

科目：無機化學(2003)

校系所組：中央大學化學學系 交通大學應用化學系 清華大學化學系

一、單選題 (直接寫在答案卷，每題 2 分/共 50 分，答錯不倒扣分數)

- Which compound has the *smallest* bond angle?  
(A)  $\text{NF}_3$  (B)  $\text{PF}_3$  (C)  $\text{AsF}_3$  (D)  $\text{SbF}_3$  (E)  $\text{NH}_3$
- Oxide ion acceptor is often defined as an acid by?  
(A) Lewis (B) Ingold-Robinson (C) Lux-Flood (D) Usanovich (E) Solvent System
- Which statement is *not* true?  
(A)  $\text{NO}$ , bond order = 2.5, paramagnetic (B)  $\text{NO}_2$ , bent shape, paramagnetic (C)  $\text{NO}_2^+$ , linear shape (D)  $\text{NO}_2$ , paramagnetic, exists in equilibrium with  $\text{N}_2\text{O}_4$  (E)  $\text{N}_2\text{O}_4$ ,  $D_{2h}$ , has a  $\text{N}=\text{N}$  bond.
- Which one is *hard* acid?  
(A)  $\text{Mn}^{2+}$  (B)  $\text{Cu}^+$  (C)  $\text{Cd}^{2+}$  (D)  $\text{Hg}_2^{2+}$  (E)  $\text{Au}^+$
- Which carbide is *not* known?  
(A)  $\text{Al}_4\text{C}_3$  (B)  $\text{CaC}_2$  (C)  $\text{Mg}_2\text{C}_3$  (D)  $\text{BeC}_2$  (E)  $\text{Be}_2\text{C}_3$
- $\text{TiO}_2$  in the rutile structure has distorted  $\text{TiO}_6$  octahedra that form columns by sharing edges, resulting in coordination numbers of  $a$  and  $b$  for Ti and O atom, respectively.  
(A)  $a = 6$ ;  $b = 2$  (B)  $a = 6$ ;  $b = 3$  (C)  $a = 6$ ;  $b = 4$  (D)  $a = 4$ ;  $b = 4$  (E)  $a = 4$ ;  $b = 4$
- Which statement is *not* true about nitrogen atom?  
(A) nitrogen exists in three anionic forms,  $\text{N}^{3-}$ ,  $\text{N}_3^-$  and  $\text{N}^{2-}$ . (B) nitrides of primarily ionic character formed by Li and the Group 2 elements. (C)  $\text{N}^{3-}$  is considered as a strong  $\pi$ -donor ligand toward transition metals. (D) many nitrides have a greater degree of covalence. (E)  $\text{HN}_3$  is known as hydrazoic acid and  $\text{N}_3^-$  is a *bent* structure.
- Which one of the following superacids is the most strongest in acidity?  
(A)  $\text{H}_2\text{SO}_4$  (B)  $\text{HF}$  (C)  $\text{HClO}_4$  (D)  $\text{HSO}_3\text{CF}_3$  (E)  $\text{HSO}_3\text{F}$
- The point group of the compound  $\text{BrF}_5$  is?  
(A)  $D_{3h}$  (B)  $C_4$  (C)  $C_{5v}$  (D)  $C_{4v}$  (E)  $D_{5d}$
- Which one is *not* amphoteric?  
(A)  $\text{BeO}$  (B)  $\text{Al}_2\text{O}_3$  (C)  $\text{Ga}_2\text{O}_3$  (D)  $\text{Al}(\text{OH})_3$  (E)  $\text{SiO}_2$
- Which statement is *not* true about fullerene,  $\text{C}_{60}$ ?  
(A) consists of fused five- and six-membered carbon rings. (B) each 6-membered ring is surrounded, alternately, by hexagons and pentagons. (C) all 60 atoms are equivalent and give rise to a single  $^{13}\text{C}$  NMR resonance. (D) all C-C bonds are also equivalent. (E) each pentagon is fused to five hexagons.
- Which one has a *shortest* O-O distance?  
(A)  $\text{O}_2^+$  (B)  $\text{O}_2$  (C)  $\text{O}_2^-$  (D)  $\text{O}_2^{2-}$  (E)  $\text{O}_3$
- Which one has a *tetrahedral* geometry at metal center?  
(A)  $\text{AgF}_4^-$  (B)  $\text{Ni}(\text{CN})_4^{2-}$  (C)  $\text{NiCl}_2(\text{PPh}_3)_2$  (D)  $\text{PtCl}_4^{2-}$  (E)  $\text{Ni}(\text{CO})_4$
- Low spin of  $d^7$ - $M^{2+}$  ion has an Exchange Energy of?  
(A)  $4\Pi_e$  (B)  $5\Pi_e$  (C)  $6\Pi_e$  (D)  $7\Pi_e$  (E)  $8\Pi_e$
- Which ligand for square planar complexes has a higher *Trans Effect* when undergoing substitution reactions?  
(A)  $\text{CO}$  (B)  $\text{PH}_3$  (C)  $\text{Br}^-$  (D)  $\text{NH}_3$  (E)  $\text{H}_2\text{O}$
- Which compound does *not* obey the 18-electron rule?  
(A)  $\text{CpNi}(\text{lin-NO})$  (B)  $\text{CpCr}(\text{CO})_2(\text{NS})$  (C)  $(\text{PPh}_3)_2(\text{bent-NO})\text{Ir}(\text{CO})\text{Cl}$  (D)  $\text{fac-Re}(\text{CO})_3(\text{en})\text{Br}$

