AREN 2110: Thermodynamics _____
Midterm 2 **Name**
Fall 2004

Test is open book and notes. Answer all questions and sign honor code statement: ***I have neither given nor received unauthorized assistance during this exam***.

Signed_____

Remember to show your work – partial credit will be given for a correct approach!

Question	Points
1	/35
2	/35
3	/30
Total	/100

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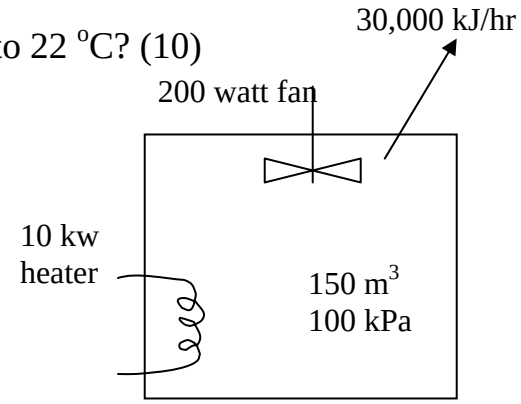
1. (35 points) A room with volume = 150 m^3, pressure = 100 kPa loses an average of 30,000 kJ/hr of heat to the surroundings continuously during the winter. The house is heated by a 10 kw electric resistance heater. A 200-watt fan that runs all the time mixes the room air. During the day when no one is home, the thermostat is set to 15 ^oC. At 5 PM, the thermostat set point is increased to 22 ^oC and the room is kept at that temperature until 8 AM the next day. Use specific heat at room temperature (300K).

a) How long will it take to warm the room air from 15 to 22 ^oC? (10)



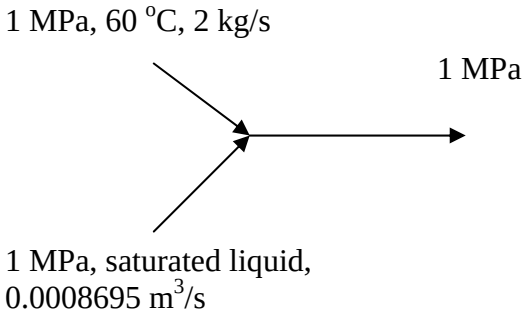
b) How long will the resistance heater run between 5 PM and 8 AM the next day to keep the room at 22 ^oC? (Neglect time to warm room.) (5)

c) If the heater turns off at 8 AM, how long will it take the house to cool to 15 ^{o}C? (10)

d) The homeowner is considering replacing the electric heater with a steam radiator. Steam enters the radiator at 200 kPa and 150 ^{o}C, and leaves as saturated liquid at the same pressure. What is the mass flow rate of steam required to keep the house at 22 ^{o}C from 5 PM to 8 AM? (10)

2. (35 points total) Refrigerant (R-134a) at a pressure of 1 MPa and 60 ^{o}C flows into a well-insulated mixing chamber at a rate of 2 kg/s. Saturated liquid R-134a at the same pressure enters the mixer at a rate of 0.0008695 m^3/s. Assume steady flow conditions.

a) What is the temperature of the refrigerant at the mixer outlet? (10)



