國立臺北科技大學

九十三學年度材料及資源工程系碩士班入學考試

普通熱力學試題

填准考證號碼

注意事項：

1. 本試題共七題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

I. For a van der Waals gas :

(a) P_c is the critical pressure , show that $P_c = a/27b^2$.

(b) If $\pi_T = (\partial U/\partial V)_T$, show that $\pi_T = a/V_m^2$. 20%

II. (a) If $\alpha = (1/V)(\partial V/\partial T)_P$ and
$\kappa = -(1/V)(\partial V/\partial P)_T$, then
Show that, by use of the second law, the
$$C_p - C_v = [P+(\partial U/\partial V)_T](\partial V/\partial T)_P$$
may be determined more easily from experiment, as
$$C_p - C_v = TV\alpha^2/\kappa .$$

(b) Show that the osmotic pressure of a real solution is given by
$$\prod V_m = -RT \ln a_A . \qquad 20\%.$$

III. Show that the effect of external hydrostatic pressure P on the vapor pressure p of a partial molar volume V_{ml} is given by
$$RT(d\ln p/dP) = V_{ml}$$
Provided the vapor behaves as a perfect gas. <*Hint*: When the pressure is change at constant temperature, $dG_l = dG_{vap}$ >. 10%

IV. A tube was filled with 500 g of an ideal gas (molar mass = 40 g / mol) at 27℃ and 760 torr. After two days, due to leakage through the valve, a certain amount of gas escaped and the pressure fell to 600 torr at the same temperature. How much gas molecules has leaked out ? 10%

V. Two moles of a ideal gas, initially at standard ambient temperature and pressure, expand isothermally and irreversibly to 89.6 dm^3. The work done by the system is -400 J. Calculate ΔS. 10%

VI. The temperature of a building is maintained at 20℃ by means of a heat pump, and on a particular day the external temperature is 10℃. The work is supplied to the heat pump by a heat engine that burns fuel at 1000℃ and operate at 20℃. Calculate the performance factor for the system (i.e. , the ratio of the heat delivered to the building to the heat produced by the fuel in the heat engine). Assume perfect efficiencies of the pump and the engine. 15%

VII. Eighteen grams of water at -10℃ are shaken until converted into a homogeneous mixture of ice and water at 0℃ . Find the change in entropy if the specific heats of water and ice are 4.184 J / g and 2.09 J / g , respectively; and molar enthalpy of fusion is 6.01 kJ / mol . 15%

【 $\log 2 = 0.301$; $\log 3 = 0.477$; $\log 7 = 0.845$ 】