

## 國立臺北科技大學 106 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

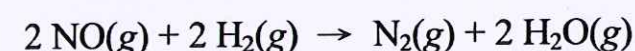
第一頁 共一頁

**注意事項：**

1. 本試題共 7 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. Two moles of an ideal gas for which  $C_{V,m} = 3/2 R$  undergoes the following two-step process: (1) From an initial state of the gas described by  $T = 15^\circ\text{C}$  and  $P = 130 \text{ kPa}$ , the gas undergoes an isothermal expansion against a constant external pressure of  $38 \text{ kPa}$  until the volume has doubled. (2) Subsequently, the gas is cooled at constant volume. The temperature falls to  $-20^\circ\text{C}$ . Calculate  $q$ ,  $w$ ,  $\Delta U$ , and  $\Delta H$  for each step and for the overall process. (16%)
2. The dissolution of  $6.20 \text{ g}$  of a substance in  $660 \text{ g}$  of benzene at  $298 \text{ K}$  raises the boiling point by  $0.575^\circ\text{C}$ . Note that  $K_f = 5.12 \text{ K kg mol}^{-1}$ ,  $K_b = 2.53 \text{ K kg mol}^{-1}$ , and the density of benzene is  $0.8766 \text{ g cm}^{-3}$ . Calculate the freezing point depression, the ratio of the vapor pressure above the solution to that of the pure solvent, the osmotic pressure, and the molecular weight of the solute.  $P_{\text{benzene}}^* = 103 \text{ Torr}$  at  $298 \text{ K}$ . (15%)
3. Consider the cell:
 
$$\text{Fe}(s) | \text{FeSO}_4(aq, a_{\pm} = 0.0250) | \text{Hg}_2\text{SO}_4(s) | \text{Hg}(l)$$
  - (a) Write the cell reaction. (5%)
  - (b) Calculate the cell potential, the equilibrium constant for the cell reaction, and Gibbs energy at  $25^\circ\text{C}$ . (9%)
 For the half-cell:  $\text{Hg}_2\text{SO}_4 + 2 e^- \rightarrow 2 \text{Hg} + \text{SO}_4^{2-}$ ,  $E^\circ = 0.6125 \text{ V}$ ,  
 $\text{Fe}^{2+} + 2 e^- \rightarrow \text{Fe}$ ,  $E^\circ = -0.447 \text{ V}$ .

4. If an electron passes through an electrical potential difference of  $1 \text{ V}$ , it has an energy of  $1 \text{ electron-volt}$ . What potential difference must it pass through in order to have a wavelength of  $0.380 \text{ nm}$ ? (10%)
5. Pulsed lasers are powerful sources of nearly monochromatic radiation. Lasers that emit photons in a pulse of  $5.00 \text{ ns}$  duration with a total energy in the pulse of  $0.175 \text{ J}$  at  $875 \text{ nm}$  are commercially available.
  - (a) What is the average power in units of watts associated with such a pulse? (5%)
  - (b) How many  $1000\text{-nm}$  photons are emitted in such a pulse? (5%)
6. The reaction rate as a function of initial reactant pressures was investigated for the reaction



and the following data were obtained:

| Run | $P_{0,\text{H}_2} / \text{kPa}$ | $P_{0,\text{NO}} / \text{kPa}$ | Rate / $\text{kPa s}^{-1}$ |
|-----|---------------------------------|--------------------------------|----------------------------|
| 1   | 53.3                            | 40.0                           | 0.137                      |
| 2   | 53.3                            | 20.3                           | 0.033                      |
| 3   | 38.5                            | 53.3                           | 0.213                      |
| 4   | 19.6                            | 53.3                           | 0.105                      |

What is the rate law expression for this reaction? (20%)

7. The following data were obtained for the adsorption of krypton on a  $1.21 \text{ g}$  sample of a porous solid:

| Pressure / Torr                       | 1.11 | 3.08 |
|---------------------------------------|------|------|
| Volume adsorbed / $\text{cm}^3$ (STP) | 1.48 | 1.88 |

If the saturation vapor pressure is  $19.0 \text{ Torr}$ , estimate a surface area for the solid, assuming that a molecule of krypton occupies an area of  $2.1 \times 10^{-21} \text{ m}^2$ . (15%)