

系別：化學工程與材料工程學系

科目：物理化學

准帶項目請打「V」	
✓	簡單型計算機
本試題共 頁	

$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ , use SI unit

(每一題 20 分)

- (a) Derive the Clausius-Clapeyron equation. Naphthalene,  $\text{C}_{10}\text{H}_8$ , melts at  $80.2^\circ\text{C}$ . If the vapor pressure of the liquid is 10 Torr at  $85.8^\circ\text{C}$  and 40 Torr at  $119.3^\circ\text{C}$ , use the Clausius-Clapeyron equation to calculate (b) the enthalpy of vaporization (use unit: kJ/mol), (c) the normal boiling point ( $^\circ\text{C}$ ), (d) the entropy of vaporization at the normal boiling point (use unit: J/mol K).
- Consider the equilibrium  $\text{NO}_{2(g)} \leftrightarrow \text{NO}_{(g)} + 1/2 \text{O}_{2(g)}$ . One mole of  $\text{NO}_{2(g)}$  is placed in a vessel and allowed to come to equilibrium at a total pressure of 1 atm. An analysis of the contents of the vessel gives the ratio values of partial pressure  $P_{\text{NO}}/P_{\text{NO}_2}$ :

T	700 K	800 K
$P_{\text{NO}}/P_{\text{NO}_2}$	0.872	2.50

- Calculate equilibrium constant  $K_p$  at 700 and 800 K. (b) Calculate  $\Delta G^\circ_{\text{reaction}}$  (use unit: kJ/mol) at 700 and 800 K. (c) Calculate  $\Delta H^\circ_{\text{reaction}}$  (in kJ/mol), assuming it is independent of temperature. (d) Calculate  $\Delta G^\circ_{\text{reaction}}$  (use unit: kJ/mol) at 298.15 K.
- An ideal solution at 298 K is made up of 1 mole of A and 3 moles of B, for which saturated vapor pressure  $P_A^* = 200$  Torr and  $P_B^* = 100$  Torr. (a) Calculate  $\Delta H_{\text{mix}}$  (kJ/mol),  $\Delta S_{\text{mix}}$  (J/mol K),  $\Delta G_{\text{mix}}$  (kJ/mol), (b) Calculate the total vapor pressure (in Torr) and the composition in the vapor phase.
  - A strong absorption of infrared radiation is observed for  $^1\text{H}^{35}\text{Cl}$  at  $2991 \text{ cm}^{-1}$ .
    - Calculate the force constant,  $k$  (in N/m), for this molecule. (b) By what factor do you expect this frequency to shift if deuterium ( $^2\text{H}$ ) is substituted for hydrogen in this molecule? The force constant is unaffected by this substitution.  $^1\text{H} = 1.008 \text{ amu}$ ,  $^{35}\text{Cl} = 34.969 \text{ amu}$ ,  $^2\text{H} = 2.0140 \text{ amu}$ .
  - Using the following data for the reaction:  $A + B \xrightarrow{k} C$ , determine the order of the reaction with respect to A and B, and the rate constant  $k$  (in  $\text{M}^{-2}\text{s}^{-1}$ ) for the reaction:

[A] (M)	[B] (M)	Initial Rate ( $\text{M s}^{-1}$ )
$2.30 \times 10^{-4}$	$3.10 \times 10^{-5}$	$5.25 \times 10^{-4}$
$4.60 \times 10^{-4}$	$6.20 \times 10^{-5}$	$4.20 \times 10^{-3}$
$9.20 \times 10^{-4}$	$6.20 \times 10^{-5}$	$1.70 \times 10^{-2}$