

1. A metal rod of uniform density ρ , cross-section A and specific heat C has length L . Initially, two of its ends are connected to two very large reservoirs maintained at temperatures T_1 and T_2 . The environment around the rod is such that when a steady state is reached, the temperature gradient in the rod is constant. At this time, the reservoirs are removed and the rod is surrounded by adiabatic walls. In this initial state the entropy of the rod S_0 . Calculate the equilibrium entropy of the rod S_{eq} – that is when the temperature of the rod becomes uniform.
2. In the earlier question, what would be the maximum work that can be extracted from the rod?
3. Upon measurement, the isothermal compressibility κ_T and the volume expansion coefficient α_P of one mole of a certain substance are found to be related to the volume v and T as :

$$\alpha_P = R\kappa_T/(v - b)$$

and

$$\kappa_T^{-1} = RTv/(v - b)^3 - (2a/v^3)$$

. R, b and d are constants. Construct the equation of state for the substance.