1. A classical particle of mass $m$ moves within a part of the $x - y$ plane $z = 0$ of area $A$, and is attracted to it by the gravitational force $mg$, i.e., potential energy $V(z)$ in the $z$-direction (orthogonal to the plane) is

$$V(z) = \begin{cases} mgz, & z > 0, \\ +\infty, & z < 0. \end{cases}$$

Assuming that the particle is in equilibrium at temperature $T$, find its internal energy $E$ and the entropy $S$.

2. A single-particle level of energy $\epsilon$ is in equilibrium with a reservoir of effectively non-interacting electrons with temperature $T$ and chemical potential $\mu$. Find the standard deviation $\sigma$ of the number of particles $N$ in this level.

3. Calculate the heat capacity $C_L$ per unit length $L$ of a one-dimensional equilibrium gas of photons ("blackbody radiation") at temperature $T$. 