Thermodynamics (MP460) Assignment 8

Please hand in your solutions no later than Thursday, November 28, 10:05 am. Late assignments will not be accepted. If you have questions about this assignment, please ask your lecturer,
Joost Slingerland, (`joost-at-thphys-dot-nuim-dot-ie`), Office 1.7D, Mathematical Physics

Ex. 8.1

This is exercise 3 on page 76 of the book by Fermi.

Ex. 8.1

(a) Derive that the heat capacities C_V and C_p of a system described by the thermodynamic variables pressure, volume and temperature (p, V, T), and with energy U, are given by the following expressions,

$$C_V = \left(\frac{\partial U}{\partial T}\right)_V \qquad \text{and} \qquad C_p = \left(\frac{\partial U}{\partial T}\right)_p + p\left(\frac{\partial V}{\partial T}\right)_p .$$

(b) Derive that $C_p - C_V = \left(\frac{\partial V}{\partial T}\right)_p \left(\left(\frac{\partial U}{\partial V}\right)_T + p\right)$

(b) Derive from the formula given in part **(b)** that $C_p - C_V = T\left(\frac{\partial p}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_p$.
You may use the Maxwell relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial p}{\partial T}\right)_V$ without proof.

(c) Consider a gas which has equation of state

$$p(V - nb) = nRT(T/T_0)^\gamma,$$

where b, T_0 and γ are constants, n is the number of *mol* of gas and R is the gas constant. Show that for this gas, $C_p - C_V = (\gamma + 1)^2 nR(T/T_0)^\gamma$