<물리화학 Home Assignment #3>

*** First law of thermodynamics :** $dU = C_v dT = dQ + dW = dQ - PdV$

*** Ideal gas law :** $P = \frac{RT}{V}, \quad C_p = C_v + R$

1. 위의 수식을 이용하여 dQ와 dW를 아래 parameter의 함수로 각각 표현하시오.
   (유도과정 필수!!)
   (a) (T, V)
   (b) (T, P)
   (c) (P, V)

2. 1번에서 구한 식을 이용하여 다음 공정에서 Q와 W를 구할 수 있는 식을 유도하시오.
   (a) Isothermal process
   (b) Isobaric process
   (c) Isochoric process

3. 다음의 a generic cubic equation of state와 관련된 문제들에 답하시오.

$$P = \frac{RT}{(V_m - b)} - \frac{a(T)}{(V_m + \epsilon b)(V_m + \sigma b)} \quad \left(a(T) = \Psi \frac{\alpha(T_r) R^2 T_c^2}{P_c}\right)$$

[표. Parameter Assignments for Equations of State]

Eq. of State	$\alpha(T_r)$	σ	ϵ	Z_c
vdW (1873)	①	②	③	3/8
RK (1949)	④	⑤	⑥	⑨
SRK (1972)	$\alpha_{SRK}(T_r;\omega)$	⑦	⑧	1/3
PR (1976)	$\alpha_{PR}(T_r;\omega)$	$1+\sqrt{2}$	$1-\sqrt{2}$	0.30740

   (a) 표의 ①~⑧에 알맞은 값이 무엇인지 쓰시오
   (b) ⑨에 들어갈 critical compression factor(Z_c)를 구하시오.
   (c) vdW, RK, PR 모델의 차이점을 설명하시오.

4. An ideal gas undergoes the following sequence of mechanically reversible processes in a closed system.

(a) From an initial state of 70 °C and 1 bar, it is compressed adiabatically to 150 °C.
(b) It is then cooled from 150 to 70 °C at constant P.
(c) Finally, it is expanded isothermally to its original state.

Calculate W, Q, ΔU, and ΔH for each of the three processes and for the entire cycle. Assume air to be an ideal gas with the constant heat capacities, C_v = 3/2R and C_p = 5/2R. (풀이과정 상세기술)

5. If the processes of Problem4. are carried out irreversibly but so as to accomplish exactly the same changes of state_ the same changes in P, T, U and H then different vaues of Q and W result. Calculate Q and W if each step is carried out with an efficiency of 80%.

6. A Carnot cycle uses 1.00 mol of a monatomic perfect gas as the working substance from an initial state of 10.0 atm and 600 K. It expands isothermally to a pressure of 1.00 atm (step 1), and then adiabatically to a temperature of 300 K (step 2) This expansion is followed by an isothermal compression (step 3), and then an adiabatic compression (step 4) back to the initial state. Determine the values of q, w, ΔU, ΔH, Δ S, ΔS ot, and ΔG for each stage of the cycle and for the cycle as a whole. Express your answer as a table of values.