Minor-1, Time allotted: 1 hour, Chemical Engineering Thermodynamics, CHL121
Only one A4 page hand written notes are allowed

Problem 1: At 273.16 K the enthalpy change on fusion of water is 6.0 kJ/mol and the corresponding volume change is $1.6X10^{-6}$ m^3/mol. Estimate the temperature at which ice will melt at 1000 atm pressure (take 1 atm = 10^5 N/m^2). **3**

Problem 2: Over the range of 298-848 K, the heat capacity of quarts (SiO_2) at atmospheric pressure is approximated as

$$C_p = 40.50 + (44.6 \times 10^{-3})T - (8.32 \times 10^5)T^{-2}$$

Where T is in kelvins and C_p is in J/mol.K . If 1000 Kg of quartz is heated from 300 to 700 K at atmospheric pressure, how much heat is required. **5**

Problem 3: A tank contains liquid water and steam in equilibrium at 700 kPa. If the liquid and vapor each occupy half of the volume of the tank, what is the specific enthalpy content of the tank? **5**

Problem 4: Indicate whether the following statements are True or False. **5 (+0.5 for a correct answer and -0.5 for a wrong answer)**

a) For a closed gaseous system, the value of $\int PdV$ for the change of the gas from one given state to another is independent of the path so long as all processes are reversible.
b) All ideal gases have the same molar heat capacity at constant pressure (C_p)
c) The molar heat capacity at constant volume (C_v) of an ideal gas is independent of temperature.
d) The molar heat capacity at constant pressure (C_p) of an ideal gas is independent of pressure.
e) The enthalpy of an ideal gas is a function of temperature only.
f) Work is always given by the integral $\int PdV$
g) The energy of an isolated system must be constant
h) There is but a single degree of freedom at equilibrium for a three-phase PVT system made up of three non-reacting chemical species.
i) The heat capacity at constant volume of a single component system consisting of liquid and vapor in equilibrium is infinite.
j) At the critical point the internal energy of saturated liquid is equal to the internal energy of saturated vapor

Problem 5: Derive an expression for van der Waals parameters ***a*** and ***b*** in terms of experimentally measured quantities. What do these terms physically represent in terms of molecular interactions? **5**

Problem 6: 0.01 kg of steam at 260 °C expands reversibly and isothermally in a piston and cylinder apparatus from an initial volume of 2 L to a final volume 20 L. How much work is done by the steam? Values for virial coefficients: B= -0.1422 L/mol and C = -0.00714 L^2/mol^2. **5**

Problem 7: On a PV diagram show the locations of the fluid region and the vapor region. **2**