Statistična termodinamika 2020/21

Izpit

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1. Obnašanje N_2O opišemo z Berthelotovo enačbo stanja

$$\left(p + \frac{a}{V_M^2 T}\right)(V_M - b) = RT,$$

kjer je $a = 87.2$ Jm^{3}K/mol^2 in $b = 3.25 \times 10^{-5}$ m^3/mol. Določite kritični tlak p_c! Kolikšna je izotermna stisljivost N_2O pri kritični gostoti in tlaku $2p_c$?

2. Izotermno susceptibilnost kristalnega triglicin sulfata nad temperaturo faznega prehoda v feroelektrično fazo podaja zveza $\chi_T = a/(T - T_c)$, kjer je $a = 3900$ K in $T_c = 48°$C. Za koliko se v električnem polju jakosti 10^5 V/m in pri temperaturi 50°C razlikujeta adiabatna in izotermna susceptibilnost kristala z gostoto 1690 kg/m^3? Specifična toplota c_P je enaka 1300 J/kgK.

3. Interakcijo med spinoma s_1 in s_2 opišemo s Pottsovo hamiltonko

$$H = \begin{cases} -J, & s_1 = s_2 \\ 0, & s_1 \neq s_2 \end{cases},$$

kjer je J konstanta, posamezen spin pa lahko zavzame eno izmed treh različnih vrednosti. Skicirajte fazni prostor sistema! Izračunajte njegovo toplotno kapaciteto za $J/k_BT = 2$! — Kako se spremeni zadnji rezultat, če ima vsak spin namesto treh na voljo dvanajst različnih stanj?

4. Določite temperaturo fotonskega plina v votlinici s prostornino 1 cm^3, če je amplituda fluktuacij njegove energije (σ_E) enaka 2 MeV! Kolikšna je tedaj amplituda fluktuacij števila fotonov (σ_N)?

$$\int_0^\infty \exp(-ax^2)\,\mathrm{d}x = \frac{\sqrt{\pi}}{2\sqrt{a}}$$

$$\int_0^\infty x\exp(-ax^2)\,\mathrm{d}x = \frac{1}{2a}$$

$$\int_0^\infty \frac{x\,\mathrm{d}x}{\exp(x)-1} = \frac{\pi^2}{6}$$

$$\int_0^\infty \frac{x^2\,\mathrm{d}x}{\exp(x)-1} \approx 2.404$$

$$\int_0^\infty \frac{x^3\,\mathrm{d}x}{\exp(x)-1} = \frac{\pi^4}{15}$$

$$\int_0^\infty \frac{x^4\,\mathrm{d}x}{\exp(x)-1} \approx 24.886$$

$$\int_0^\infty \frac{x^5\,\mathrm{d}x}{\exp(x)-1} \approx \frac{8\pi^6}{63}$$

$$\int_0^\infty \frac{x^6\,\mathrm{d}x}{\exp(x)-1} \approx 726.011$$

$$\int_0^\infty \frac{x\,\mathrm{d}x}{\exp(x)+1} = \frac{\pi^2}{12}$$

$$\int_0^\infty \frac{x^2\,\mathrm{d}x}{\exp(x)+1} \approx 1.803$$

$$\int_0^\infty \frac{x^3\,\mathrm{d}x}{\exp(x)+1} = \frac{7\pi^4}{120}$$

$$\int_0^\infty \frac{x^4\,\mathrm{d}x}{\exp(x)+1} \approx 23.331$$

$$\int_0^\infty \frac{x^5\,\mathrm{d}x}{\exp(x)+1} = \frac{31\pi^6}{252}$$

$$\int_0^\infty \frac{x^6\,\mathrm{d}x}{\exp(x)+1} \approx 726.011$$

$$\int_0^\infty x^2\exp(-ax^2)\,\mathrm{d}x = \frac{\sqrt{\pi}}{4\sqrt{a^3}}$$

$$\int_0^\infty x^3\exp(-ax^2)\,\mathrm{d}x = \frac{1}{2a^2}$$

$$\int_0^\infty \frac{x^2\exp(x)}{(\exp(x)-1)^2}\mathrm{d}x = \frac{\pi^2}{3}$$

$$\int_0^\infty \frac{x^3\exp(x)}{(\exp(x)-1)^2}\mathrm{d}x \approx 7.212$$

$$\int_0^\infty \frac{x^4\exp(x)}{(\exp(x)-1)^2}\mathrm{d}x = \frac{4\pi^4}{15}$$

$$\int_0^\infty \frac{x^5\exp(x)}{(\exp(x)-1)^2}\mathrm{d}x \approx 124.431$$

$$\int_0^\infty \frac{x^6\exp(x)}{(\exp(x)-1)^2}\mathrm{d}x = \frac{16\pi^6}{21}$$

$$\int_0^\infty \frac{x^7\exp(x)}{(\exp(x)-1)^2}\mathrm{d}x \approx 5082.08$$

$$\int_0^\infty \frac{x\exp(x)}{(\exp(x)+1)^2}\mathrm{d}x = \ln(2)$$

$$\int_0^\infty \frac{x^2\exp(x)}{(\exp(x)+1)^2}\mathrm{d}x = \frac{\pi^2}{6}$$

$$\int_0^\infty \frac{x^3\exp(x)}{(\exp(x)+1)^2}\mathrm{d}x \approx 5.409$$

$$\int_0^\infty \frac{x^4\exp(x)}{(\exp(x)+1)^2}\mathrm{d}x = \frac{7\pi^4}{30}$$

$$\int_0^\infty \frac{x^5\exp(x)}{(\exp(x)+1)^2}\mathrm{d}x \approx 116.654$$

$$\int_0^\infty \frac{x^6\exp(x)}{(\exp(x)+1)^2}\mathrm{d}x = \frac{31\pi^6}{42}$$