NAME: ________________________________

ChBE 2130 Thermodynamics I
Fall 2015
Exam 2

Remember

- Write down relevant relationships needed to solve each problem
- Provide details, intermediate steps, and units
- Note any assumptions
- Show your work
- Where indicated, place your final answer on the ________________________
- **Submit your crib sheet with your exam.**

Problem	Possible Points	Score
1	20	
2	24	
3	24	
4	32	
Crib Sheet	Yes No (-5)	
Total	100	

1. Concept Questions **[20 pts: 5 points each,** no partial credit within sub-problem**]**

- An ideal gas is compressed isothermally. What happens to the **entropy** of the gas?
  a. Increases
  b. Decreases
  c. Remains the same
  d. Not enough information to determine

- The pressure of an ideal gas is increased while keeping the entropy constant. What happens to the **enthalpy** of the gas?
  a. Increases
  b. Decreases
  c. Remains the same
  d. Not enough information to determine

- A power plant operates using a hot reservoir of 350°C and a cold reservoir of 30°C. The system (heat engine) efficiency is 55% of the Carnot efficiency for these reservoirs. What is the system efficiency?
  a. 55%
  b. 50.3%
  c. 28.3%
  d. 26.7%

- Which of the following systems is isentropic?
  a. An adiabatic system
  b. An isothermal system
  c. A reversible adiabatic system
  d. A reversible isothermal system

2. A closed, rigid vessel containing 4 lb_m of saturated vapor methane has a total volume of 4 ft^3 (State 1). The surroundings are at 80°F. Heat transfers from the surroundings to the vessel until the final temperature of the methane is 80°F (State 2).
Note: Temperature conversion of °F + 460 = °R and Entropy values on the diagram are in units of btu lb_m/R where R is °Rankine

    a. **[6 pts]** What is the final pressure (State 2)?

    ____

    b. **[8 pts]** What is the entropy change of methane?

    ____

    c. **[10 pts]** If the heat transfer is 420 btu, what is the total entropy generation?

    ____

3. An inventor proposes a process whereby 1.5 kmol of an ideal gas (constant C_p = 30 kJ/kmol K) is taken from 10 bar and 300 K to 1 bar and 500 K in a non-flow closed system. The process receives 50,000 kJ of heat reversibly from the surroundings at 300 K. The process produces work.
   Note: For an ideal gas, C_p - C_v = R

   a. **[12 pts]** Based upon an energy balance, how much work is produced?

   ____

   b. **[12 pts]** Is the process feasible (i.e. consistent with the 2^{nd} Law)?

   ____

4. Consider a Carnot Cycle operating on steam (Steam Table Attached). The fluid is condensed at 30°C and evaporated at 200°C. The process steps are:

   Isothermal expansion from State 1 to 2
   Adiabatic expansion from State 2 to 3
   Isothermal compression from State 3 to 4
   Adiabatic compression from State 4 to 1

   a. **[12 pts]** Complete the following chart:

State	Temp (°C)	Entropy (kJ/ kg K)
1		
2		
3		
4		

   b. **[8 pts]** Determine the heat transfer in the boiler in kJ/kg

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c. **[8 pts]** Determine the cycle efficiency

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d. **[4 pts]** Suppose that the turbine and pump operated at 85% efficiency. In other words, they did **not** operate isentropically (there was irreversibility in the equipment operation). Compare the entropy change of the steam for one complete cycle with the entropy change of a reversible cycle. Does ΔS increase, decrease, or remain the same?

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