Problem 3.10: A closed and sealed rigid tank contains 11 kg of liquid water at equilibrium with 1.17 kg of vapor at a pressure of 2 bar. The tank is equipped with two alarms: a pressure alarm that will sound if the pressure exceeds 10 bar; and a temperature alarm that will sound if the temperature exceeds 200 °C.
a) What is the volume of the tank?
b) Calculate the internal energy of the liquid-vapor mixture in the tank.
c) If we add heat to the tank continuously, which alarm will sound first?
d) We stop the heating when the contents are saturated vapor. How much heat has been added?
e) Which alarm(s), if any, will be sounding at the end of step (d)?
f) Draw a qualitative PV graph and sketch the path of the processes involved. Mark all the relevant isotherms and pressures.

Problem 3.11: a) A closed tank contains steam with 20% moisture at 3 bar. Heat is added until one of the two phases disappears. Which phase disappears and what is the final pressure and temperature?
b) Another closed tank contains steam with 99.9 % moisture at 3 bar. Heat is added until one of the two phases disappears. Which phase disappears and what is the final pressure and temperature?
c) A third closed tank contains a vapor-liquid mixture of toluene at 1 atm. Ninety-eight percent of the toluene (by mole) is in the liquid phase. Heat is added until one of the two phases disappears. Which is the phase that disappears?

Add text: The normal boiling point of toluene is 384 K.

Problem 3.12: A sealed rigid tank of 1 m^3 capacity contains 1.2 kg of water at 1 bar and 99.63 °C. To this tank we add heat until the pressure increases to 3 bar.
a) What is the temperature at the end of the heating?
b) Calculate the amount of vapor before and after the heating.
c) Calculate the amount of heat added.

Problem 3.13: A sealed rigid tank contains 1 kg of wet steam at 300 °C. The fraction of the liquid in the tank is not known. Upon adding heat to the tank it is observed that the vapor condenses. The heating stops when the system becomes saturated liquid. At that point the pressure in the tank is 148 bar.
a) What fraction of the water is initially liquid?
b) How much heat was added?
c) What is the minimum amount of liquid that must be present in the tank initially, in order to observe condensation upon heating?
d) What would be observed upon heating, if the initial amount of liquid was less than the minimum value calculated in part (c)?
e) How do you explain the fact that heating can result in condensation of the vapor?