

國立臺灣科技大學103學年度碩士班招生試題
系所組別：材料科學與工程系碩士班甲組
科目：物理化學

(總分為100分)

Useful physical constants:

Planck constant(h)= 6.626×10^{-34} J-s ; $h/(2\pi)$ = 1.05×10^{-34} J-s ; Electron mass=

9.1×10^{-31} kg ; Electron charge (e)= 1.6×10^{-19} C;

Boltzmann constant(k)= 1.381×10^{-23} J/K= 8.617×10^{-5} eV/K ; Permittivity of vacuum(ϵ_0)= 8.854×10^{-12} C²N⁻¹m⁻²

1. Please drive $P_i V_i^\gamma = P_f V_f^\gamma$ for the adiabatic reversible process, where P_i , V_i , P_f , and V_f represent the pressure and volume in the initial and final state, respectively. $\gamma = C_{p,m}/C_{v,m}$ for an ideal gas. (10 points)
2. An ideal gas undergoes a single-stage expansion against a constant external pressure $P_{external} = P_f$ at constant temperature from T , P_i , V_i to T , P_f , V_f .
 - (a) What is the largest mass m that can be lifted through the height h in this expansion? (5 points)
 - (b) The system is restored to its initial state in a single-state compression. What is the smallest mass m' that must fall through the height h to restore the system to its initial state? (5 points)

- (c) If $h = 15.5$ cm, $P_i = 1.75 \times 10^6$ Pa, $P_f = 1.25 \times 10^6$ Pa, $T = 280$ K, and $n = 2.25$ mol, calculate the values of the masses in part (a) and (b) (5 points)

3. 21.05 g of steam at 373 K is added to 415g of H₂O (l) at 298 K at a constant pressure of 1 bar. Is the final state of the system steam or liquid water? Calculate ΔS_{total} for the process. $C_{p,liq}$ (H₂O, liquid) = $C_{p,vap}$ (H₂O, vapor) = 75.3 J/Kmol; $\Delta H_{vaporization}$ (H₂O) = 40650 J/mol. (10 points)

4. Assume that 1-bromobutane and 1-chlorobutane from an ideal solution. At 273K, $P_{chloro}^* = 3790$ Pa and $P_{bromo}^* = 1394$ Pa. When only a trace of liquid is present at 273 K, $Y_{chloro} = 0.75$.

- a. Calculate the total pressure above the solution. (5 points)
- b. Calculate the mole fraction of 1-chlorobutane in the solution. (5 points)
- c. What value would Z_{chloro} (the total 1-chlorobutane ratio in the system) have in order for there to be 4.86 mol of liquid and 3.21 mol of gas at a total pressure equal to that in part (a)? (5 points)

