

※ 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。

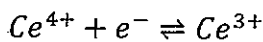
Gas Constant, $R = 8.31451 \text{ J K}^{-1} \text{ mol}^{-1}$; $0^\circ\text{C} = 273.15 \text{ K}$; Faraday Constant, $F = 96485.31 \text{ C mol}^{-1}$;
Plank constant, $h = 6.62608 \times 10^{-34} \text{ J s}$

Inorganic Chemistry (50 points)

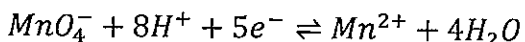
- (1) Would the following *increase*, *decrease*, or have *no effect* on the acidity of the solution? (8 pts)
- Addition of Li_3N to liquid NH_3
 - Addition of HgO to an aqueous KI solution
 - Addition of SiO_2 to molten $\text{Fe} + \text{FeO}$
 - Addition of CuSO_4 to aqueous $(\text{NH}_4)_2\text{SO}_4$
- (2) Identify the ground state with the spin multiplicity for the following cases in
(a) octahedral complexes and (b) tetrahedral complexes. (12 pts)
- Cu^{2+} , Cr^{3+} , Ni^{2+}
- (3) Sketch all of the possible geometrical isomers for the following complexes and indicate which of these would exhibit optical activity. (10 pts)
- $[\text{Co}(\text{en})(\text{NH}_3)_2\text{Br Cl}]^+$
 - $[\text{Pt}(\text{NH}_3)\text{Br Cl}(\text{NO}_2)]^-$
- (4) Give the bond order and the number of unpaired electrons for Be_2^+ , B_2^+ , C_2^+ , O_2^+ , O_2^{2-} (10 pts)
- (5) (a) Draw at least two possible structures of $\text{Os}_3(\text{CO})_9(\text{PPh}_3)_3$ (5 pts)
(b) The IR spectrum of this compound in CH_2Cl_2 has CO stretches at 1962 and 1917 cm^{-1} . How does this knowledge help to narrow the possible structures. (5 pts)

Analytical Chemistry (50 points)

- (6) Given the two half reactions



$$E^0 = 1.70 \text{ V}$$



$$E^0 = 1.507 \text{ V}$$

For a solution contains 0.100 M Ce^{3+} , $1.00 \times 10^{-4} \text{ M Ce}^{4+}$, $1.00 \times 10^{-4} \text{ M Mn}^{2+}$,
 0.100 M MnO_4^- , and 1.00 M HClO_4 at 298 K .

- Write a balanced net equation that occurs between species in this solution (2 pts)
- Calculate ΔG^0 and K for the reaction (6 pts)
- Calculate E for the conditions given (3 pts)
- Calculate ΔG for the conditions given (3 pts)

- (7) A chromatogram with ideal Gaussian bands has $t_r = 9.0$ min and $w_{1/2} = 2.0$ min
- How many theoretical plates are present? (3 pts)
 - Find the plate height if the column is 10 cm long. (3 pts)
- (8) The dibasic compound B ($pK_{b1} = 4.00$, $pK_{b2} = 8.00$) was titrated with 1.00 M HCl. The initial solution of B was 0.100 M with a volume of 100.0 mL. Find the pH at the following volumes of acid V_a added: $V_a = 0, 5, 11, 15$, and 20 mL (10 pts)
- (9) The following data were obtained for repetitive weighings of a 1.004 g standard weight on a top-loading balance:
- | | | |
|-------|-------|-------|
| 1.003 | 1.000 | 1.001 |
| 1.004 | 1.005 | 1.006 |
| 1.001 | 0.999 | 1.007 |
- Assuming the noise is random, calculate the signal-to-noise ratio for the balance. (5 pts)
 - How many measurements would have to be averaged to measure S/N to 500? (5 pts)
- (10) Cyclohexanone exhibits its strongest infrared peak at 5.86 μm , and at this wavelength a linear relationship exists between absorbance and concentration.
- Identify the part of the molecule responsible for the absorbance at this wavelength (3 pts)
 - A solution of cyclohexanone (2.0 mg/mL) in a proper solvent exhibits an absorbance of 0.40, in a cell with a path length of 0.025 mm. What is the detection limit for this compound under these conditions, if the noise associated with the spectrum of the solvent is 0.001 absorbance units? (7 pts)