INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

**Department of Metallurgical Engineering and Materials Science**

**MM 209: THERMODYNAMICS : 2019-20: FALL**

**Tutorial 1 Date:09/08/2019**

1. One kmol of CO (assume it to be an ideal gas with Cv = 2.5R J/mol.K, γ=1.4 ) at 25oC and 1 atm.pressure is allowed to expand adiabatically against vacuum to twice its volume [Evidently this is an irreversible process]. The final temperature is found to be the same as the initial one. From the same starting point, reach the same final state by the following processes :
   1. Isothermal *reversible* expansion to the final volume.
   2. (i)Adiabatic *reversible* expansion to the final volume and (ii) then thermal interaction at constant volume ( At constant volume, δq = nCvdT)
   3. (i) Isothermal reversible expansion to 1.5 times the initial volume, and then (ii) adiabatic reversible expansion to the final volume and then (iii) thermal interaction at constant volume.

For *adiabatic reversible* expansion of an ideal gas, PVγ = constant. R = 8.314 J/mol/K

For these processes fill the following table (whichever you can)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| process | Pinitial | Vinitial | Tinitial | Pfinal | Vfinal | Tfinal | q | w | ΔE= q-w |
| Expn.against  Vacuum, adia- | 1 atm. |  | 298.15K |  |  | 298.15K | 0 |  |  |
| a |  |  |  |  |  |  |  |  |  |
| b (i)  (ii) |  |  |  |  |  |  |  |  |  |
| c (i)  (ii)  (iii) |  |  |  |  |  |  |  |  |  |

1. 18.02 g of liquid water is enclosed under a frictionless weightless piston at 373.15K and 1atm pressure. The pressure above the piston is lowered slightly (infinitesimally) below 1 atm and the water is allowed to vaporize isothermally until no liquid is left. For this process, q=40671 Joule. Specific volume of water is 1.043 x 10-3m3/kg and that of steam is 1.677m3/kg at 373.15K and 1atm.
   1. Calculate the work w attending this vaporization and ∆E and ∆H for the process.
   2. Find the value of q, ∆E and ∆H for the process where the piston is removed and the water is allowed to vaporize *freely* and *isothermally* into an *evacuated* space of such volume that on vaporization the total volume is that occupied by steam at 373.15K and 1atm pressure.