Thermodynamics Tutorial: Properties of Pure Substances

Exercises:

1. Determine the saturated pressure, specific volume, internal energy and enthalphy for
   a) Saturated vapor at 70^{o}C and 75^{o}C
   b) Saturated vapor at 77 ^{o}C
   c) Saturated liquid at 100^{o}C and 303.5^{o}C
   d) Superheated water at 25bar and 320^{o}C

2. Determine the saturated temperature, specific volume, internal energy and enthalphy for
   a) Saturated liquid at 1bar and 20bar
   b) Compressed liquid water at 50bar and 140 ^{o}C
   c) Saturated vapor refrigerant-134a at 5bar and 930kPa

3. Complete the missing properties in the following table using saturated R-134a

T(^{o}C)	P_{sat}(kPa)	V_f (m^3/kg)	V_g (m^3/kg)	u_{fg} (kJ/kg)	h_{fg} (kJ/kg)
	646.18	0.0008261			
-10			0.099516		
-14	170.93				
				130.88	149.39
100				29.19	

4. For a steam at 2000kPa with quality of 0.9, calculate the specific volume, specific enthalpy and specific internal energy. Sketch the process in the form of a P-v diagram. [Ans: 0.0896m^3/kg, 2609.29kJ/kg,2429.8kJ/kg]

5. Determine the enthalpy of 2.5kg of water contained in a volume of 2m^3 at 2bar. [Ans:2493.1kJ/kg]

6. Determine the internal energy of R-13a at a temperature of 0^{o}C and a quality of 60% [Ans:158.748kJ/kg]

7. Find the quality, specific volume and specific enthalpy of steam at 950kPa and specific internal energy 2450kJ/kg [Ans:0.93, 0.1898 m^3/kg, 2633.57kJ/kg]

8. The pressure inside closed, rigid tank of water are 7bar and the mass of the saturated liquid is 2kg and the mass of the saturated vapor is 0.25kg. Heat is added to the water until the pressure increases to 80bar. Find the final temperature, enthalpy and internal energy of the water. [Ans:350.29^{o}C, 2988.97kJ/kg, 2748.97kJ/kg]

9. Steam at 100bar has a specific volume of 0.02812m^3/kg. Find the temperature, specific enthalpy and specific internal energy. [Ans: 425.21^{o}C, 2889.27kJ/kg, 3170.56kJ/kg]

10. Steam at 225kPa is contained in a 0.9m^3 rigid cylinder. The cylinder is cooled until the pressure is drop to 175kPa at constant volume. Calculate mass of steam in the cylinder and quality at final state. [Ans:1.1345kg, 0.79]

Exercises:

1. A air gas inside a rigid tank has volume 0.05m^3, pressure of 350kPa and temperature of 400K. The gas is compressed until the pressure increase to 2MPa.Calculate the mass of the gas and the final temperature of gas. Given the value of gas constant is 0.287kJ/kgK [0.1524kg, 2285.71K]

2. Calculate how many moles of gas would be present in a a gas trapped in vessel with volume 0.1L, pressure of 3 atmospheres and temperature of 300K. Given the value of R is 0.082057 L atm/molK [0.012mole]

3. A 0.2 mole of nitrogen gas inside a tank occupy 0.01m^3 at 30^oC. Calculate the pressure. Given the value of R is 0.082057 L atm/molK [0.498 atm]

4. A 80 g of gas contained in a 0.05m^3 cylinder at a pressure of 200 atm and temperature of 310K. Calculate how many moles of gas and what is its molecular weight of the gas. Given the value of R is 0.082057 L atm/molK [393.12moles, 2.035x10^{-4}kg/mole]

5. A 0.05kg of ideal gas occupies a volume of 0.008m^3 at a pressure of 7bar and temperature of 400K. Calculate the molecular weight of gas. The gas is heated and expand until the pressure is 2bar and volume is 0.07m^3. Determine the final temperature. Given the value of gas constant is 287J/kgK [0.103kg/mole,1000K]

6. A nitrogen gas inside a 2m^3 rigid tank has presure of 2 bar and 600K are connected by a valce to another tank of 1m^3 with nitrogen at 4.5bar and 700K. The valve is opened and the two tanks reach equilibrium temperature at 650K. Determine the equilibrium pressure. [283.73kPa]

7. A 1m^3 cylinder has propane at 25^oC and 5bar is connected through a valve to another cylinder of propane at 35^oC and 2bar. The valve is opened and the entire system is allowed to reach thermal equilibrium at 20^oC. Find the volume of second tank and the equilibrium pressure of propane. [2.58m^3, 274.44kPa]

8. A cylindrical gas tank with 2m long and diameter 10cm is evacuated and filled with carbon dioxide gas at 25^oC. Determine the pressure should be charged if there should be 2kg of carbon dioxide? Given the value of R is 8.3144 J/molK, atomic mass for carbon is 12 and oxygen is 16. [7.184Pa]

9. A tank contains 4kg of gas is heated at a constant volume of 1m^3 and temperature 20^oC until reach temperature of 150^oC. Assume the gas is ideal gas, determine the heat flow during the process, the initial pressure of gas and the final pressure of gas. Given c_v is 0.72 kJ/kgK and R is 287J/kgK. [374.4kJ, 336.54kPa, 485.78kPa]

10. 10g of a gas receive 200kJ as heat at constant volume process. If the temperature of the gas increases by 100^oC, determine the C_v of the process. [53.598 kJ/kgK]

11. A certain ideal gas has specific heat as follows c_p is 0.846kJ/kgK and C_v is 0.657kJ/kgK. Determine the value of the gas constant. [0.189kJ/kgK]

Exercises:

1. An ideal gas is heated at a constant temperature of $0.22m^3$ and $325kN/m^2$ until final state of $170kN/m^2$. Determine the final volume of the gas.

2. An ideal gas is heated at a constant temperature of 2bar until final state of 1 bar and volume $1m^3$. Determine the initial volume of the gas.

3. An ideal gas undergoes a constant pressure process with an initial volume at $0.54m^3$ and 345^oC respectively. If the volume of the system is decrease to $0.32m^3$, determine the final temperature of the gas.

4. An ideal gas is contained in a closed tank with an initial pressure and temperature of 2.2bar and 70 ^oC respectively. If the volume of the system is increased 1.5 times and the temperature drops to 15^oC, determine the final pressure of the gas.

5. A closed assembly contains 2kg of air at an initial pressure and temperature of 140kPa and 210^oC respectively. If the colume of the system is doubled and temperature drops to 37^oC, determine the final pressure of the air. Assume air as an ideal gas.