※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Inorganic Chemistry (50 points)

(1) Draw the d energy diagram, and determine the number of unpaired electrons and the LFSE for each of the following. (10 pts)

　a. $Fe(CN)_6^{4-}$

　b. $Ru(NH_3)_6^{3+}$

(2) Which of the following complexes obey the rule of 18 (EAN rule)? (10 pts)

$Cu(en)_3^{2+}$, $Fe(CO)_5$, $Cr(NH_3)_6^{3+}$, $Ni(CN)_4^{2-}$, $CoCl_4^{2-}$

(3) Draw all possible octahedral isomers for

$M(\overgroup{aa}\,\overgroup{bc}\,d_2)$,

$\overgroup{aa}$ is symmetric bidentate, $\overgroup{bc}$ is asymmetric bidentate (10 pts)

(4) The simple anions CrO_4^{2-}, MoO_4^{2-}, and WO_4^{2-} are tetrahedral. Why do the poly acids and poly anions of Cr differ structurally from those of Mo and W? (10 pts)

(5) The IR spectrum of $Rh_2I_2(CO)_2(PPh_3)_2$ has CO stretches at 2061 and 2005 cm^{-1}. Suggest a structure consistent with this. (10 pts)

Analytical Chemistry (50 points)

(6) Barbituric acid dissociates as:

$$HA \rightleftharpoons H^+ + A^- \quad K_a = 9.8 \times 10^{-5}$$

　a. Calculate the pH and fraction of dissociation of $10^{-2.00}$ M barbituric acid (5 pts)

　b. Calculate the pH and fraction of dissociation of $10^{-10.00}$ M barbituric acid (5 pts)

(7) For the cell

Pt(s) | VO^{2+}(0.116 M), V^{3+}(0.116 M), H^+(1.57 M) || Sn^{2+}(0.0318 M), Sn^{4+}(0.0318 M),

E (not E^0) = – 0.289 V at 298K. Write the net cell reaction and calculate its equilibrium constant.

(R = 8.314 J/(K mol), F = 9.649 x 10^4 C/mol) (10 pts)

(8) A mixture placed in an Erlenmeyer flask comprises 6 ml of silica gel and 40 ml of a solvent containing, in solution, 100 mg of a non-volatile compound. After stirring, the mixture was left to stand before a 10 ml aliquot of the solution was extracted and evaporated to dryness. The residue weighed 12 mg. Calculate the adsorption coefficient, K = C_S / C_M, of the compound in this experiment. (10 pts)

(9) The equilibrium constant for the conjugate acid/base pair of the indicator

$$HIn + H_2O \rightleftharpoons H_3O^+ + In^-$$
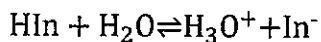
is 8.00×10^{-5}. From the following information

Species	Absorption Maximum, nm	Molar Absopitivity	
		430 nm	600 nm
HIn	430	8.04×10^3	1.23×10^3
In⁻	600	0.775×10^3	6.96×10^3

calculate the absorbance at 430 nm and 600 nm for the following indicator concentrations:
3.00×10^{-4} M and 0.5×10^{-4} M (10 pts)

(10) Students measured the concentration of HCl in a solution by titrating with different indicators to find the end point.

Indicator	Mean HCl concentration (M) (± standard deviation)	Number of measurements
1. Bromothymol Blue	0.09565 ± 0.00225	28
2. Methyl Red	0.08686 ± 0.00098	18
3. Bromocresol green	0.08641 ± 0.00113	29

Is the difference between indicators 1 and 2 significant at the 95% confidence level? Answer the same question for indicators 2 and 3. (10 pts)