

1 Entropy, energy, and enthalpy of van der Waals gas

In this entire problem, keep results to first order in the van der Waals correction terms a and b .

(a) Show that the entropy of the van der Waals gas is

$$S = Nk \left\{ \ln \left(\frac{n_Q(V - Nb)}{N} \right) + \frac{5}{2} \right\} \quad (1)$$

(b) Show that the energy is

$$U = \frac{3}{2}NkT - \frac{N^2a}{V} \quad (2)$$

(c) Show that the enthalpy $H \equiv U + pV$ is

$$H(T, V) = \frac{5}{2}NkT + \frac{N^2bkT}{V} - 2\frac{N^2a}{V} \quad (3)$$

$$H(T, p) = \frac{5}{2}NkT + Nbp - \frac{2Nap}{kT} \quad (4)$$

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Figure 1: *Effects of High Altitude* by Randall Munroe, at xkcd.