106 CH02

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

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°C and P = 130 kPa, the gas undergoes an isothermal expansion against a constant external pressure of 38 kPa until the volume has doubled. (2) Subsequently, the gas is cooled at constant volume. The temperature falls to −20°C. Calculate q, w, ΔU, and ΔH for each step and for the overall process. (16%)

2. The dissolution of 6.20 g of a substance in 660 g of benzene at 298 K raises the boiling point by 0.575°C. Note that K_f = 5.12 K kg mol^{-1}, K_b = 2.53 K kg mol^{-1}, and the density of benzene is 0.8766 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. $P^*_{benzene}$ = 103 Torr at 298 K. (15%)

3. Consider the cell:

$$Fe(s) \mid FeSO_4\ (aq, a_{\pm} = 0.0250) \mid Hg_2SO_4(s) \mid Hg(l)$$

(a) Write the cell reaction. (5%)

(b) Calculate the cell potential, the equilibrium constant for the cell reaction, and Gibbs energy at 25°C. (9%)

For the half-cell: $Hg_2SO_4 + 2\ e^- \rightarrow 2\ Hg + SO_4^{2-}$, $E° = 0.6125$ V,

$Fe^{2+} + 2\ e^- \rightarrow Fe$, $E° = -0.447$ V.

4. If an electron passes through an electrical potential difference of 1 V, it has an energy of 1 electron-volt. What potential difference must it pass through in order to have a wavelength of 0.380 nm? (10%)

5. Pulsed lasers are powerful sources of nearly monochromatic radiation. Lasers that emit photons in a pulse of 5.00 ns duration with a total energy in the pulse of 0.175 J at 875 nm are commercially available.

(a) What is the average power in units of watts associated with such a pulse? (5%)

(b) How many 1000-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

$$2\ NO(g) + 2\ H_2(g) \rightarrow N_2(g) + 2\ H_2O(g)$$

and the following data were obtained:

Run	P_{0,H_2} / kPa	$P_{0,NO}$ / kPa	Rate / 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 g sample of a porous solid:

Pressure / Torr	1.11	3.08
Volume adsorbed / cm^3 (STP)	1.48	1.88

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