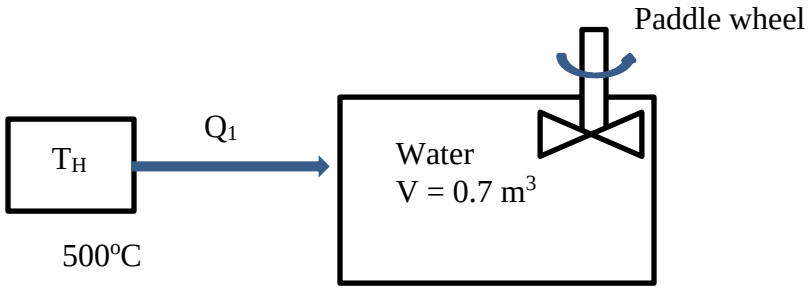
In the oral exam, you will be asked to present your approach to the solution of the following problems. Because time will be limited, it is most important that you demonstrate that you know <u>how</u> to solve the problem, even if you don't have time to work through the detailed algebra to a final solution, and you should estimate any interpolated values from tables to save time. In preparing your notes, bear in mind that you will be asked to state and defend any assumptions you make.

Question 1 (33 points) E3Sp16

A rigid tank of total volume 0.7 m^3 contains water, where initially 0.5% of the volume is occupied by liquid and 99.5% is vapor at a pressure of 20 kPa. Heat from a high temperature source at 500°C (which can be considered a reversible heat transfer reservoir) is transferred to the tank until the mixture inside is saturated vapor. In addition, during the process a paddle wheel does 23 kJ of work on the water. Determine:

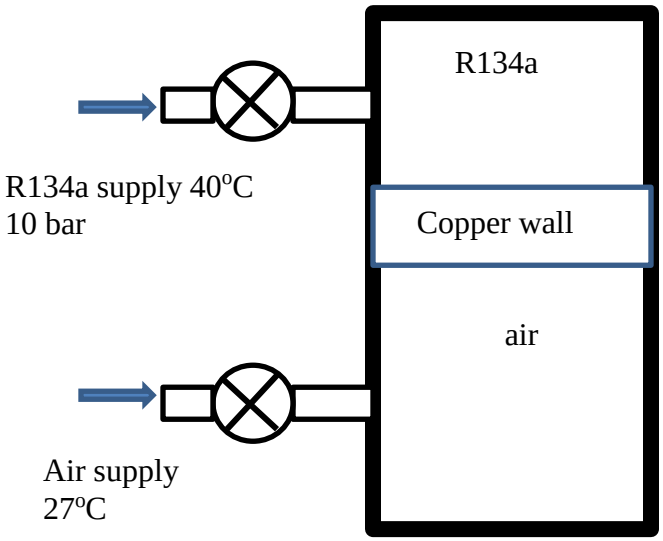
a) The initial temperature of the water (°C).
b) The heat transfer (kJ).
c) The Total entropy generation for the process (kJ/K).
d) Sketch the process on a T-s diagram. Be sure to show the vapor dome.



Question 2 (34 points) E2Sp16

An insulated tank is divided into two chambers. The divider between the two chambers is a relatively massive 10 kg piece of copper that is fixed in place. One chamber is connected to an air-line through a valve; the other chamber is connected to a line that supplies refrigerant R134a through another valve. Initially, the air chamber contains 0.6 kg of air at 100 kPa pressure while the R134a chamber is evacuated. Initially everything within the insulated tank is at a temperature of 17°C. At some point the air valve is opened for 4 minutes and air flows into the chamber at a constant rate of 0.002 kg/s. The valve is then closed and the R134a valve is opened for 2 minutes and closed. The contents of the tank are allowed to come to equilibrium at which point the temperature throughout is 32°C and the R134a is saturated vapor. The conditions upsteam of the valves are shown in the figure below. Assume the air to have **variable** specific heat.

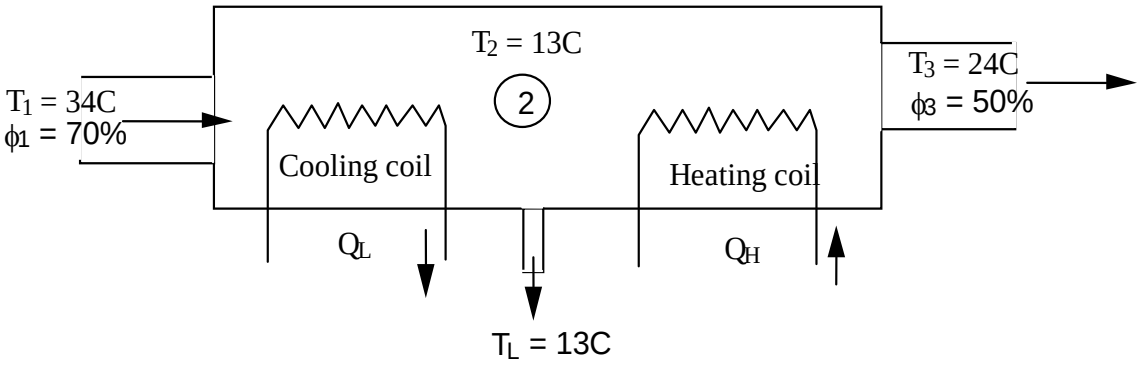
a) What is the final mass of air in the tank (kg)?
b) What is the final pressure of the air, P_2 (kPa)?
c) What is the final pressure of the R134a (kPa)?
d) What is the final mass of R134a in the tank (kg)?

