

# 國立臺北科技大學九十八學年度碩士班招生考試

系所組別：3712 有機高分子研究所甲組

## 第二節 物理化學（選考）試題

第一頁 共二頁

### 注意事項：

1. 本試題共 9 題，配分共 100 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。

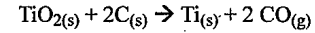
1. Explain the following terms: (20%)

- (1) Boyle temperature (4%)
- (2) internal pressure (4%)
- (3) Clausius inequality (4%)
- (4) Stopped-flow technique (4%)
- (5) Heisenberg Uncertainty Principle (4%)

2. (1) Please write down the van der Waals equation, the approximate equation of state for real gas. (4%) (2) Explain the physical meaning of two new terms involved in van der Waals equation for correcting the real gas behavior from ideal gas. (6%) (3) There is 131 g of Xenon gas in a vessel of 1.0 L at 25 °C. Please calculate pressure it would exert if it behaved as van der Waals gas. (Xe: atomic weight 131, Van der Waals coefficients,  $a = 4.137 \text{ atm L}^2 \text{ mol}^{-3}$ ,  $b = 5.16 \times 10^{-2} \text{ L mol}^{-1}$ ) (10%)

3. How much energy is available for sustaining muscular activity from the combustion of 1.00 mol of glucose molecules under standard conditions at normal blood temperature (37 °C) given the standard entropy of reaction is  $182.4 \text{ JK}^{-1}\text{mol}^{-1}$  and the standard enthalpies of reaction is  $-2808 \text{ kJ mol}^{-1}$ . (10%)

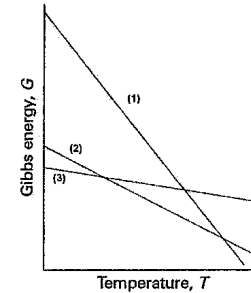
4. Titanium occurs naturally as the mineral rutile,  $\text{TiO}_2$ . One possible method of its extraction involves the reduction of the mineral by heating it with carbon with the following equation:



- (1) Calculate  $\Delta H^\circ$  for this reaction, given the standard enthalpies of formation of  $\text{TiO}_{2(s)}$  and  $\text{CO}_{(g)}$  are  $-944$  and  $-111 \text{ kJ mol}^{-1}$ , respectively. (3%) (2) Estimate  $\Delta G$  for this equation at 2200 K, given the entropy change ( $\Delta S^\circ$ ) of  $366 \text{ JK}^{-1}\text{mol}^{-1}$  for this reaction. (3%) (3) Comment on the feasibility of the reaction at 2200 K based on  $\Delta H$ ,  $\Delta S$ , and  $\Delta G$ . (4%)

5. Estimate the mean free path of nitrogen molecule at  $1 \times 10^{-3}$  Torr. (5%)

6. The following figure describes the variation of the Gibbs energy with the temperature for gas, liquid, and solid. Please assign each line denoted by (1), (2), and (3) to gas, liquid, or solid and explain the reason. (5%)



7. In a reaction mixture at a fixed temperature, the concentration of a species [A], varies with time, t, in the following manner:

t/s	0	500	1000	2000	3000	4000
[A]/mol dm <sup>-3</sup>	1.0	$2.1 \times 10^{-6}$	$1.0 \times 10^{-6}$	$4.8 \times 10^{-7}$	$3.3 \times 10^{-7}$	$2.5 \times 10^{-7}$

- (1) Please determine the overall reaction order by constructing the necessary plot(s). Calculate the rate constant and give an expression for the reaction rate. (8%)
  - (2) What is the concentration of A after three hours have elapsed since the reaction started. (2%)
8. What is (1) the average value of the linear momentum ( $p$ ) of a particle in a box with quantum number  $n$ , and (2) the average value of  $p^2$ ? (10%, 每小題 5 分)
9. For a linear conjugated polyene with each of  $N$  carbon atoms contributing an electron in a  $2p$  orbital, the energy  $E_j$  of the resulting  $\pi$  molecular orbitals are given by:
- $$E_j = \alpha + 2\beta \cos [j\pi / (N+1)] \quad j = 1, 2, 3, \dots, N$$

注意：背面尚有試題

If  $\alpha = -13 \text{ eV}$  and  $\beta = -6 \text{ eV}$ , which is the shortest conjugated carbon chain molecule capable of absorbing some visible light? (10%)

**Table 1.2** The gas constant in various units

R
8.314 47 J K <sup>-1</sup> mol <sup>-1</sup>
8.205 74 × 10 <sup>-2</sup> L atm K <sup>-1</sup> mol <sup>-1</sup>
8.314 47 × 10 <sup>-2</sup> L bar K <sup>-1</sup> mol <sup>-1</sup>
8.314 47 Pa m <sup>3</sup> K <sup>-1</sup> mol <sup>-1</sup>
62.364 L Torr K <sup>-1</sup> mol <sup>-1</sup>
1.987 21 cal K <sup>-1</sup> mol <sup>-1</sup>

avg 7-2