[tex14] **Entropy and internal energy of the classical ideal gas**

The classical ideal gas for a fixed number N of particles is specified by the equation of state $pV = Nk_BT$ and the constant heat capacity $C_V = \alpha Nk_B$ [$\alpha = \frac{3}{2}$ (monatomic), $\alpha = \frac{5}{2}$ (diatomic), $\alpha = 3$ (polyatomic)].

(a) Use this information to calculate the internal energy $U(T,V)$ and show that the result is, in fact, independent of V.

(b) Use the same information to calculate the entropy $S(T,V)$.

(c) Determine the mechanical response functions α_p (thermal expansivity), κ_T (isothermal compressibility), and κ_S (adiabatic compressibility).