AREN 2110
Fall 2007
Sections 001 and 002

Homework #3

DO PROBLEMS 1 – 11. EXTRA CREDIT PROBLEMS ARE OPTIONAL
Due Thursday, 9/20.

1. If the pressure of a substance is increased during the boiling process, will the temperature also increase or will it remain constant? Why?

2. Complete the following table for H_2O

P (kPa)	T (^oC)	v (m^3/kg)	phase
	50	4.16	
200			Saturated vapor
400	250		
600	110		

3. Complete the following table for H_2O:

P (kPa)	T (^oC)	h (kJ/kg)	x	phase
200			0.7	
	140	1800		
950			0.0	
500	80			
800		3162.2		

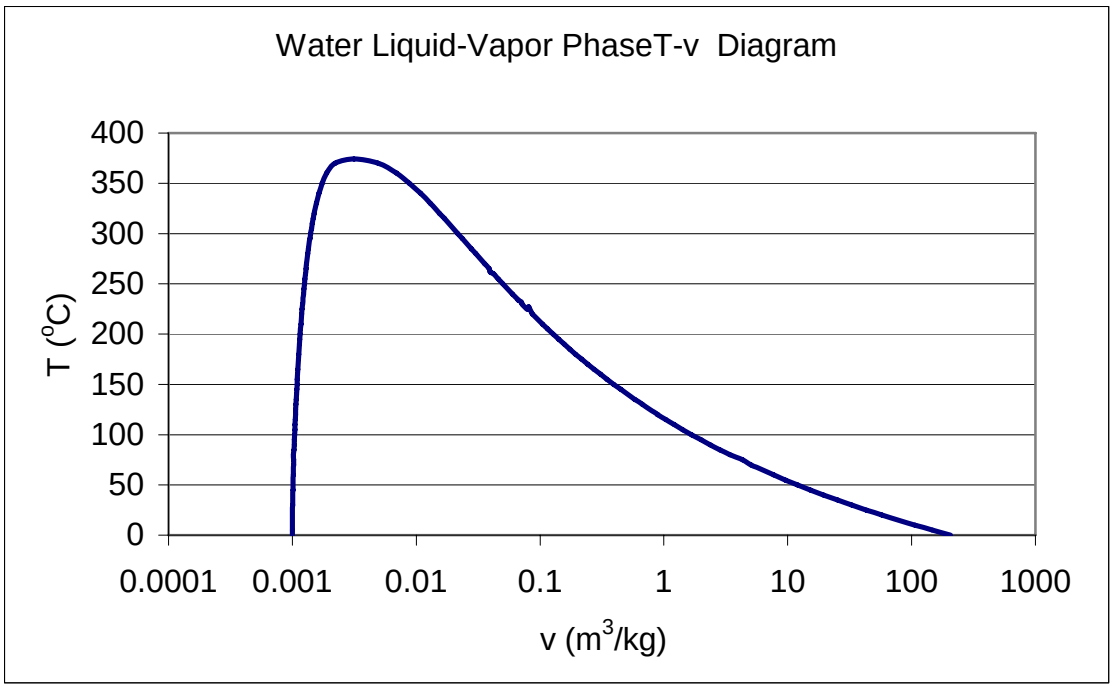
4. Complete the following table for the various substances

substance	P (kPa)	T (^oC)	v (m^3/kg)	x*	phase
H_2O		150		0.4	
H_2O		150	0.4708		
air	100	150			
R-134a		0	0.0500		
R-134a	400	0			

* use "na" for "not applicable" where quality does not apply

5. A piston-cylinder device contains 0.85 kg of refrigerant 134a at -10 ^{o}C (263 K). The piston has a mass of 12 kg and a diameter of 25 cm. The local atmospheric pressure is 88 kPa. Now, heat is transferred to the refrigerant until the temperature is 15 ^{o}C. Determine:
    a. The final pressure
    b. The change in volume of the cylinder space
    c. The change in enthalpy of the refrigerant

6. A rigid tank with a volume of 2.5 m3 contains 15 kg of saturated liquid-vapor mixture of water at 75 ^{o}C. Now the water is slowly heated.
    a. What is the quality of the mixture?
    b. Determine the temperature at with the liquid in the tank is completely vaporized to saturated vapor.
    c. What is the pressure in the tank?
    d. Show the process on the T-v diagram, below.



7. One kilogram (1 kg) of water vapor at 200 kPa fills the left chamber of a partitioned system shown below. The volume of this chamber is 1.1989 m^3. The right chamber has twice the volume of the left chamber and is evacuated at the initial state.

1 kg water 200 kPa 1.1989 m^3	

7. (continued) Now the partition is removed and heat is transferred so that the temperature of the water is 3 ^{o}C.

   a. What is the initial temperature of the water (before the partition is removed)?
   b. What is the pressure of the water after the partition is removed and heat transferred?
   c. What is the quality of water at the final equilibrium state?

8. Under what conditions is the ideal gas assumption suitable for real gases?

9. An informative article in a magazine states that tires lose approximately 1 psi of pressure for every 10 ^{o}F drop in outside temperature.
   a. Convert this relation to degrees Celsius
   b. Show if the relation is valid or not.

10. Argon in the amount of 0.2 kg fills a 0.05-m^3 piston-cylinder device at 400 kPa. Now, the weight of the piston is changed so that the piston moves and the final volume is twice the initial volume. The process is carried out so it is isothermal. What is the final pressure in the cylinder?

11. A combustion chamber in a gasoline engine may be approximated by a constant volume heat addition process. A uniform mixture of air and fuel is in the cylinder before combustion and after, the combustion gases. Both of these may be approximated by air, an ideal gas. The cylinder conditions before combustion are 1.8 MPa and 450 ^{o}C. After combustion, the temperature of the gas is 1300 ^{o}C. What is the pressure at the end of the combustion process?

EXTRA CREDIT PROBLEMS

1. (2 points) Derive the units of the gas constant, R, when pressure is KPa, mass is kg, volume is m^3, and temperature is degrees K. Repeat for the universal gas constant, R_u, when all units are the same except mass is in kmole.

2. (1 point) The mass flow rate of a substance is proportional to the velocity as:
   $\dot{m} = cV$ where V = velocity (m/s) and $\dot{m}$ = mass flow rate (kg/s).

   a. What are the units of c?

3. (1 point) The specific kinetic energy of a substance, ke, is equal to:

$$ke = \frac{V^2}{2} \text{ where } V = \text{velocity (m/s).}$$

   Show that the units of ke (J/kg) are consistent with the units of the right hand side.

4. (3 points) Joe Smith, an engineering student, believes that the boiling point of water is the best point of reference for temperature scales. He does not like the fact the in the existing absolute temperature scales the boiling point is an odd number. He has proposed instead a new absolute temperature scale, the Smith scale. The temperature unit in the Smith scale is S, and the boiling point of water is 1000 S.
    a. Is the Smith scale a valid absolute temperature scale? Why/Why not?
    b. What is the ice point of water on the Smith scale?
    c. Develop a formula to convert from Smith to Celsius.