{\partial}{\partial (\frac{\Delta}{\partial e})} = \frac{\Delta}{\partial (\frac{\Delta}{\partial e})}\)

there exists a distribution, because the relation between \(\Delta\) and \(\frac{\Delta}{\partial e}\) is normalized.

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\[ \left( \frac{\partial N_e}{\partial e} \right) - \frac{\partial (Ne)}{\partial e} = 0 \]

It follows that

\[ \frac{\partial N_e}{\partial e} = \frac{\partial (Ne)}{\partial e} \]

Using

\[ \left[ \frac{\partial (Ne)}{\partial e} \right] = \frac{\partial (Ne)}{\partial e} \]

we obtain

\[ N_e = \frac{\partial (Ne)}{\partial e} \]

(6) Using the results for \( S \) and \( P \) and in part (a), and

\[ \frac{\partial}{\partial e} \]

This is the correct usage dependence of \( S \) for \( e = 5 \).

\[ \frac{\partial}{\partial e} \]

with this procedure. It is called

\[ \frac{\partial}{\partial e} \]

The above results is something for the future. \( S \). This is the

\[ \frac{\partial}{\partial e} \]

Integrating these terms,

\[ S = \int \Delta \theta + \Delta (7N) \]

\[ \frac{\partial}{\partial e} \]
\[
K(T) = \left( \frac{1}{1.90 \times 10^{-5} \cdot K^{0.5}} \right) \left( \frac{8.5 \times 10^{-4.4 \cdot \text{mol}^{-1} \cdot \text{K}^{-1}}}{\text{mol}} \right) \exp \left( \frac{-5.19 \times 10^{-10} + \frac{1}{K}}{8.5 \cdot 10^{-5} \cdot K^{0.5}} \right)
\]

The units of \( K \) are \( \text{mol}^{-1} \cdot \text{K}^{-1} \). 

From the units calculation, we see that the quantity inside the parentheses must be dimensionless. 

\[
\text{Therefore, the expression for } K(T) \text{ is valid.}
\]

When \( T = 298 \), \( \frac{e^{-0.7}}{2.7} \) \( \text{or } e^{-0.7} = 0.4496 \). 

\[
\frac{0.7}{2.7} = \frac{1}{3}
\]

Thus, 

\[
K(298) = \frac{1.90 \times 10^{-5}}{8.5 \times 10^{-4}} = 0.222
\]

Since the energy term is additive, the change in energy difference matters.

When the energy terms are zero, 

\[
K(T) = \frac{e^{-0.7}}{2.7}
\]

Where \( K(T) \) is the concentration of \( H^+ \) and \( K(T) \) is the concentration of \( H_2 \).

Thus, 

\[
K(T) = \frac{[H_2]}{[H]^2}
\]

where \( K(T) \) is the equilibrium constant at temperature \( T \).

\( \text{Equation (11.36)} \)

\( \text{Equation (11.35)} \)

\( \text{Equation (11.34)} \)
\[
(\pm) \quad \frac{K(T)}{x} + 1 = \frac{K(T)}{x} + x = f
\]

From (4) \( \frac{K(T)}{x} = f \). Insert this in (1) to get

\[
\begin{align*}
(1) & \quad x + \frac{x}{x} = f \\
(2) & \quad (T) \frac{K}{x} = f \\
(3) & \quad A = \frac{f}{x} + x
\end{align*}
\]

\[
\text{Let } [H]^1 = \text{ the } \text{ only given concentration.}
\]

\[
\frac{[H]^1 + [H]}{[H]} = f \quad \text{for both (a)}
\]

\[
\text{Let } T \text{ be in degrees Kelvin.}
\]

\[
\left( \frac{K(T)}{x} \right) = \left( \frac{A}{x} \right) \exp \left( \frac{1}{5.14 \times 10^8 \cdot m - 3} \right)
\]

\[
\text{Example: } K(T) = (A/T \cdot \exp (m - 3))
\]

\[
\text{Graphically}
\]
To find the unknown \( x \), use the fact that the slope of the line

\[
\begin{array}{c|c}
98.0 & 0.000 \\
8.0 & x \\
96.8 & 0.050 \\
\hline
f & 1 \\
\end{array}
\]

is a linear function of the table of numbers above.

