

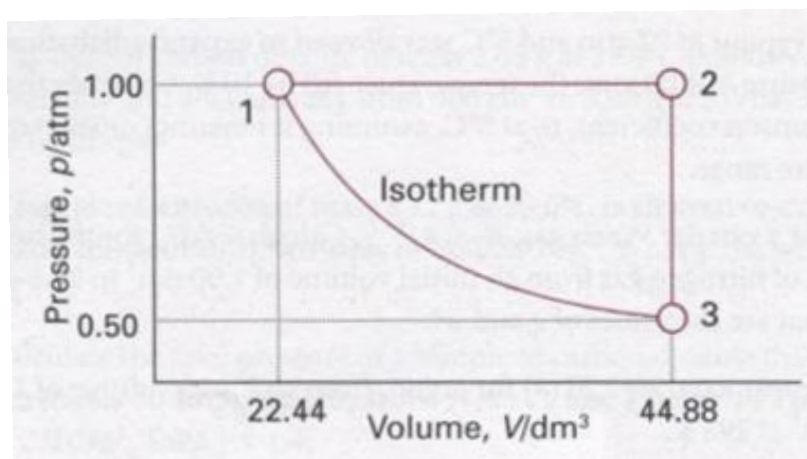
## <물리화학 Homework #2>

1. Consider the reversible expansion of a perfect gas. Provide a physical interpretation of the fact that  $pV^\gamma = \text{constant}$  for an adiabatic change, whereas  $pV = \text{constant}$  for an isothermal change.

2. A sample consisting of 1 mol of perfect gas atoms (for which  $C_{V,m} = \frac{3}{2}R$ ) is taken through the cycle shown in Figure.

(a) Determine the temperature at the points 1, 2, and 3.

(b) Calculate  $q$ ,  $w$ ,  $\Delta U$ , and  $\Delta H$  for each step and for the overall cycle. If a numerical answer cannot be obtained from the information given, then write +, -, 0, or ? as appropriate.



3. The molar heat capacities of ethane, C(s), and H<sub>2</sub>(g) are represented in the following table in the temperature range of 298 K to 400 K by the empirical expression

$$C_{p,m} \text{ (J /K mol)} = A + BT + C/T^2.$$

Calculate the standard enthalpy of formation of ethane at 380 K from its value at 298 K:

$\Delta_f H^\ominus(298\text{K}) = -84.68 \text{ kJ/mol}$ . Can we assume that  $C_{p,m}$  is constant?

|                    | A     | B/(10 <sup>-3</sup> K <sup>-1</sup> ) | C/(10 <sup>5</sup> K <sup>2</sup> ) |
|--------------------|-------|---------------------------------------|-------------------------------------|
| Ethane             | 14.73 | 127.3                                 | 0                                   |
| C(s)               | 16.86 | 4.77                                  | -8.54                               |
| H <sub>2</sub> (g) | 27.28 | 3.26                                  | 0.5                                 |

4. What is the change in molar enthalpy of N<sub>2</sub> when it is heated from 25°C to 100°C? Use the heat capacity information in Table.

**Table 2.2\*** Temperature variation of molar heat capacities,  $C_{p,m}/(\text{J K}^{-1} \text{ mol}^{-1}) = a + bT + c/T^2$

|                     | <i>a</i> | <i>b</i> /(10 <sup>-3</sup> K) | <i>c</i> /(10 <sup>5</sup> K <sup>2</sup> ) |
|---------------------|----------|--------------------------------|---|
| C(s, graphite)      | 16.86    | 4.77                           | -8.54                                       |
| CO <sub>2</sub> (g) | 44.22    | 8.79                           | -8.62                                       |
| H <sub>2</sub> O(l) | 75.29    | 0                              | 0   |
| N <sub>2</sub> (g)  | 28.58    | 3.77                           | -0.50                                       |

5. Starting from the expression  $C_p - C_v = T(\partial p / \partial T)_v(\partial V / \partial T)_p$ , use the appropriate relations between partial derivatives to show that

$$C_p - C_v = - \frac{T(\partial V / \partial T)_p^2}{(\partial V / \partial p)_T}$$

Evaluate  $C_p - C_v$  for a perfect gas.