HW10: Due on Dec 4 in class. CODE NUMBER: ————— SCORE: ————

Problem #1: Concepts of a Carnot engine

(a) Two reversible engines operate on Carnot cycles between the same minimum and maximum volume, maximum and minimum pressure, and maximum and minimum temperature. One engine uses helium as the working substance, the other uses argon. Which engine delivers more work per cycle? What's the ratio?

(b) In a modern steam power plant using superheated steam, the temperature in the steam generator is 600 °C. The intake of river water used to cool the condenser is at 15 °C. What maximum efficiency could such a plant have?

Problem #2: Engine cycles of a thermodynamical process

An ideal gas with coefficient, γ, is initially at the condition P_0=1 atm, V_0 = 1 liter, T_0 = 300 K. It is then:

1. Heated at constant V until $P = 2$ atm.
2. Expanded at constant P until $V = 2$ liters.
3. Cooled at constant V until $P = 1$ atm.
4. Contracted at constant P until $V = 1$ liter.

(a) Draw a P-V diagram for this process.

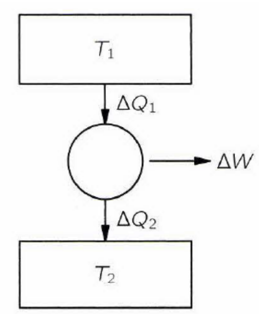
(b) What work W is done per cycle?

(c) What is the maximum temperature T_{max} the gas attains?

(d) What is the total heat input ΔQ in steps 1 and 2?

(e) What is the combined change ΔS in entropy during steps 1 and 2?

Problem #3: Heat conduction of two bodies



As shown above, two "identical" bodies of constant heat capacity C_p, originally at temperatures T_1 and T_2, are used as reservoirs for a Carnot engine operating in infinitesimal reversible cycles. If the bodies remain at constant pressure and undergo no phase changes,

(a) show that after the engine comes to rest, the final temperature $T_f = \sqrt{T_1 T_2}$,

(b) find the total work W done by the engine.

Hint: Recall that ΔQ is related to ΔT and consider what happens to the entropy in a reversible cycle.

Problem #4: Entropy Increase

(Based on a true story) A careless experimenter left the valve of a tank of argon slightly open over the holiday. The argon gas, originally at 15 atmospheres and room temperature (25 °C) slowly escaped to the environment isothermally, until a balance was reached. What change in entropy ΔS per kg of gas occurred?