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國立臺北科技大學 109 學年度碩士班招生考試

系所組別：3520 化學工程與生物科技系化學工程碩士班乙組

第一節　物理化學　試題

注意事項：

1.本試題共 6 題，共 100 分。
2.不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3.全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. The constant-pressure heat capacity of a sample of a perfect gas was found to vary with temperature according to the expression:

   $C_P/(\mathrm{J\ K^{-1}}) = 20.38 + 0.5016\ (T/\mathrm{K})$

   Calculate q, w, ΔU, and ΔH when the temperature is raised from 9°C to 90°C.

   (a) at constant pressure. (8%)

   (b) at constant volume. (8%)

2. When the state of 2.25 moles of perfect gas molecules, for which $C_{p,m} = 3$ R, is changed at constant pressure 5.00 atm from 150°C to 25°C, and then is changed at constant temperature 25°C from 5.00 atm to 1.00 atm.

   (a) Calculate the ΔS (for the system and the surroundings). Take the surroundings in a room at a temperature of 25°C. (10%)

   (b) Calculate the q and w. (10%)

3. The molar volume of a certain solid is 161.0 $\mathrm{cm^3\ mol^{-1}}$ at 1.00 atm and 350.75 K, its melting temperature. The molar volume of the liquid at this temperature and pressure is 163.3 $\mathrm{cm^3\ mol^{-1}}$. At 100 atm the melting temperature changes to 351.26 K.

   (a) Calculate the enthalpy and entropy of fusion of the solid. (12%)

   (b) Calculate the Gibbs energy of fusion of the solid at 351.26 K. (6%)

4. The vapor pressure of pure liquid A at 330 K is 79.7 kPa and that of pure liquid B is 53.0 kPa. These two compounds form ideal liquid and gaseous mixtures. Consider the equilibrium composition of a mixture in which the mole fraction of A in the vapor is 0.380. Calculate the total pressure of the vapor and the composition of the liquid mixture. (12%)

5. The equilibrium constant for the reaction:

   $2\ C_3H_6(g) \rightleftharpoons C_2H_4(g) + C_4H_8(g)$

   is found to fit the expression:

   $\ln K = A + B/T + C/T^2$

   between 300 K and 600 K, with $A = -1.04$, $B = -1088$ K, and $C = 151000\ \mathrm{K^2}$. Calculate the standard reaction enthalpy and standard reaction entropy at 380 K. (16%)

6. The gas-phase reaction

   $H_2(g) + I_2(g) \rightarrow 2\ HI(g)$

   is second order. Its rate constant at 400°C is $2.34\times10^{-2}\ \mathrm{dm^3\ mol^{-1}\ s^{-1}}$, and its activation energy is 150 $\mathrm{kJ\ mol^{-1}}$. Calculate, at 390°C, the frequency factor A, the enthalpy of activation $\Delta^{\ddagger}H$, the entropy of activation $\Delta^{\ddagger}S$, and the Gibbs energy of activation $\Delta^{\ddagger}G$. (18%)