Thermodynamics

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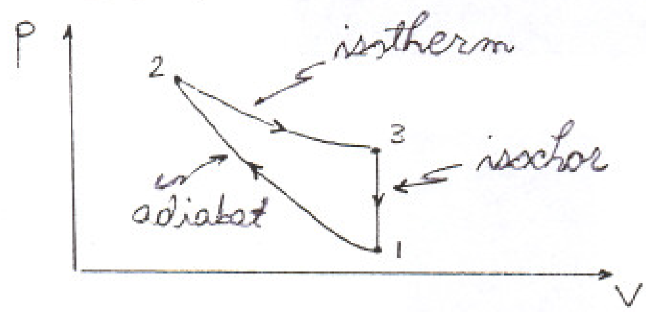
30 pts. 1) Assuming that the working gas is an ideal gas with temperature-independent heat capacities, find the efficiency η of the following cycle. Express the final answer for η in terms of γ (the heat capacity ratio) and V_2/V_3 only).



30 pts. 2) A mass m of water at temperature T_1 is isobarically and adiabatically mixed with an equal mass of water at temperature T_2. Assume a constant specific heat C_p. Calculate the final temperature of the total system and the entropy change of the total system.

40 pts. 3) A certain solid can exist in two phases at low temperatures. At normal pressure (1 atm), the chemical potentials μ_i ($i = 1,2$) of the two phases have the form

$$\mu_i = a_i - b_i T^2 - c_i T^4, \qquad i = 1,2$$

where the coefficients $a_1 = 3.5$ J/g, $a_2 = 0.5$ J/g, $b_1 = 4$ J/gK^2, $b_2 = 2$ J/gK^2, $c_1 = 2$ J/gK^4, and $c_2 = 1$ J/gK^4.

(20 pts.) (a) Find the temperature T_c of the phase transition. Indicate which phase is stable below T_c and which phase is stable above T_c. Why?

(10 pts.) (b) Calculate the latent heat of this transition? Based on your result, is this transition first or second order? Why?

(10 pts.) (c) Calculate the specific heat jump ΔC_p at T_c.