MAE 3310-001 – Thermodynamics I

Problem Set # 7

Due on 3/24/2009 before 2 PM

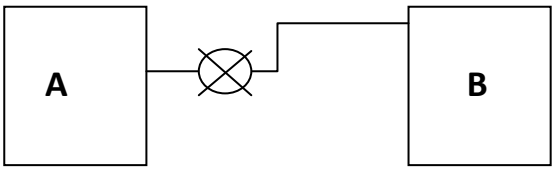
1. A cylindrical vessel of diameter 25cm and 1m height contains 2.5 kg of saturated mixture of vapor and liquid water at 40 ^{o}C.

a. What is the initial level of liquid water inside the vessel?

b. As heat is being to the vessel (slowly), will the water level rise to the top or fall to the bottom within the vessel?

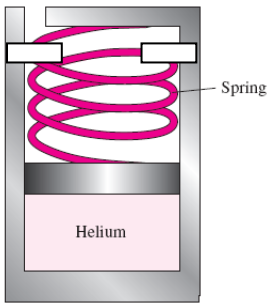
c. What if the vessel contained 250 g of water instead of 2.5 kg?

2. Tank A, shown in the figure, has a volume of 0.75 liter and contains R-134a at 30^{o}C, 10% liquid by volume and 90% vapor by volume, while tank B is evacuated. The valve connecting the tank is now opened and the tanks eventually come to a uniform state, at 30^{o}C and 200 kPa. What is the volume of the tank B?



3. Consider 2.5 kg of water at its triple point. The volume of the liquid phase is equal to that of the solid phase, and the volume of the vapor phase is 10^4 times that of the liquid phase. Determine the mass of water in each phase at this state.

4. The cylinder shown in the figure is fitted with a piston that is restrained by a spring so arranged that for zero volume in the cylinder the spring is fully extended. The spring force is proportional to the spring displacement and the weight of the piston is negligible. The enclosed volume in the cylinder is 120L when the piston encounters the stops. The cylinder contains 4 kg of water initially at 350 kPa, 1% quality, and the water is then heated until it exists as saturated vapor. Show this process on a P-V diagram and determine:



(a) The final pressure in the cylinder.

(b) The work done by the water during the process.

5. A cylinder piston device contains an ideal gas. The gas undergoes two successive cooling processes by rejecting heat to the surroundings. First the gas is cooled at constant pressure until T2 = 0.75 T1. Then the piston is held stationary while the gas further cooled to T3 = 0.5 T1. The temperatures are all in K.

(a) Find the ratio of the initial volume to the final volume

(b) What is the work done on the gas by the piston?

(c) What is the total heat transferred from the gas?

6. Assume that you own a heater business. A client asks for a heater of an appropriate size to heat a swimming pool which is 2m deep, 25 m long and 25 m wide. The client requires the heating time to heat the pool from 20^{o}C to 30^{o}C should not exceed 3h. If the heating losses are estimated at 1000 W/m^{2}, what is the size of the recommended heater if the efficiency of such a heater is 80%? If the swimming pool is to be maintained at 30oC subsequently, would the heater designed for heating up be sufficient? Use steam tables for water properties.