Thermodynamics. Problems. Sheet 2.

1. One mole of ideal gas expands isothermally from (P_1, V_1, T) to (P_2, V_2, T) in a single stage, against a constant opposing pressure equal to P_2. If P_1 = 10 atm, P_2= 5 atm and T=300 K, what is the work done by the system? Represent the transformation in a P-V plane and indicate what the work is on the graph.

2. The same isothermal expansion of the previous problem is carried out, but in a reversible way (infinite stages). What is now the work produced by the system? Represent it graphically in a P-V plane.

3. Write the reversible work of isothermal expansion of a van der Waals gas.

4. A system consists of a gas contained in a cylinder closed by a piston. The system undergoes the following transformations:

   a) **A→C**: a volume reduction at constant pressure, during which it receives 25 J of work and gives up 50 J of heat to the environment.

   b) **C→B**: a constant volume pressure rise during which it receives 75 J of heat.

   c) **B→A**: returns to state A through an adiabatic transformation.

   Represent the process by means of a P-V diagram and calculate the amount of work exchanged with the medium during stage c).

5. Liquid water, at 0°C and atmospheric pressure, has a density of 1,000 g cm^{-3}. Under the same conditions, ice has a density of 0.917 g cm^{-3}. How much work does 1 kg of ice do when it melts under these conditions?

6. A copper block weighs 0.2 kg and has an initial temperature of 400 K. A perfectly insulated copper tank weighing 0.5 kg contains 4 kg of water, initially at 300 K. The copper block is immersed in the water and equilibrium is allowed to settle.

   a) What is the change in the internal energy of the copper block and the water?

   b) What is the change in energy of the entire system, including the tank?

   Ignore the effects of expansion and contraction and assume that the specific heats are constant and equal to 4.184 J g^{-1} K^{-1} for water and 0.380 J g^{-1} K^{-1} for copper.

7. Express the work done by 1 mole of gas, which has the equation of state

$$PV_m = RT + APT - BP$$

   when it expands in a reversible isothermal process from volume V_1 to volume V_2. A and B are characteristic constants of the gas, and V_m is the molar volume.

8. Compute the maximum work that can be obtained from:

   a) an isothermal expansion

   b) an adiabatic expansion

   from 2.0 mols of nitrogen, initially at 25ºC, from 10 liters up to 20 liters. Assume c_V= 2.5 R and that the gas is ideal. Represent the two transformations in a P-V plane.

9. A 583 m^3 piece of ice at atmospheric pressure and 0ºC is heated and becomes water at 4ºC. Compute the increase in internal energy. Ice density= 0.917 g cm^{-3}; water density (l) = 1.00 g cm^{-3}. c_p (H2O, l) = 4.180 J g^{-1} K^{-1}. Ice's enthalpy of fusion = 80.0 cal g^{-1}.