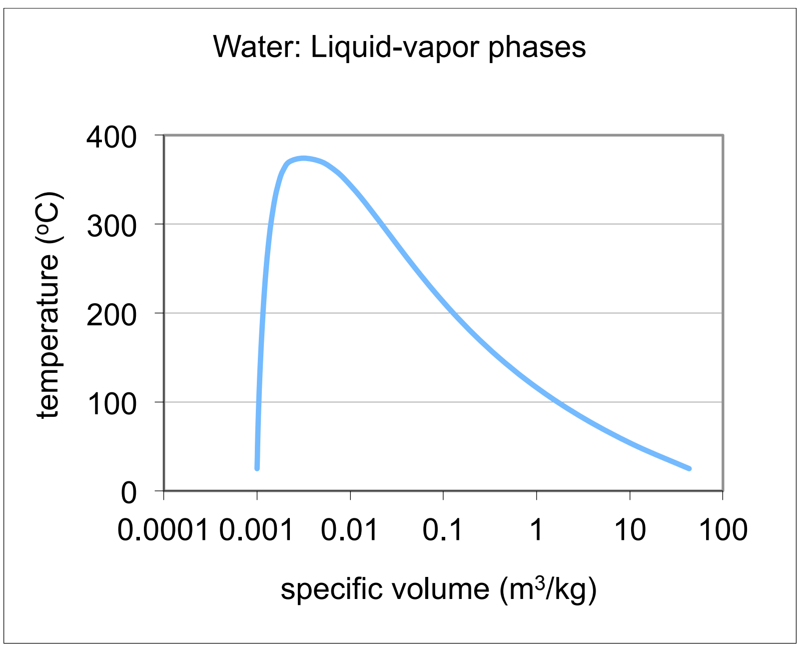
AREN 2110
Spring 2011

Homework #3: Due Friday, Feb. 4, 6 PM

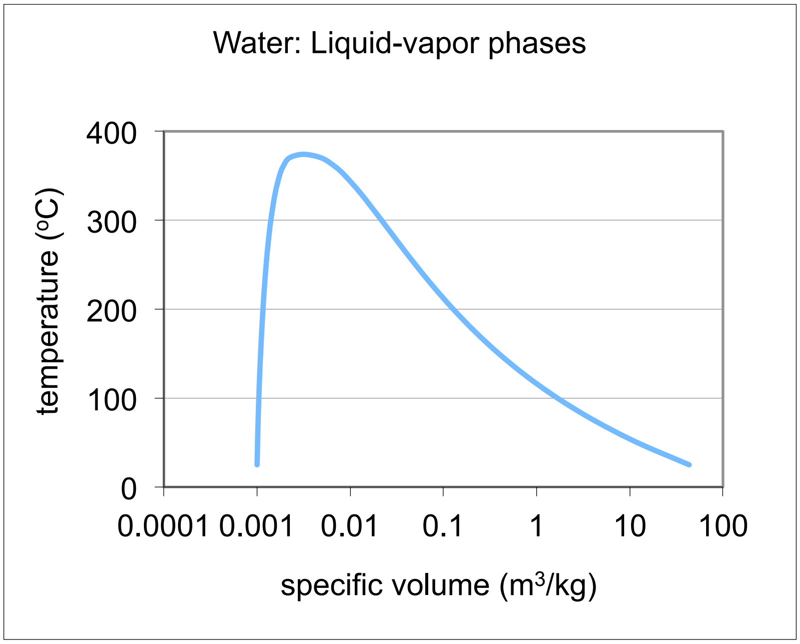
1. A piston-cylinder device initially contains 50L of liquid water at 10 ^{o}C and 300 kPa. Heat is added to the water at constant pressure until the temperature reaches 250 ^{o}C. Determine the following:
    a) the mass of the water
    b) the volume after heating in m^3
    c) the enthalpy change after heating in kJ

Now the water is compressed in an isothermal process until half the mass is in the liquid form.
    d) What is the final volume?
    e) What is the final pressure?
    f) What is the enthalpy change in the water for the 2-step process?
    g) Show the two processes on the T-v diagram



