

# 國立臺北科技大學九十九學年度碩士班招生考試

系所組別：3520 化學工程研究所乙組

## 第一節 物理化學 試題

第一頁 共一頁

### 注意事項：

1. 本試題共 6 題，配分共 100 分。第 1~5 題各 18 分，第 6 題 10 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

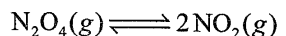
1. Suppose that a gas obeys the van der Waals equation:

$$\left(P + \frac{a}{V_m^2}\right)(V_m - b) = RT$$

Prove that

$$\left(\frac{\partial U}{\partial V_m}\right)_T = \frac{a}{V_m^2}$$

2. Nitrogen dioxide,  $\text{NO}_2$ , exists in equilibrium with dinitrogen tetroxide,  $\text{N}_2\text{O}_4$ :



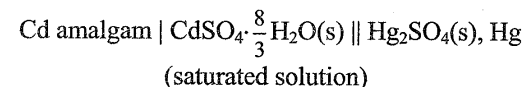
At  $25.0^\circ\text{C}$  and a pressure of 0.597 bar the density of the gas is  $1.477\text{ g dm}^{-3}$ . Calculate the degree of dissociation under those conditions, and the equilibrium constants  $K_c$ ,  $K_p$ , and  $K_x$ . What shift in equilibrium would occur if the pressure were increased by the addition of helium gas?

3. Suppose that you find in the literature the vapor pressure  $P$  of a liquid with molar mass of  $63.9 \times 10^{-3}\text{ kg mol}^{-1}$  listed with  $P$  in mmHg as

$$\log P = 5.4672 - 1427.3 T^{-1} - 3169.3 T^{-2}$$

The densities of the liquid and vapor phases are  $0.819\text{ kg dm}^{-3}$  and  $3.15 \times 10^{-4}\text{ kg dm}^{-3}$ , respectively. Calculate the  $\Delta_{\text{vap}}H$  at the normal boiling point,  $398.4\text{ K}$ . How do you handle the fact that  $P$  is listed in mmHg?

4. The Weston standard cell is



Write the cell reaction. At  $25.0^\circ\text{C}$ , the emf is  $1.01832\text{ V}$  and  $\partial E^\circ/\partial T = -5.00 \times 10^{-5}\text{ V K}^{-1}$ . Calculate  $\Delta G^\circ$ ,  $\Delta H^\circ$ , and  $\Delta S^\circ$ ?

5. The following data relate to an enzyme reaction.

$10^3 [\text{S}] / \text{mol dm}^{-3}$	$10^5 V / \text{mol dm}^{-3} \text{ s}^{-1}$
2.0	13
4.0	20
8.0	29
12.0	33
16.0	36
20.0	38

The concentration of the enzyme is  $2.0\text{ g dm}^{-3}$ , and its molecular weight is 50000. Calculate Michaelis constant  $K_m$ , maximum rate  $V$ , and catalytic constant  $k_c$ ?

6. When the subatomic species muonium (Mu) was first discovered in 1960, it was not known whether it bore an electric charge. The answer was provided by a kinetic study of the ionic strength effect on the reaction  $\text{Mu} + \text{Cu}^{2+}$  in aqueous solution. The following rate constants were measured at two ionic strengths:

$$I = 0, \quad k = 6.50 \times 10^9 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$$

$$I = 0.9 \text{ M}, \quad k = 6.35 \times 10^9 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$$

What do you deduce about the actual charge on muonium?