1. What is the change in molar enthalpy of N_2, when it is heated from 0°C to 100°C? Use the heat capacity information in Table.

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

	a	$b/(10^{-3}\,\mathrm{K})$	$c/(10^5\,\mathrm{K}^2)$
C(s, graphite)	16.86	4.77	−8.54
$CO_2(g)$	44.22	8.79	−8.62
$H_2O(l)$	75.29	0	0
$N_2(g)$	28.58	3.77	−0.50

2. A sample consisting of 1 mol of perfect gas atoms (for which $C_{V,m} = \frac{3}{2}R$ is) is taken through the cycle($1 \rightarrow 2 \rightarrow 3 \rightarrow 1$) shown in Fig. 1 (a) Determine the temperature at the points 1, 2, and 3. (b) Calculate q, w, ΔU, and ΔH 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.

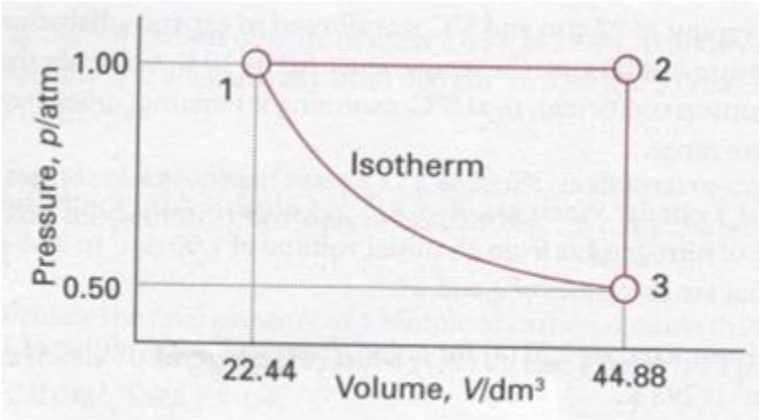

Fig. 1

3. (a) Given the reaction (1) and (2) below, determine (i) $\Delta_r H^{\ominus}$ and $\Delta_r U^{\ominus}$ for reaction (3), (ii) $\Delta_f H^{\ominus}$ for both HCl(g) and H_2O(g), all at 298K.

(1) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ $\Delta_r H^{\ominus} = -184.62KJ\ mol^{-1}$

(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta_r H^{\ominus} = -483.64KJ\ mol^{-1}$

(3) $4HCl(g) + O_2(g) \rightarrow 2Cl_2(g) + 2H_2O(g)$

(b) Given the reaction (1) and (2) below, determine (i) $\Delta_r H^{\ominus}$ and $\Delta_r U^{\ominus}$ for reaction (3), (ii) $\Delta_f H^{\ominus}$ for both HI(g) and H_2O(g), all at 298K.

(1) $H_2(g) + I_2(s) \rightarrow 2HI(g)$ $\Delta_r H^{\ominus} = +52.96\ KJ\ mol^{-1}$

(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta_r H^{\ominus} = -483.64\ KJ\ mol^{-1}$

(3) $4HI(g) + O_2(g) \rightarrow 2I_2(s) + 2H_2O(g)$

4. Show that Maxwell relations (4 equations) of U (Internal Energy), H (Enthalpy), A (Helmholtz Energy), G (Gibbs free energy) using exact differential equation.

5. Starting from the expression $\mathrm{C_p - C_v = T(}{}^{\partial \mathrm{p}}/_{\partial \mathrm{T}}\mathrm{)v(}{}^{\partial \mathrm{V}}/_{\partial \mathrm{T}}\mathrm{)p}$, use the appropriate relations between partial derivatives to show that

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

Evaluate Cp-Cv for a perfect gas.