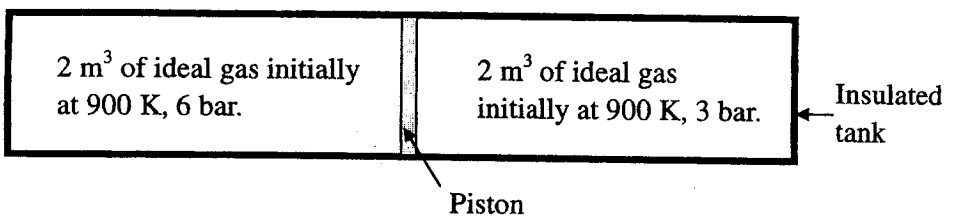
3. For an ideal gas,

(a) show that $c_p - c_v = R$. Where c_p and c_v represent the specific heats at constant pressure and constant volume, respectively. **(5%)**

(b) if this gas is placed in an insulated tank that is divided into two parts by a frictionless, thermally conducting piston, as shown in the following schematic. On one side of the piston is 2 m^3 of gas at 900 K, 6 bar. On the other side is 2 m^3 of the same gas at 900 K, 3 bar. The piston in released and finally a new equilibrium is reached. Calculate the entropy production during the process? (If you do not have an electronic calculator with you, please write down the solution procedures, including all equations, as detailed as possible.) **(10%)**



4. Referring to the following attached schematic, steam initially at pressure of 30 bar and temperature of 500℃ is contained in a large vessel, System A. The System A is connected to a turbine, Turbine C, by a valve, Valve B that is closed initially. The exhausted steam from Turbine C is discharged to an initially evacuated tank, Tank D, with volume of 2 m^3.

(a) Taking Turbine C as a control volume system, based on the 1st law of thermodynamics, write down appropriate equation(s) and assumptions you make (if there are) to analysis transport of energy for this control volume system. **(5%)**

(b) Taking Tank D as a control volume system, based on the 1st Law of thermodynamics, write down appropriate equation(s) and assumptions you make (if there are) to analysis transport of energy for this control volume system. **(5%)**

(c) Taking both Turbine C and Tank D together as a control volume system, based on the 1st law of thermodynamics, write down appropriate equations and assumptions you make (if there are) to analysis transport of energy for this combined system. **(5%)**

(d) When a power output from Turbine C is required, the Valve B is opened. The steam after passing through Turbine C is discharged in Tank D until Tank D is at pressure of 30 bar. At the final state, the temperature of the steam in Tank D is 600℃. Determine the amount of work developed during this process **(10%)**