A system is composed of two harmonic oscillators, each of natural frequency ω_0, and having permissible energies $(n + 1/2)\hbar\omega_0$, where n is any non-negative integer. The total energy of the system is $E' = n'\hbar\omega_0$, where n' is a positive integer.

- For a given energy, how many microstates are available to the system ? What is * the entropy of the system ?
- A second system is also composed of two harmonic oscillators, each of natural frequency $2\omega_0$. The total energy of this system is $E'' = n''\hbar\omega_0$, where n'' is an even integer.
  - How many microstate are available to this system ?
  - What is the entropy of a system composed of the two preceeding subsystems (separated and enclosed by a totally restrictive wall) ? Express the entropy as a function of E' and E''.

We are now asked to estimate the probability of $E - \langle E \rangle = 10^{-6} \langle E \rangle$

for a system of $N = 10^{21}$.

Take an ideal gas $\langle E \rangle = \frac{3}{2} N k_B T$, $C_V = \frac{3}{2} N k_B$

(Note $(E - \langle E \rangle)^2 \sim N^2$, $C_V \sim N$ only, so the

standard deviation $\sim \frac{1}{N}$

$$\Rightarrow \boxed{\frac{p(E)}{p(\langle E \rangle)} \sim e^{-10^9}}$$

This is for a monoatomic ideal gas. People may use different models.