注意：背面有試題

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(E)  $\text{Cp}_2\text{Ta}(\text{CH}_3)(\text{CH}_2)$

17. Which one of the following species has a lower  $\nu(\text{CO})$  frequency?  
(A)  $\text{Ti}(\text{CO})_6^{2-}$  (B)  $\text{V}(\text{CO})_6^-$  (C)  $\text{Cr}(\text{CO})_6$  (D)  $\text{Mn}(\text{CO})_6^+$  (E)  $\text{Fe}(\text{CO})_6^{2+}$
18. Which one has no bridging CO's ( $\mu_2\text{-CO}$ ) in its structure?  
(A)  $\text{Ir}_4(\text{CO})_{12}$  (B)  $\text{Cp}_2\text{Fe}_2(\text{CO})_4$  (C)  $\text{Cp}_2\text{Mo}_2(\text{CO})_4$  (D)  $\text{Co}_4(\text{CO})_{12}$  (E)  $\text{Os}_3(\text{CO})_{12}$
19. The complex,  $[\text{Mo}_2(\text{SO}_4)_4]^{4+}$  has a bond order of?  
(A) 2.0 (B) 2.5 (C) 3.0 (D) 3.5 (E) 4.0
20. The heteroborane compound,  $\text{CPB}_{10}\text{H}_{11}$  was classified as a structural type of?  
(A) *closo* (B) *nido* (C) *arachno* (D) *hypho* (E) *klado*
21. Which electronic configuration is not expected to have a Jahn-Teller effect?  
(A) high spin- $d^4$  (B) high spin- $d^9$  (C) low spin- $d^7$  (D) low spin- $d^9$  (E) low spin- $d^6$
22. The ground term for a low spin- $d^4$  metal ion is  
(A)  $^5D$  (B)  $^3H$  (C)  $^4F$  (D)  $^3D$  (E)  $^3F$
23. Which one has a geometry of trigonal bipyramid (TBP)?  
(A)  $\text{XeO}_2\text{F}_2$  (B)  $\text{XeO}_3$  (C)  $\text{XeO}_2\text{F}_4$  (D)  $\text{XeF}_2$  (E)  $\text{XeO}_3\text{F}_2$
24. Which ligand has the largest cone angle?  
(A)  $\text{P}(\text{C}_6\text{H}_5)_3$  (B)  $\text{P}(\text{CF}_3)_3$  (C)  $\text{P}(\text{cyclo-C}_6\text{H}_{11})_3$  (D)  $\text{PBr}_3$  (E)  $\text{P}(\text{C}_6\text{F}_5)_3$
25. Which one of the following oxyacids of the halogens is known?  
(A) HOFO (B) HOCIO (C) HOBrO (D) HOIO (E) HOFO<sub>2</sub>

二、問答題 (共 50 分)

1. Predict the products for following reactions. (每題 2 分/共 10 分)  
(A)  $\text{CrCl}_3 + \text{CO} + \text{Al} \rightarrow$   
(B)  $\text{Na}_3\text{P} + \text{H}_2\text{O} \rightarrow$   
(C)  $\text{trans-Ir}(\text{CO})\text{Cl}(\text{PBt}_3)_2 + \text{H}_2 \rightarrow$   
(D)  $\text{SF}_4 + \text{XeF}_4 \rightarrow$   
(E)  $\text{Cl}_2 + \text{OH}^- \rightarrow$
2. Please draw the structure for the following compounds (每題 3 分/共 15 分)  
(A)  $\text{Cp}_2\text{Cr}_2(\text{NO})_4$  (B)  $\text{ReH}_9^{2-}$  (C)  $\text{N}_2\text{O}_3$  (D)  $\text{As}(\text{N}_3)_6^-$  (E)  $\text{F}_3\text{SCCF}_3$
3.  $\text{IF}_5$  undergoes auto-dissociation into  $\text{IF}_4^+$  and  $\text{IF}_6^-$ .  $\text{SbF}_5$  acts as an acid and  $\text{KF}$  acts as a base when dissolved in  $\text{IF}_5$ . Write balanced chemical equations for these reactions. (6 分)
4. Indicate how you could use NMR spectroscopy to monitor the following questions; (A) What happens when  $\text{Me}_3\text{N}$  is added to a THF solution of  $\text{THF}\cdot\text{BH}_3$ ? (B) Will  $\text{Me}_2\text{O}$  displace  $\text{Me}_3\text{P}$  from  $\text{Me}_3\text{P}\cdot\text{BH}_3$ ? (C) Is  $[\text{BH}_4]^-$  stable in THF solution with respect to a displacement reaction? (D) Propose the relative stabilities of adducts  $\text{L}\cdot\text{BH}_3$  ( $\text{L} = \text{Me}_3\text{P}, \text{THF}, \text{Me}_2\text{O}, \text{Me}_3\text{N}$ ) based on above NMR data observations. (8 分)
5. Which octahedral complexes are chiral:  $\text{cis-CoCl}_2(\text{en})_2^+$ ,  $\text{Cr}(\text{ox})_3^-$ ,  $\text{trans-PtCl}_2(\text{en})_2^{2+}$ ,  $\text{Ni}(\text{phen})_3^{2+}$ ,  $\text{RuBr}_4(\text{phen})^-$  and  $\text{cis-RuCl}(\text{py})(\text{phen})_2^+$ ? (4 分)
6. When an aqueous solution of KCN is added to a solution of aluminum sulfate, a precipitate forms. What and why is it? (4 分)
7. What is the structure of borazine? (3 分)