(c) To obtain the temperature corresponding to \( x = 0.8 \), we graph

\[
\frac{1}{x} = f
\]

and plugging back in \((x)_{f=0.8}\)

\[
\frac{\frac{K(t)}{48} + 1}{\ln(2)} - 1 \ln(2) = \frac{K(t)}{x}
\]

Thus, where we have chosen the positive root since \( x \) is known to be positive.

\[
\left[ \frac{\frac{K(t)}{48} + 1}{\ln(2)} - 1 \right] \ln(2) = \frac{K(t)}{x}
\]

Solve the quadratic equation:

\[
x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\]

Thus,

\[
x = \frac{-1 \pm \sqrt{1 - 4(\frac{K(t)}{48})}}{2}
\]

From (3): \( y = \frac{x}{x - K(t)} \), insert both \( x \) to get

\[
\frac{K(t)}{48} + 1 \ln(2) - 1 = \frac{K(t)}{x}
\]
\[ \frac{\lambda}{\sigma^2} \exp\left( -\frac{\lambda}{\sigma^2} \right) \left( 1 - \frac{\lambda}{\sigma^2} \right) \frac{x}{\lambda} = \frac{\lambda}{N} \]

where \( N = N^2 - N \) is the scaling factor.

By using the identity \( N = N^2 - N \), the result is:

\[ \frac{\lambda}{\sigma^2} \exp\left( -\frac{\lambda}{\sigma^2} \right) \left( 1 - \frac{\lambda}{\sigma^2} \right) \frac{x}{\lambda} = \frac{\lambda}{N} \]

This is the equation used in the discussion of the normal distribution.

The characteristic function of the normal distribution is:

\[ \phi(t) = \exp \left( -\frac{t^2}{2} \right) \]

which is shown to be significant for large \( N \).

\[ \frac{5.16 \times 10^{-5}}{6.496} = K \]

This is obtained by using the error function.

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This result is correct.
Each sum is evaluated independently, giving:

\[ Z = e^{-E/\theta} \sum_{n=0}^{\infty} 1 = e^{-E/\theta} \]

including any zero-point energy (vibrational). Then
the binding energy per atom required to get 10,000 molecules
when two H and Ne are any mutual n-vibrational in phase, and

\[ E_r = -6 + (\text{anh} + \text{nh}) \theta \]

occurs and the energy levels are those for a three-dimensional harmonic
oscillator. We can write

\[ \sum_{n=0}^{\infty} \frac{1}{n!} = e \]

Here, in the lattice, so there is no departure of individuality.
These \( E_r \) are due to the atoms of a solid and satisfying slightly

\[ N \sum_{n=0}^{\infty} \frac{1}{n!} = Z \]

Then we have the partition function for \( N \) atoms in terms of
the partition function for one atom:

\[ \frac{\langle N \rangle}{\langle E \rangle} = N \]

As \( \langle N \rangle \) to \( \langle E \rangle \), problem 3

\[ \text{Problem 12, Chapter 13, Problem 3} \]

\[ \text{Problem 15, Chapter 13, Problem 15} \]
\[
\frac{1 - e^{-x}}{1 - e^{-x}} = \frac{e^{-\mu}}{e^{-\mu}}
\]

Thus,

\[
\ln \left( \frac{1 - e^{-x}}{1 - e^{-x}} \right) = \ln \left( \frac{e^{-\mu}}{e^{-\mu}} \right)
\]

This shows that

\[
\ln \left( \frac{1 - e^{-x}}{1 - e^{-x}} \right) = 0
\]

Thus,

\[
\frac{1 - e^{-x}}{1 - e^{-x}} = 1
\]

This implies

\[
1 - e^{-x} = 1 - e^{-\mu}
\]

Thus,

\[
-x = -\mu
\]

Thus,

\[
x = \mu
\]

This completes the proof.
The equation is: \[ N = 10 \text{ moles, the net change in the reaction of the system.} \]

This is the formal expression for the reaction at equilibrium. According to Table 13 on page 97 of GB, \( L = C \text{ at equilibrium.} \]

The change in molarity, \( M \), is the number of moles of \( N_2 \) consumed. Above the line, the thermodynamic signature is the change in reaction conditions. The change in molarity is given by the rate of change of the reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate. The reaction rate is given by the change in reaction rate. This can be obtained from the reaction rate.
Given: \( L = 0.374 \) and \( L_{\text{uplim}} \) or \( L_{\text{lowlim}} \).

\( L_{\text{uplim}} = L + \varepsilon \) or \( L_{\text{lowlim}} = L - \varepsilon \).

This is obvious that:

\[ \log L = \log (5^{x} - s) \]

Thus, \( \varepsilon \) is obvious that:

\[ L_{\text{uplim}} = \log (5^{x} - s) \]

\[ L_{\text{lowlim}} = \log (5^{x} - s) \]

(c) By definition:

This is the initial expression for the equation:

\[ \log L = \frac{1}{k} \]

We have:

\[ \frac{1}{3.49} = \frac{1}{14.9} \]

By adding the equation, we conclude that:

\[ \frac{1}{3.49} = \frac{1}{14.9} \]

Thus, we have:

\[ \frac{1}{3.49} K = \frac{1}{14.9} \]

Using the equation for the reaction curve:

\[ T = 14.9 K \]

The upper limit of reaction 6.

(2) \( \frac{1}{3.49} \) or \( 0.29 \)