In-class problem linked to lecture pages 152-163

Consider a system of 10^{24} particles at room temperature for which $\mu = -1$ eV. By what factor does the number of accessible states increase if the number of particles is increased by 0.01% without adding energy to or doing work on the system? Express your answer as a power of 10.

In-class 152:163.

$$\frac{\Omega_2}{\Omega_1} = e^{-\left(\frac{\mu \Delta N}{kT}\right)}$$

$\mu = -1 \text{ eV}$

$\Delta N = 0.0001 \times 10^{24} = 10^{20}$

$k = 8.63 \times 10^{-5} \frac{eV}{K}$

$T = 300 K$

$$\frac{\Omega_2}{\Omega_1} = \exp\left[\frac{-(-1)(10^{20})}{(8.63\times10^{-5})(300)}\right] = \exp\left[3.86\times10^{21}\right]$$

To convert this to a power of 10:

let $x = e^{3.86\times10^{24}}$

$\ln x = 3.86 \times 10^{21}$

$\ln x = \log x \ln 10$

$\ln 10 = 2.3$

$\log x \cdot 2.3 = 3.86 \times 10^{24}$

$\log x = \frac{3.86}{2.3} \times 10^{21} = 1.7 \times 10^{24}$

$x = 10^{1.7\times10^{24}}$