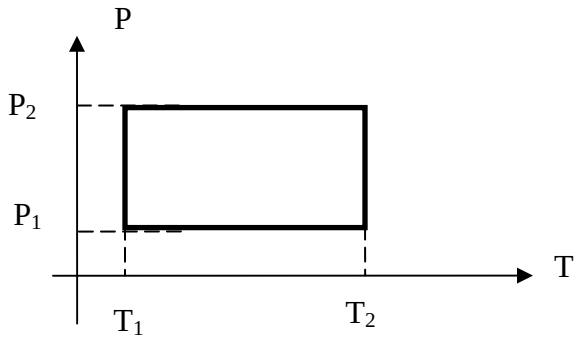
Homework #5

Problem #1

A piece of ice with mass 0.1 kg and temperature 0 ^{o}C is dropped in thermally isolated container with benzene at temperature 50 ^{o}C. The mass of benzene is 2 kg, its heat capacity is 1.75 kJ/kg K. Find the change in the entropy of the system after equilibrium is established. (You will need to use latent heat and heat capacity of water in this problem)

Problem#2

Find the efficiency of a heat engine operating along a cycle shown in figure if working substance of the engine is an ideal monoatomic gas.



Problem #3

Suppose $g(U) = CU^{3N/2}$, where g is multiplicity, C is constant, N is the number of particles and U is internal energy. (a) Show that $U = \frac{3}{2} k_B NT$ (b) Show that $\left(\frac{\partial^2 S}{\partial U^2} \right)_N$ is negative, where S is entropy. This form of *g(U)* actually applies to an ideal gas.

Problem #4

A river with a water temperature T_l=20 ^{0}C is to be used as the low temperature reservoir of a large power plant, with a steam temperature of T_h=500 ^{0}C. If ecological consideration limit the amount of heat that can be damped into the river to 1500 MW, what is the largest electrical output that the plant can provide? If improvement in hot-steam technology would permit rising T_h by 100 ^{0}C what would this have on the plant capacity?

Problem #5 (extra-credit problem 5 points)

There are two bodies with temperatures T_1 and T_2 (T_1>T_2) and heat capacitances C_1 and C_2. The first body is used as a heater and the second body as a cooler in a cyclic thermal engine. What is the maximum work that can be produced with two bodies? The bodies are not infinite and their temperatures change in the process.