PHYSICAL CHEMISTRY

EXAM I (4/12/2012) Dept. Chem. & Biol. Eng., Korea Univ. Prof. D. J. Ahn

1(20). 다음에 답하시오.

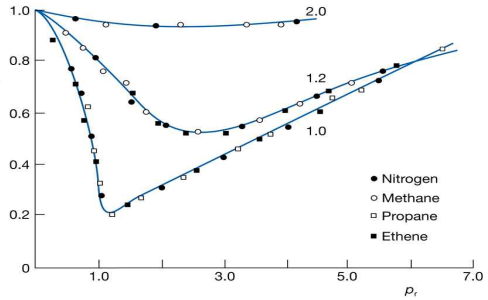
(a) 가역공정(reversible process)의 과정을 묘사하고 정의하시오. 또한, 엔트로피(S)를 이용하여 설명하시오.

(b) 열역학 1법칙과 2법칙을 간단히 정의하고, 이 두 가지 법칙에 기반하여 화학공학자가 성취하고자 하는 목표에 대해 설명하시오.

(c) 아래 그림과 같이 낮은 온도에서 높은 온도 쪽으로 열이 이동될 수 있음을 증명하시오. 이 사실에 기반하여 냉장기계를 고안하여 제시하시오. (간략한 설계도와 각 부분의 기능을 표시함.)

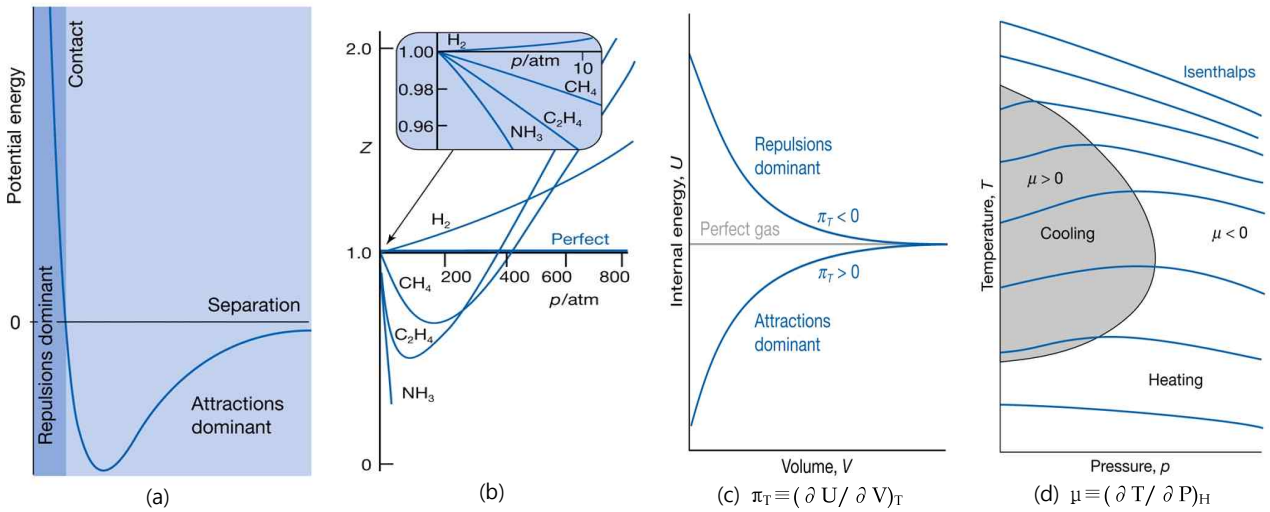
2(20). (a) Perfect gas law [$PV_m=RT$], van der Waals EOS [$(P+a/V_m^2)(V_m-b)=RT$], virial EOS [$PV_m/RT=1+B/V_m+C/V_m^2+\cdots$]의 장단점을 상호 비교하시오

(b) 오른쪽 그림이 묘사하는 것은 무엇인지 지칭하고, 이것의 장단점을 설명하시오. (수리적 증명과정이 있으면 추가점수 부여함.)



