1) Derivation of equation of state. In a certain system the internal energy $E$ is related to the entropy $S$, the particle number $N$, and the volume $V$ through

$$E = \text{constant} \times N \left( \frac{N}{V} \right)^\alpha \exp \left\{ \frac{\alpha S}{N k} \right\}.$$ 

a) Show that the system satisfies the ideal gas law independent of the value of the constant $\alpha$.

b) Find the coefficient $\gamma$ in the adiabatic equation of state $p v^\gamma = \text{constant}$ ($v = V/N$) and the specific heats $C_p$ and $C_V$ of the system.