

Thermodynamics 3

1. Show that when a paramagnet is adiabatically demagnetized, its temperature lowers (*magnetic refrigeration*). Assume that work is given by $DW = \vec{H} \circ d\vec{M}$, where \vec{M} is the magnetization and \vec{H} is the magnetic field. Further, $\vec{M} = \chi\vec{H}$, where χ is the susceptibility, the internal energy of a (perfect) paramagnet depends on the temperature only and the work associated with any changes in the value of the paramagnet is negligible.
2. A rubber band is made of polymers. When the band is stretched, the polymers order and orientate parallel to each other. As a result, the entropy of the band lowers. Show that the thermal expansion coefficient of rubber is negative.
3. Show that the Gibbs free energy of a mixture of n_1 particles of one kind and n_2 particles of another kind is given by $G = \mu_1 n_1 + \mu_2 n_2$, where $\mu_{1,2}$ are the chemical potentials.
4. Explain the *Maxwell construction*. The key point is the position of the horizontal fragment replacing the unphysical section of a van der Waals isotherm.