(파라미터 값은 Tr을 의미함)

3(20). 그림(a)-(d)를 보고 의미하는 바를 각각 기술하시오(16점). 각 그림간 상호 연관성에 대해 기술하시오(4점).



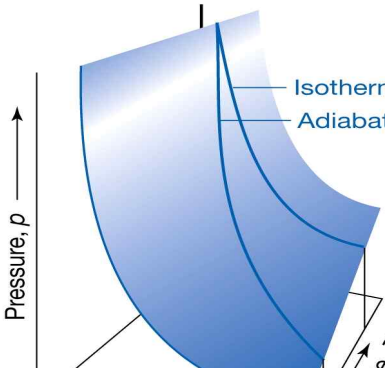
(a) (b) (c) $\pi_T \equiv (\partial U/\partial V)_T$ (d) $\mu \equiv (\partial T/\partial P)_H$

4(30). Answer the followings:

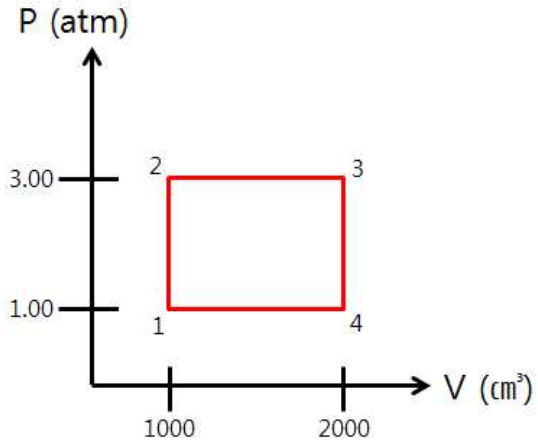
(a) For an ideal gas, prove that process relations PV=constant and PV^{γ} =constant are valid for reversible isothermal expansion and reversible adiabatic expansion, respectively, as shown in the figure.

(b) Find out such process relations for a van der Waals gas.

※ You may need the following information on exact differentials dU, dH, dA, and dG: dU=TdS-PdV, dH=TdS+VdP, dG=-SdT+VdP, dA=-SdT-PdV.



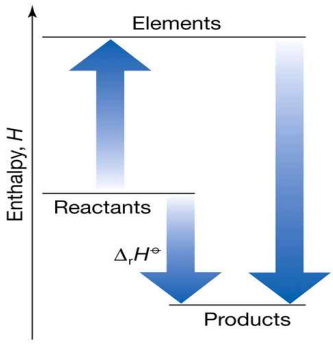
5(20). Suppose 0.1 mol of a perfect gas having $C_{V,m} = 1.50R$ independent to temperature undergoes the reversible cyclic process 1→2→3→4→1 shown in Fig. 4, where either P or V is held constant in each step. Calculate $q, w, \triangle U \text{and} \triangle H$ for each step and for the complete cycle.



6(30). Answer the followings:

(a) Explain the fact that the following energy diagram tells us regarding the (reversible) chemical reaction "Reactants" ↔ "Products".

(b) In case the reaction occurs in an isolated system, predict the changes in product yield and reaction speed.



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(c) The molar heat capacities of ethane, C(s), and H_2(g) are represented in the following table in the temperature range of 298 K to 500 K by the empirical expression $C_{p,m}/(J\ K^{-1}\ mol^{-1}) = A + BT + C/T^2$. Calculate the standard enthalpy of formation of ethane at 500 K from its value at 298 K: $\Delta_r H^\ominus(298K)$ = -84.68 kJ/mol. Can we assume that $C_{p,m}$ is constant?

	A	$B/(10^{-3}\ K^{-1})$	$C/(10^5\ K^2)$
Ethane	14.73	127.3	0
C(s)	16.86	4.77	-8.54
H_2(g)	27.28	3.26	0.5

[총점 140점]