朝陽科技大學 101 學年度碩士班招生考試試題

系（所）別：應用化學系　　總分：100 分
組　　別：一般生
科　　目：物理化學及無機化學　　第 / 頁共 4 頁

物理化學(50%)

1. (5%) Calculate the molar volume of Xe(g) at 500.0 K and 200.0 atm by treating it as a van der Waals gas: $P = \frac{RT}{V_m - b} - \frac{a}{V_m^2}$, $a = 4.137$ atm L^2/mol^2, $b = 0.0516$ L/mol.

2. (5%) The **constant-pressure** heat capacity of a sample of perfect gas was found to be $C_{P,m} = 20.17$ J/K mol. Calculate ΔU_m(J/mol) when the temperature of this perfect gas is raised from 20°C to 200°C at **constant volume**.

3. (5%)Calculate the standard Gibbs energy of the reaction: $2CH_3CHO(g) + O_2(g) \rightarrow 2CH_3COOH(l)$.

(1 bar, 298.15 K)	CH_3CHO (g)	O_2(g)	CH_3COOH(l)
$\Delta_f H°$ (kJ/mol)	-166.19	0	-484.5
$\Delta_f G°$ (kJ/mol)	-128.86	0	-389.9

4. (5%) If the enthalpy of reaction is a constant, calculate the Gibbs energy change for the above reaction: $2CH_3CHO(g) + O_2(g) \rightarrow 2CH_3COOH(l)$ at 1 bar and 100 K.
【the Gibbs-Helmholtz equation: $\left(\frac{\partial(G/T)}{\partial T}\right)_P = -\frac{H}{T^2}$】

5. (5%) The osmotic pressure of solution of an enzyme in water was measured at 20°C and the pressure was expressed in terms of the height of the solvent (i.e. water). If the concentration of the solution is 3.221 mg/mL, and the osmotic pressure is 5.746 cm, estimate the molar mass of the enzyme.
【The density of water at 20°C is 0.997 g/mL.】

6. (5%) The equilibrium constant of the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 4.0×10^{24} at 300K, 2.5×10^{10} at 500K. Estimate the reaction enthalpy, which is supposed be a constant.

7. (5%) The rate of a second-order reaction was measured over the temperature range 300-500 K, and the rate constants are reported below. Find the activation energy, E_a.

T (K)	300	350	400	450	500
k (L/mol s)	7.9×10^6	3.0×10^7	7.9×10^7	1.7×10^8	3.2×10^8

8. (5%) The Michaelis-Menten mechanism is often used to describe enzyme catalysis reaction:

$E + S \underset{k_1'}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$, where E is enzyme, S is substrate, and P is product. Please express the Michaelis constant, K_M, in terms of k_1, k_1', k_2.

9. (5%) How many radial nodes does the atomic orbital $5f_{z(x^2-y^2)}$ have?

10. (5%) According to the molecular orbital theory, which one of O_2, O_2^+, O_2^- is paramagnetic?

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無機化學 （50%）

1. The Pt-Cl stretching band is observed at 314 cm^{-1} in *cis*-[Pt $((CH_3)_3As)_2Cl_2$] but in the *trans* isomer it is seen at 375 cm^{-1}. Explain the difference in band position for the two isomers. (5%)

2. Predict the products (**I, II**) of the following substitution reactions based on *trans effect* (10%)
   $[PtCl_4]^{2-}$ + CO ⟶ **(I)**, **(I)** + NH_3 ⟶ **(II)**

3. Determine which of the following is paramagnetic. Explain your choice and estimate its magnetic moment (5%)
   $[Cr(CN)_6]^{4-}$　$[Fe(H_2O)_6]^{2+}$　$[IrF_6]^{3-}$

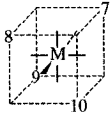
4. List the following acids in order of acid strength in aqueous solution, and explain your reason. (5%)
   HClO, $HClO_2$, $HClO_4$, $HClO_3$

5. Dissolution of KF in IF_5 increases the conductivity of IF_5. Suggest an explanation. (5%)

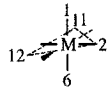
6. On the basis of the 18- electron rule, identify the first-row transition metal for each of the complexes:
   (A) $H_3CM(CO)_5$ (B) $(\eta^4\text{-}C_8H_8)M(CO)_3$ (10%)

7. Using the angular overlap model, determine the energies of the d orbitals of the metal for trigonal-bipyramidal ML_5 complex. Assume that the ligands are capable of sigma interaction only. (10%)

Octahedral positions



Tetrahedral positions



Trigonal-bipyramidal positions

Sigma Interactions (all in units of e_σ)
Metal d Orbital

Ligand Position	z^2	$x^2 - y^2$	xy	xz	yz
1	1	0	0	0	0
2	$\frac{1}{4}$	$\frac{3}{4}$	0	0	0
3	$\frac{1}{4}$	$\frac{3}{4}$	0	0	0
4	$\frac{1}{4}$	$\frac{3}{4}$	0	0	0
5	$\frac{1}{4}$	$\frac{3}{4}$	0	0	0
6	1	0	0	0	0
7	0	0	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
8	0	0	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
9	0	0	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
10	0	0	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
11	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{9}{16}$	0	0
12	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{9}{16}$	0	0