Solutions to Pathria's Statistical Mechanics Chapter 7

SM-at-THU

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Problem 7.1

Problem 7.4

We can deduce from 7.1.30 and 7.1.26a,when p is a const:

$$g_{\frac{5}{2}} \propto T^{-\frac{5}{2}}$$

So we have:

$$(\frac{\partial}{\partial T} g_{\frac{5}{2}}(z))_p = -\frac{5}{2T} g_{\frac{5}{2}}(z)$$

According to the D.10 from appendix D:

$$z\frac{\partial}{\partial z} g_{\frac{5}{2}}(z) = g_{\frac{3}{2}}(z)$$

Combine the two equation:

$$\frac{1}{z}(\frac{\partial z}{\partial T})_p = -\frac{5}{2T}\frac{g_{\frac{5}{2}}(z)}{g_{\frac{3}{2}}(z)}$$

If you compare with 7.1.36 you can get:

$$\gamma = \frac{5}{3}\frac{g_{\frac{5}{2}}(z) g_{\frac{1}{2}}(z)}{g_{\frac{3}{2}}(z)^2}$$

Problem 7.14

From the definition of p and U:

$$p = \frac{kT}{\lambda^n} g_{\frac{5}{2}}(z)$$

$$U = \frac{nkTV}{s\lambda^n} g_{\frac{5}{2}}(z)$$

So we get:

$$p = \frac{sU}{nV}$$

And when $T \to \infty$,we could use the ideal gas equation.

$$pV = nRT$$

So

$$C_V = \frac{n}{s}Nk, C_p = (\frac{n}{s}+1)Nk$$

Problem 7.24

We can deduce from 7.3.12 and 7.3.19 and 7.3.23.

$$u = 4.16 * 10^{-14}$$

$$s = 2.03 * 10^{-14}$$

$$n = 4.09 * 10^{8}$$

Problem 7.34

For the n-dimensional Debye system,we can get the function of state number:

$$g(\omega) \propto \begin{cases} 0 & (\omega > \omega_D) \\ \omega^{n-1} & (0 < \omega < \omega_D) \end{cases}$$

Then we consider the energy of the Debye system:

$$U_{ph} \propto \int_0^{\omega_D} \frac{\omega^n}{exp(\beta\hbar\omega) - 1} d\omega \propto T^{n+1}$$

We can know the specific heat from thermodynamics:

$$C_V = (\frac{\partial U}{\partial T})_V \propto T^n$$