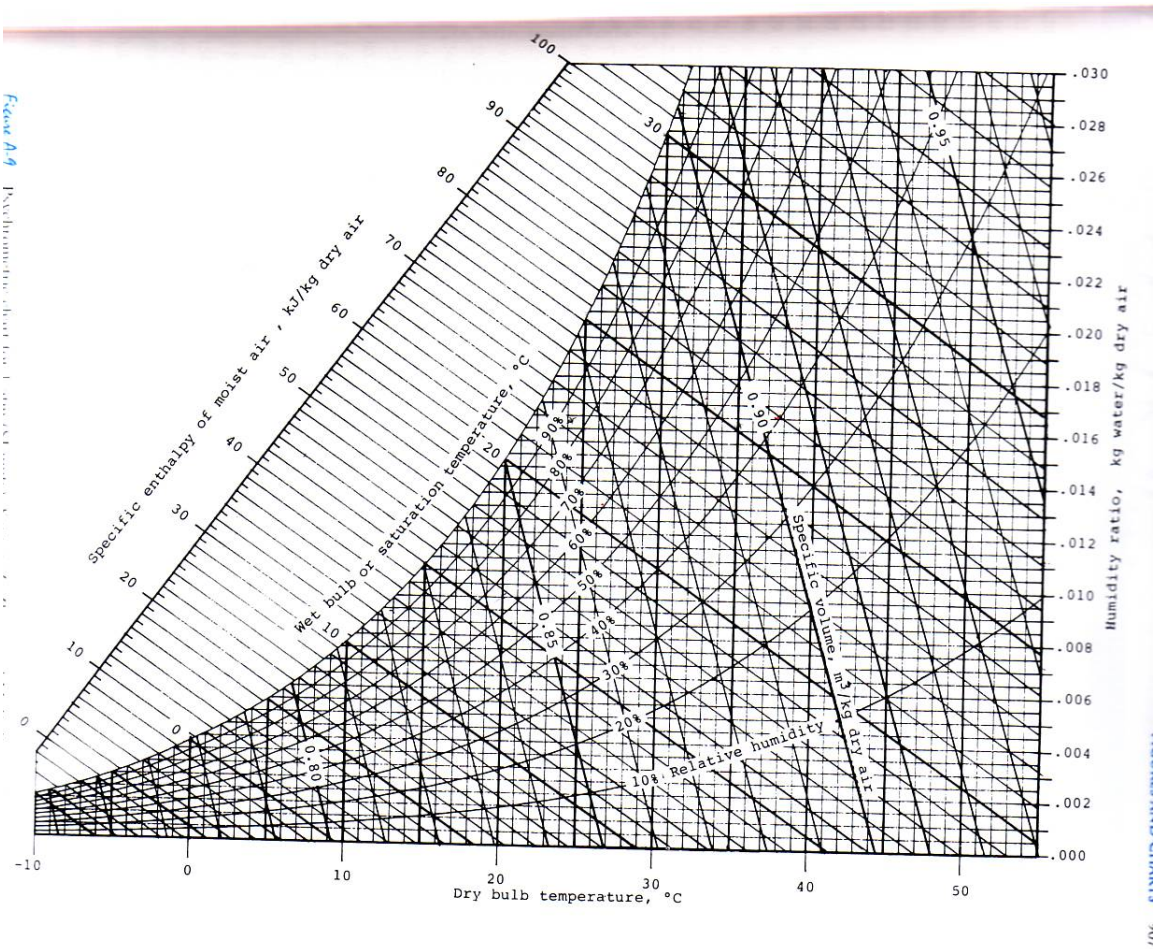


Question 3 (33 points) 343E2FL04

A central air conditioning system operates as shown below. The mass flow rate of moist air into the system is 8.6 kg/min. P = 1 atm. Using the psychrometric chart as much as possible to:

a) Sketch the process on the psychrometric chart. (draw heavy lines and label state points).
b) Calculate the required cooling capacity of the cooling coils in *kJ/min*.
c) Calculate the rate of heat transfer for the heating coils in *kJ/min*.
d) Determine the amount of condensate produced in one hour of operation.




Specific enthalpy of moist air, kJ/kg dry air
Wet bulb or saturation temperature, °C
Humidity ratio, kg water/kg dry air
Dry bulb temperature, °C
Specific volume, m³/kg dry air
Relative humidity
100
90
80
70
60
50
40
30
20
10
0
-10
.030
.028
.026
.024
.022
.020
.018
.016
.014
.012
.010
.008
.006
.004
.002
.000
0.95
0.90
0.85
0.80
90%
80%
70%
60%
50%
40%
30%
20%
10%