[tex18] Sound velocity in the classical ideal gas I

In a sound wave the classical ideal gas [$pV = nRT$, $C_V = \alpha nR = \text{const}$, molar mass M] is *adiabatically* compressed and expanded.
(a) Show that the sound velocity is related to the adiabatic compressibility κ_S and the mass density ρ as follows:

$$c^2 = \frac{1}{\rho \kappa_S} = \left(\frac{\partial p}{\partial \rho} \right)_S .$$

(b) Use thermodynamic properties of the classical ideal gas to infer from this expression the result $c^2 = \gamma RT/M$, where $\gamma = 1 + 1/\alpha$.

Solution: