SHEET (3)

1. Answer the following questions:
   a. Is iced water a pure substance? Why?
   b. What is the difference between saturated liquid and compressed liquid?
   c. What is the difference between saturated vapor and superheated vapor?
   d. Is it true that water boils at higher temperatures at higher pressures? Explain.
   e. Why are the temperature and pressure dependent properties in the saturated mixture region?
   f. What is the difference between the critical point and the triple point?
   g. Is it possible to have water vapor at -10°C?
   h. A househusband is cooking beef stew for his family in a pan that is (*a*) uncovered, (*b*) covered with a light lid, and (*c*) covered with a heavy lid. For which case will the cooking time be the shortest? Why?
   i. Does the amount of heat absorbed as 1 kg of saturated liquid water boils at 100°C have to be equal to the amount of heat released as 1 kg of saturated water vapor condenses at 100°C?
   j. Does the reference point selected for the properties of a substance have any effect on thermodynamic analysis? Why?
   k. Is it true that it takes more energy to vaporize 1 kg of saturated liquid water at 100°C than it would at 120°C?
   l. What is quality? Does it have any meaning in the superheated vapor region?
   m. Which process requires more energy: completely vaporizing 1 kg of saturated liquid water at 1 atm pressure or completely vaporizing 1 kg of saturated liquid water at 8 atm pressure?
   n. Does h_{fg} change with pressure? How?
   o. Can quality be expressed as the ratio of the volume occupied by the vapor phase to the total volume? Explain.
   p. In the absence of compressed liquid tables, how can the specific volume of a compressed liquid at a given P and T be determined?
   q. Propane and methane are fuels, and the leakage of these fuels, even for short periods, poses a fire danger. Which gas leakage do you think poses a greater risk for fire? Explain.
   r. What is the difference between R and R_u? How are these two related?
   s. What is the difference between mass and molar mass? How are these two related?

2. Complete this table for H_2O:

T, °C	p, kPa	v, m^3/kg	u, kJ/kg	Phase description
50		4.16		
	200			Saturated vapor
250	400			
110	600			
	550			Saturated liquid
	400		1450	
	4000		3040	

3. Complete this table for H_2O:

T, °C	*p*, kPa	*h*, kJ/kg	*x*	Phase description
	200		0.7	
140		1800		
	950		0	
80	500			
	800	3162.2		

4. A 1.8-m^3 rigid tank contains steam at 220°C. One-third of the volume is in the liquid phase and the rest is in the vapor form. Determine (*a*) the pressure of the steam, (*b*) the quality of the saturated mixture, and (*c*) the density of the mixture.

5. Water is to be boiled at sea level in a 30-cm-diameter stainless steel pan placed on top of a 3–kW electric burner. If 60 percent of the heat generated by the burner is transferred to the water during boiling, determine the rate of evaporation of water.

6. Water is boiled at 1 atm pressure in a 25-cm internal diameter stainless steel pan on an electric range. If it is observed that the water level in the pan drops by 10 cm in 45 min, determine the rate of heat transfer to the pan.

7. Saturated steam coming off the turbine of a steam power plant at 30°C condenses on the outside of a 3-cm outer-diameter, 35-m-long tube at a rate of 45 kg/h. Determine the rate of heat transfer from the steam to the cooling water flowing through the pipe.

8. The average atmospheric pressure in Saint Catherine is 87 kPa. Determine the temperature at which water in an uncovered pan boils

9. Water in a 5-cm-deep pan is observed to boil at 98°C. At what temperature will the water in a 40-cm-deep pan boil? Assume both pans are full of water.

10. A cooking pan whose inner diameter is 20 cm is filled with water and covered with a 4-kg lid. If the local atmospheric pressure is 101 kPa, determine the temperature at which the water starts boiling when it is heated.

11. A rigid tank with a volume of 2.5 m^3 contains 15 kg of saturated liquid–vapor mixture of water at 75°C. Now the water is slowly heated. Determine the temperature at which the liquid in the tank is completely vaporized. Also, show the process on a *T*-*v* diagram with respect to saturation lines.

