1. Calculate the equation of state, entropy and heat capacity for the dilute ($n = N/V \to 0$) Bose gas taking into account only leading deviations from the classical ideal gas. Note that in this limit $\mu \to -\infty$ and fugasity $z = e^{\beta\mu}$ is small and proportional to n. The results for 2nd virial coefficient, entropy and C_V are

$$\begin{aligned} B_2(T) &= \frac{\hbar^3}{2g}\left(\frac{\pi}{mk_BT}\right)^{3/2} \\ S &= S^{\text{class.}} - Nk_B\frac{n\hbar^3}{4g}\left(\frac{\pi}{mk_BT}\right)^{3/2} \\ C_V &= C_V^{\text{class.}} + Nk_B\frac{3n\hbar^3}{8g}\left(\frac{\pi}{mk_BT}\right)^{3/2} \end{aligned}$$

   At which temperature does n deviate 10% from the classical value at atmospheric pressure for bosons with a mass of ^4He-atom?

2. Show the following results for the ideal Bose gas below the condensation temperature:

$$\begin{aligned} E &= c_1 m^{3/2} T^{5/2} V \\ p &= c_2 m^{3/2} T^{5/2} \\ C_V &= \frac{5}{2}\frac{E}{T} \\ S &= \frac{5}{3}\frac{E}{T} \end{aligned}$$

   What are constants c_1, c_2?

3. Determine the so-called solar constant, which is the solar radiation power measured from a surface element perpendicular to the direction to the Sun ($\mathrm{W/m^2}$). The surface temperature of the Sun is $T_S \approx 5800\,\mathrm{K}$, diameter $1.392 \times 10^9\,\mathrm{m}$ and mean distance from Earth $1.496 \times 10^8\,\mathrm{km}$. Compare to the experimental value $1.39\,\mathrm{kW/m^2}$