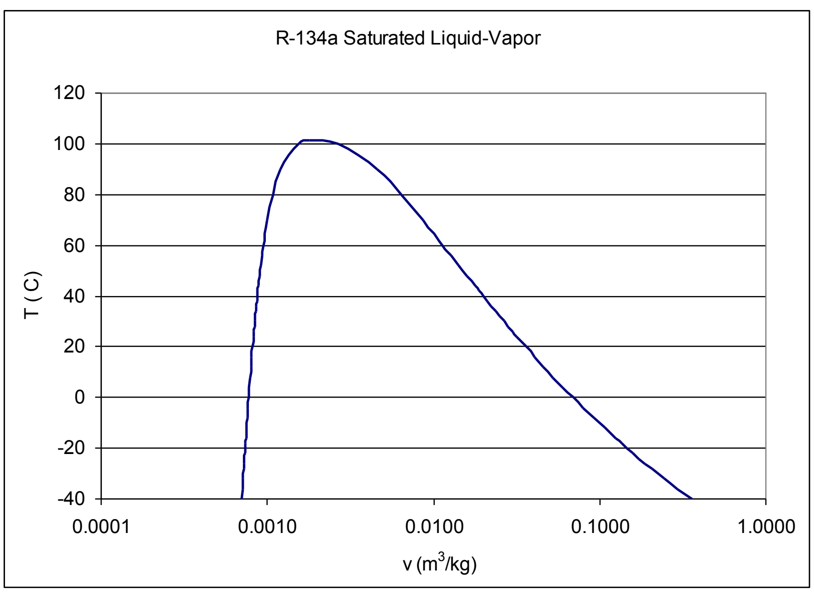
2. Determine the specific volume, internal energy and enthalpy of compressed liquid water at 100 ^{o}C and 15 MPa using the saturated liquid approximation. Compare these values to the ones obtained from the compressed liquid tables.

3. A piston-cylinder device contains 0.8 kg of steam at 300 C and 1 MPa. Steam is cooled at constant pressure until on 75% of its mass condenses. Show the process on a T-v diagram, find the final temperature and determine the volume change.



4. A rigid-wall tank with a volume of 0.1450 m^3/kg contains one kg of R-134a at a temperature of -40 °C (233K). The container is heated until the pressure of the R-134a is 200 kPa.

   a) What is the initial pressure?
   b) What is the final temperature of the R-134a?
   c) Draw the process on the T-v diagram



5. The pressure gage on a 1.3 m^3 oxygen tank reads 500 kPa. Determine the amount of oxygen in the tank if the temperature is 24 C and atmospheric pressure is 97 kPa.

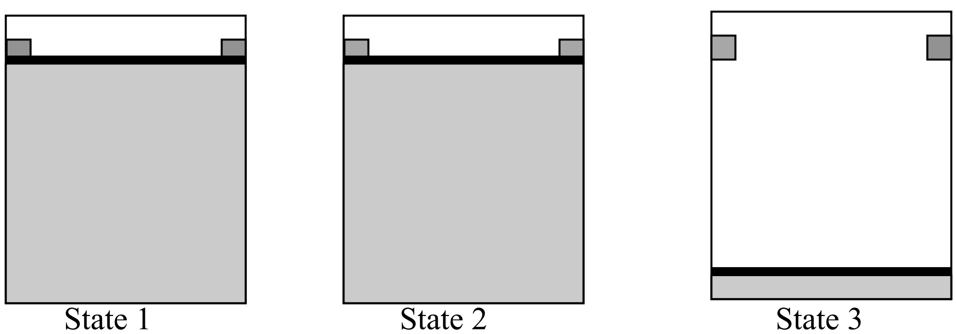
6. The pressure in an automobile tire depends on the temperature of air in the tire. When the air temperature is 25C, a pressure gauge reads 210 kPa. If the volume of the tire is 0.025 m^3, determine the pressure rise in the tire when the air temperature rises to 50C. Also determine the amount of air that must be bled off to restore pressure to its original value at this temperature. Assume atmospheric pressure to be 100 kPa.

7. Argon with a mass of 0.2 kg fills a piston-cylinder device with a volume of 0.05 m^3 and at a pressure of 400 kPa. The piston is moved by changing the weights until the volume is 0.1 m^3. The expansion is isothermal. Calculate the final pressure of the argon.

8. A rigid tank contains an ideal gas at 300 kPa and 600K. In a process, half the gas is withdrawn from the tank and the final pressure in the tank is 100 kPa.

   a) What is the final temperature of the gas?
   b) Suppose instead that no gas was withdrawn from the tank, and by another process, the same final temperature as in part a) was reached. What would the final pressure be?

9. A piston-cylinder device contains 25 kg of refrigerant (R-134a). Initially the refrigerant is at 320 kPa with a specific volume of 0.084 m^3/kg and the piston is exerting pressure force on the stops:



Heat is removed so that all of the refrigerant becomes saturated vapor and the piston is just touching the stops at equilibrium state 2. Then more heat is removed until the R-134a condenses at constant pressure with quality = 0 at state 3.

a) Find the initial temperature of the R-134a at equilibrium state 1
b) Find the temperature and pressure of the R-134a at equilibrium state 2,
c) Find the final volume (V_3) and temperature of the refrigerant at state 3.
d) Find the total enthalpy change for the two-step process in kJ.
e) If work, W, for this system is

$$W = \int_{V_1}^{V_3} P dV \quad (kJ)$$

calculate the work done between states 1 and 3. Is the work positive or negative?

f) Graph the process sequence on the P-V diagram (below)