NAME :



# Quiz 14

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(a) Starting from the differential form of the Helmholtz free energy $F$ i.e. $\mathrm{d}F = -S\mathrm{d}T - P\mathrm{d}V + \mu\mathrm{d}N$, derive the Maxwell relation

$$\left(\frac{\partial S}{\partial V}\right)_{T,N} = \left(\frac{\partial P}{\partial T}\right)_{V,N}. \tag{1}$$

Explain *clearly* what you're doing. [6]

(b) Using the equation of state for an ideal gas, compute $\left(\partial P/\partial T\right)_{V,N}$. [2]

(c) Compute $\left(\partial S/\partial V\right)_{T,N}$ and show that it is equal to the result from part (b), using the expression for the entropy of an ideal gas: [2]

$$S = Ns_0 + NR\ln\left[\left(\frac{U}{U_0}\right)^c\left(\frac{V}{V_0}\right)\left(\frac{N}{N_0}\right)^{-(c+1)}\right], \qquad \text{where} \quad s_0 = (c+1)R - \left(\frac{\mu}{T}\right)_0. \tag{2}$$

**Hint:** What do you know about the internal energy of an *ideal* gas?