

科目：無機化學

適用：應化系

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

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一、True (T) or False (F). (30%, 2% each)

- (1) Both  $I_3^-$  and  $NH_2^-$  have a linear molecular structure.
- (2) Acetylene (HCCH) has 6 vibration modes.
- (3)  $H_2O$  and  $CH_2Cl_2$  belong to the same point group.
- (4)  $O_2$  is a paramagnetic compound, while  $N_2$  is a diamagnetic compound.
- (5) On the basis of molecular orbitals,  $NO^+$  has the shortest bond length among  $NO$ ,  $NO^-$ , and  $NO^+$ .
- (6) A close-packed structure showing an ABCABC structure is called hexagonal close packing (hcp).
- (7) The formation constant for  $[Ni(NH_2CH_2CH_2NH_2)_3]^{2+}$  is smaller in magnitude than that for  $[Ni(CH_3NH_2)_6]^{2+}$ .
- (8) For an  $s^1p^1$  configuration, there are 12 microstates.
- (9) Triammineaquadichlorocobalt(III) chloride has three stereoisomers.
- (10) Metals from the second and third transition series form low-spin complexes more readily than metals from the first transition series.
- (11) Cyanide ( $CN^-$ ) is a weaker  $\sigma$  donor and a substantially stronger  $\pi$  acceptor than carbonyl (CO).
- (12) Brønsted and Lowry defined an acid as a species with a tendency to gain a hydrogen ion and a base as a species with a tendency to lose a hydrogen ion.
- (13) For a  $d^3$  configuration in an octahedral geometry, the ground term is  $^4F$ .
- (14)  $[Mn(CO)_6]^+$  has the shortest C—O bond among these metal carbonyl complexes  $[V(CO)_6]^-$ ,  $[Cr(CO)_6]$ , and  $[Mn(CO)_6]^+$ .
- (15) The  $CH_3$  fragment is isolobal with the  $[Fe(CO)_5]^+$  fragment.

二、(6%)

Draw the ligand-field splitting of the  $d$  energy levels in an octahedral complex.

三、(8%)

Draw an appropriate molecular orbital energy-level diagram for CO.

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四、(8%, 2% each)

According to VSEPR model, predict the structures of the following compounds:

- (a)  $\text{NO}_2^-$                       (b)  $\text{XeF}_4$                       (c)  $\text{ICl}_3$                       (d)  $\text{O}_3$

五、(8%, 2% each)

Assign the following molecules or ions to their appropriate point groups.

- (a)  $\text{CHCl}_3$                       (b)  $\text{CO}_2$                       (c)  $\text{Fe}(\text{CO})_5$                       (d)  $\text{trans}[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$

六、(8%, 2% each)

Calculate the ligand-field stabilization energy (LFSE) of octahedral complexes in  $\Delta_o$  unit.

- (a)  $[\text{MnF}_6]^{4-}$                       (b)  $[\text{Cr}(\text{CN})_6]^{3-}$                       (c)  $[\text{Ti}(\text{H}_2\text{O})_6]^+$                       (d)  $[\text{Co}(\text{NH}_3)_6]^{3+}$

七、(8%, 2% each)

Give the valence electron count for the following species.

- (a)  $(\eta^5\text{-Cp})_2\text{Ti}(\text{CO})_2$                       (b)  $[\text{Co}(\text{CN})_5]^{3-}$   
 (c)  $[\text{Ni}(\text{CN})_4]^{2-}$                       (d)  $\text{cis-PtCl}_2(\text{NH}_3)_2$

八、(8%, 2% each)

Classify the following as *closo*, *nido*, or *arachno*:

- (a)  $\text{B}_6\text{H}_6^{2-}$                       (b)  $\text{C}_4\text{B}_2\text{H}_6$                       (c)  $\text{Co}_4(\text{CO})_{12}$                       (d)  $\text{P}_4$

九、(8%)

The solubilities of silver halides in water decrease, going down the column of halogens in the periodic table:  $\text{AgF}$  ( $K_{sp} = 205$ )  $\gg$   $\text{AgCl}$  ( $K_{sp} = 1.8 \times 10^{-10}$ )  $>$   $\text{AgBr}$  ( $K_{sp} = 5.2 \times 10^{-13}$ )  $>$   $\text{AgI}$  ( $K_{sp} = 8.3 \times 10^{-17}$ ). Explain briefly.

十、(8%)

Determine the packing efficiency of atoms in a body-centered cubic structure.