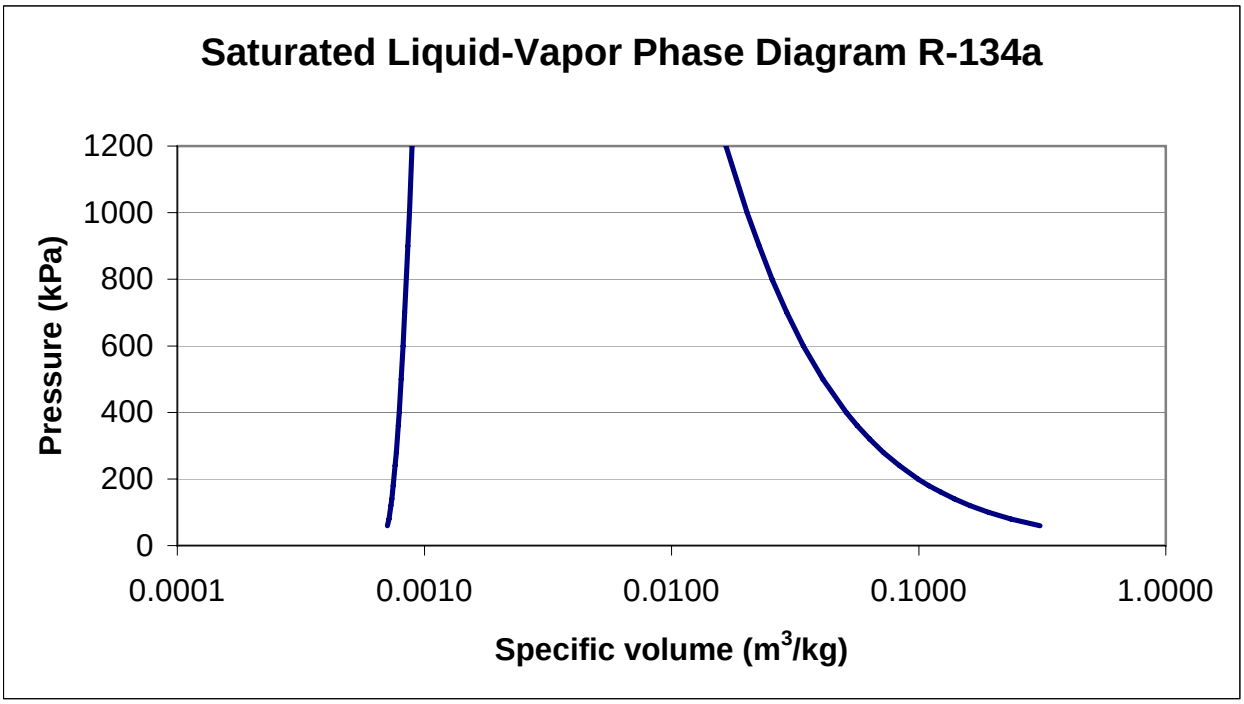
b) What is the percent liquid in the refrigerant at the mixer outlet? (5)

c) After mixing, the refrigerant enters an adiabatic throttling valve that reduces the pressure to 200 kPa. What is the specific enthalpy of the refrigerant at the throttling valve outlet? (5)

d) What is the temperature of the refrigerant at the throttling valve outlet? (5)

e) What percent of the R-134a is liquid at the throttling valve outlet? (5)

e) Draw the throttling valve process on the P-v diagram for refrigerant. (5)



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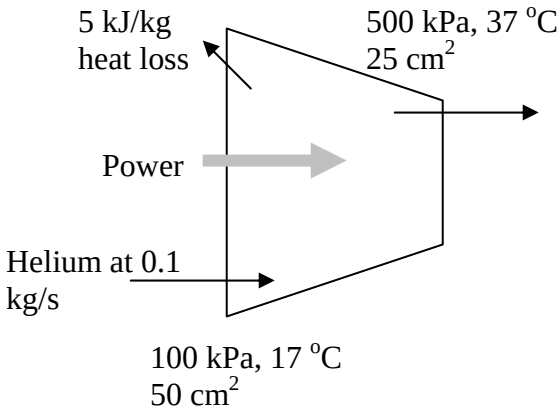
3. (30 points) Helium (He) enters a compressor at 100 kPa and 17 ^{o}C at a steady flow rate of 0.1 kg/s. The inlet area is 50 cm^2. Helium leaves the compressor at 500 kPa and 37 ^{o}C through a 25 cm^2 outlet. The compressor loses heat to the surroundings at a rate of 5 kJ/kg. Note: 1 cm^2 = 10^{-4} m^2.

a) Calculate the volumetric flow rates of He at the inlet and outlet, in m^3/s? (10)



b) Calculate the change in kinetic energy of the helium during compression, in kw. (10)

c) What is the power required for compressing the helium, in kw? Use room temperature value for specific heat (300K). (10)