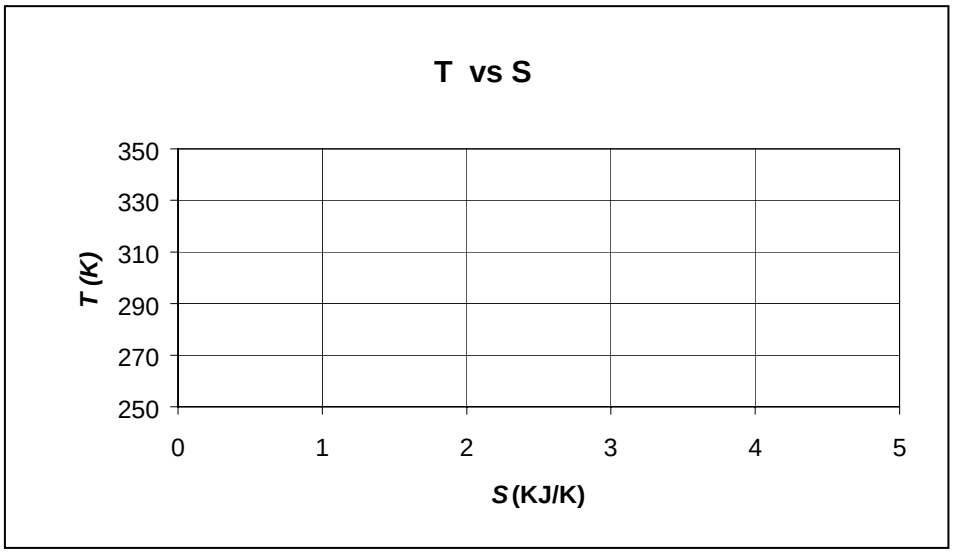
AREN 2110: Thermodynamics
Review Problems, part 2
Fall 2005

1. Engineers are designing a refrigerator that will take in heat from a cold box kept at -3 ^{o}C and reject heat to a room maintained at 22 ^{o}C. They want to know the highest performance theoretically possible for a refrigerator operating under those conditions, in order to understand the limits for their new device.

    a) Draw the process diagram for the refrigeration cycle with the highest possible coefficient of performance. The minimum entropy of the system = S_1 and the maximum entropy = $4S_1$. Use the temperature-entropy graph below. Number process end-points and put arrows to show direction.



    b) Calculate the coefficient of performance for this refrigeration cycle from part a

    c) Calculate the cooling capacity of this refrigerator from part a, in terms of S_1.

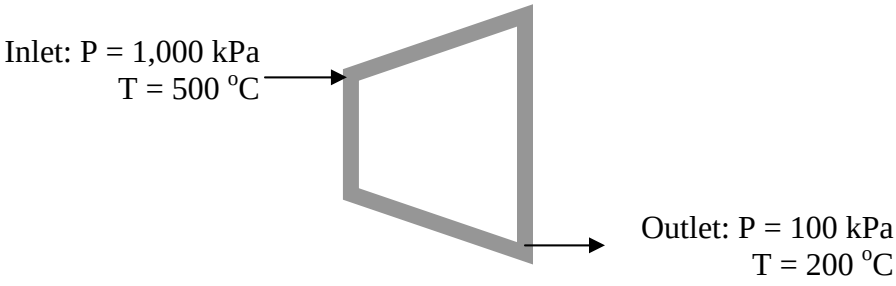
d) Calculate the required work input for the refrigeration cycle from part a), in terms of S_1.

e) What is the maximum amount of entropy change in the system for any <u>one</u> process, in terms of S_1?

f) In which process is the maximum heat transferred? How much is the maximum heat transfer in terms of S_1?

g) What is the generated entropy for the entire cycle, in terms of S_1?

2. Air is expanded in an adiabatic turbine to produce 1,000 kw power, as below.



a) Calculate the mass flow rate of air required.

b) Calculate the rate of entropy generated in the surroundings.

c) If the turbine process were reversible, the entropy generated in the surroundings would - justify your answer -:

1. Increase
2. Decrease
3. Stay the same
4. Can't tell

3. Answer the five the multiple-choice questions below by circling the best choice (or choices if indicated). Justify all answers. Partial credit will be given for a good attempt to analyze the question even if the answer is incorrect.

a) According to the 1st Law of Thermodynamics, the maximum efficiency of a heat engine could be - justify your answer -:

5. 1
6. $1-\frac{Q_{out}}{Q_{in}}$
7. $1-\frac{T_L}{T_H}$
8. none of the above

b) Steam entering a turbine at 10 MPa and 350 ^{o}C is expanded in a reversible adiabatic process. The entropy of the steam at the turbine outlet will be - justify your answer:

1. 5.2112 kJ/kg-K
2. 5.6141 kJ/kg-K
3. 5.9443 kJ/kg-K
4. none of the above

c) Air is throttled in an adiabatic throttling valve to reduce the pressure. The entropy of the air from inlet to outlet will - justify your answer -

1. stay the same
2. increase
3. decrease
4. cannot tell from information given

d) It is possible for a process that is adiabatic to be (circle ALL that are correct) - justify your answer

1. reversible and isentropic
2. isentropic and irreversible
3. isothermal and reversible
4. isothermal and irreversible

e) The process of saturated steam condensing to saturated liquid at constant pressure in a heat exchanger cannot be - choose one and justify your answer:

1. irreversible
2. reversible
3. isentropic
4. isothermal