12. A piston–cylinder device contains 0.1 m^3 of liquid water and 0.9 m^3 of water vapor in equilibrium at 800 kPa. Heat is transferred at constant pressure until the temperature reaches 350°C.
    - *(a)* What is the initial temperature of the water?
    - *(b)* Determine the total mass of the water.
    - *(c)* Calculate the final volume.
    - *(d)* Show the process on a *P*-*v* diagram with respect to saturation lines.

13. A piston–cylinder device initially contains 50 L of liquid water at 40°C and 200 kPa. Heat is transferred to the water at constant pressure until the entire liquid is vaporized.
    - *(a)* What is the mass of the water?
    - *(b)* What is the final temperature?

(*c*) Determine the total enthalpy change.
(*d*) Show the process on a *T-v* diagram with respect to saturation lines.

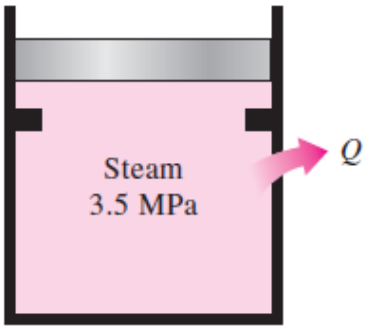
14. A 0.3-m^3 rigid vessel initially contains saturated liquid–vapor mixture of water at 150°C. The water is now heated until it reaches the critical state. Determine the mass of the liquid water and the volume occupied by the liquid at the initial state.

15. Determine the specific volume, internal energy, and enthalpy of compressed liquid water at 100°C and 15 MPa using the saturated liquid approximation. Compare these values to the ones obtained from the compressed liquid tables and determine the corresponding error percentage.

16. A piston–cylinder device contains 0.8 kg of steam at 300°C and 1 MPa. Steam is cooled at constant pressure until one-half of the mass condenses.
    (*a*) Show the process on a *T-v* diagram.
    (*b*) Find the final temperature.
    (*c*) Determine the volume change.

17. A rigid tank contains water vapor at 250°C and an unknown pressure. When the tank is cooled to 150°C, the vapor starts condensing. Estimate the initial pressure in the tank.

18. A piston–cylinder device initially contains steam at 3.5 MPa, superheated by 5°C. Now, steam loses heat to the surroundings and the piston moves down hitting a set of stops at which point the cylinder contains saturated liquid water. The cooling continues until the cylinder contains water at 200°C. Determine (*a*) the initial temperature, (*b*) the enthalpy change per unit mass of the steam by the time the piston first hits the stops, and (*c*) the final pressure and the quality (if mixture).



19. The pressure in an automobile tire depends on the temperature of the air in the tire. When the air temperature is 25°C, the pressure gage 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 in the tire rises to 50°C. Also, determine the amount of air that must be bled off to restore pressure to its original value at this temperature. Assume the atmospheric pressure is 100 kPa.

20. A 1-m^3 tank containing air at 25°C and 500 kPa is connected through a valve to another tank containing 5 kg of air at 35°C and 200 kPa. Now the valve is opened, and the entire system is allowed to reach thermal equilibrium with the surroundings, which are at 20°C. Determine the volume of the second tank and the final equilibrium pressure of air.

21. A rigid tank contains an ideal gas at 300 kPa and 600 K. Now half of the gas is withdrawn from the tank and the gas is found at 100 kPa at the end of the process. Determine (*a*) the final temperature of the gas and (*b*) the final pressure if no mass was withdrawn from the tank and the same final temperature was reached at the end of the process.

22. On the property diagrams indicated below, sketch (not to scale) with respect to the saturated liquid and saturated vapor lines and label the following processes and states for steam. Use arrows to indicate the direction of the process, and label the initial and final states:

(*a*) On the *P*-*v* diagram sketch the constant temperature process through the state p = 300 kPa, v = 0.525 m^3/kg as pressure changes from p_1 = 200 kPa to p_2 = 400 kPa. Place the value of the temperature on the process curve on the *P*-*v* diagram.

(*b*) On the *T*-*v* diagram sketch the constant specific volume process through the state T = 120° C, v = 0.7163 m^3/kg from P_1 = 100 kPa to P_2 = 250 kPa. For this data set place the temperature values at states 1 and 2 on its axis. Place the value of the specific volume on its axis.