**Q4001 Thermodynamics of Materials** **August, 2019**
**Homework 2**

1. Indicate whether the following statements are true or false. Justify your reasoning.

   (a) In an isobaric compression, $\Delta H = 0$.

   (b) In an isocoric process, $\Delta H = 0$.

   (c) For a perfect gas, $\Delta U = n\overline{C}_P \Delta T$, in an isobaric process.

   (d) During an adiabatic expansion against a vacuum, $w = 0$

   (e) For an adiabatic process $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

2. Demonstrate that for a adiabatic reversible process

$$w_{\text{ad}} = \frac{1}{\gamma - 1} \left[ P_f V_f - P_i V_i \right]$$

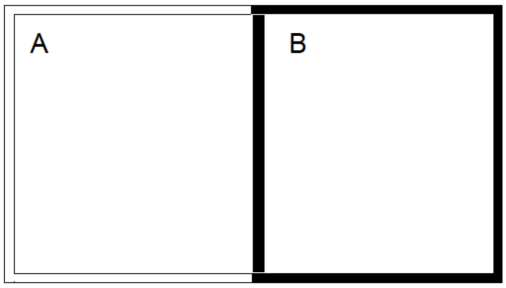
3. One mole of $N_2$ gas is contained at 273 K and pressure of 1 atm. The addition of 3000 J of heat to the gas at constant pressure causes $-832$ J of work to be done during the expansion. Calculate:

   (a) The final state of the gas.

   (b) The values of $\Delta U$ and $\Delta H$ for the change of the state.

   (c) The values of $\overline{C}_V$ and $\overline{C}_P$ for $N_2$.

4. A semi-insulated system, as shown bellow, is formed by a container that has two compartments, A and B, separated by an movable adiabatic wall. Each compartment has an initial volume of 5 L and 1 atm of pressure. Each contains 0.5 mole of a perfect monoatomic gas.




   In the beginning, the temperatures of A and B are the same. Then, the gas A expands and displaces the gas B is compressed in a reversible and adiabatic way until it reaches a final volume of 2 L.

   (a) Draw a $PV$ diagram for this process to indicate the behavior corresponding to the subsystems A and B.

   (b) With this information, calculate $\Delta U$ and $\Delta H$ for A, B, the surroundings and the universe. In addition, calculate the final pressures and temperatures of A and B.

5. The molar heat capacity, $C_V$, of solids at low temperature is given by the Debye's law:

$$C_V = A\left(\frac{T}{\theta}\right)^3$$

The quantity $A$ is a constant equal to $3.7 \times 10^3\,\mathrm{J/mol\,K}$, and $\theta$ is the Debye temperature, equal to 230 K for KCl.

(a) What is the molar heat capacity at constant volume of KCl at 5 K and at 30 K?

(b) How much heat is required to raise the temperature of 2 moles of KCl from 5 K to 30 K at constant volume?

6. Paramagnetic materials present a magnetic behavior described by Curie's equation:

$$\frac{M}{H} = \frac{\mathcal{C}}{T}$$

where $M$ is the magnetization of the material, $H$ is the external magnetic field in Tesla, $\mathcal{C}$ is a constant and $T$ is the temperature.

(a) Indicate whether $M$ and $H$ are intensive or extensive properties. Explain.

(b) Write the form of the configuration work, $đw$, for this system.

(c) Find an expression for the work that has to be done on the system to change its magnetization from 0 to $M$.

Due date: Tuesday, august 27th.