

科目：無機化學(2003)

校系所組：中大化學學系

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(單選，每題 2 分，答錯不倒扣分數)

一 單選題 答案請填寫於電腦答案卡上 (2% each, 54% total)

For questions 1 and 2

In a one-dimensional particle-in-a-box, for a wavefunction with  $n = 8$ :

1. How many wavelengths equal the size of the box?

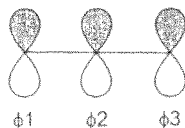
(A) 4 (B) 5 (C) 6 (D) 7 (E) 8

2. How many nodes are there?

(A) 4 (B) 5 (C) 6 (D) 7 (E) 8

For questions 3 and 4

Linear combination  $\phi_1 + \phi_2 + \phi_3 =$



3. To what type of interaction does the linear combination belong?

(A)  $\sigma$  (B)  $\mu$  (C)  $\pi$  (D)  $\eta$  (E)  $\delta$

4. Which one of the following linear combinations is an allowed antibonding interaction?

(A)  $\phi_1 + \phi_2 + \phi_3$  (B)  $\phi_1 - \phi_2 + \phi_3$  (C)  $\phi_1 - \phi_2 - \phi_3$  (D)  $\phi_1 - \phi_2$  (E)  $\phi_1 - \phi_3$

5. What is the shape of  $\text{SF}_4$ ?

(A) tetrahedral (B) trigonal bipyramidal (C) seesaw (D) square planar (E) T-shaped

6. Which one of the following diatomic molecules and ions is paramagnetic?

(A) CO (B)  $\text{N}_2$  (C)  $\text{NO}^+$  (D)  $\text{O}_2^{2-}$  (E)  $\text{NO}^-$

7. For an octahedral complex  $\text{Ma}_3\text{bcd}$  (M is the center atom while a, b, c, and d are ligands), how many stereoisomers can be found?

(A) 2 (B) 3 (C) 4 (D) 5 (E) 6

8. What is the ground state term of  $\text{Mn}^{2+}$ ?

(A)  $^5\text{D}$  (B)  $^4\text{F}$  (C)  $^3\text{F}$  (D)  $^4\text{G}$  (E)  $^6\text{S}$

9. For  $\text{Mn}(\text{OH}_2)_6^{3+}$ , which one of the following magnetic moments (in Bohr magneton) is most likely?

(A) 1.73 (B) 2.83 (C) 3.87 (D) 4.90 (E) 5.92

For questions 10 and 11

Consider  $\text{CaF}_2$  (fluorite structure):

10. What are the coordination numbers of the ions in  $\text{CaF}_2$ ?

(A) Ca: 2, F: 4 (B) Ca: 8, F: 4 (C) Ca: 4, F: 8 (D) Ca: 4, F: 4 (E) Ca: 8, F: 8

11. What are the numbers of the ions per unit cell?

(A) Ca: 2, F: 4 (B) Ca: 8, F: 4 (C) Ca: 4, F: 8 (D) Ca: 4, F: 4 (E) Ca: 8, F: 8

For questions 12 and 13

Consider Pt:

12. The density of Pt is  $21.09 \text{ g}\cdot\text{cm}^{-3}$ . Pt crystallizes in a cubic close-packed structure. Estimate its atomic radius.

(A) 100 pm (B) 113 pm (C) 126 pm (D) 139 pm (E) 152 pm

13. What is the ratio of the volume occupied by Pt atoms to the volume of the solid?

(A) 0.80 (B) 0.74 (C) 0.68 (D) 0.60 (E) 0.52

14. Which one of the following complexes is not an 18-electron species?

(A)  $\eta^5\text{-Cp}_2\text{Co}$  (B)  $\text{Ph}(\text{MeO})\text{C}=\text{Cr}(\text{CO})_5$  (C)  $\eta^5\text{-CpFe}(\text{CO})_2\text{Cl}$  (D)  $\text{HCo}(\text{CO})_4$  (E)  $\text{Mn}(\text{CO})_5\text{Cl}$

15. Consider the following compounds. Which one has the largest affinity towards  $\text{H}^+$  in gas phase?

(A)  $\text{NF}_3$  (B)  $\text{NH}_3$  (C)  $\text{NMeH}_2$  (D)  $\text{NMe}_2\text{H}$  (E)  $\text{NMe}_3$

16. Which one of the following molecules has the highest M-C bond enthalpy? (M is the center atom)

(A)  $\text{CMe}_4$  (B)  $\text{SiMe}_4$  (C)  $\text{GeMe}_4$  (D)  $\text{SnMe}_4$  (E)  $\text{PbMe}_4$

注意：背面有試題

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17. Which one of the following compounds does not contain three-center two-electron bonds?

 (A)  $B_2H_6$  (B)  $B_4H_{10}$  (C)  $Al_2Me_6$  (D)  $Al_2Me_4Cl_2$  (E)  $Al_2Ph_6$ 

 18.  $Mo_2(O_2CMe)_4$  has a Mo-Mo quadruple bond.  $Rh_2(O_2CMe)_4$  is isostructural to the Mo complex. What is the Rh-Rh bond order?

(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

19. According to the Frost diagrams of Cr, Mo and W shown on the right, determine their most stable oxidation numbers.

(A) Cr:6, Mo:6, W:0 (B) Cr:0, Mo:0, W:0 (C) Cr:3, Mo:4, W:6 (D) Cr:4, Mo:4, W:4 (E) Cr:3, Mo:5, W:5

20. Which one of the following complexes displays the lowest CO stretching frequency?

 (A)  $Ti(CO)_6^{2-}$  (B)  $V(CO)_6^-$  (C)  $Cr(CO)_6$  (D)  $Mn(CO)_6^+$  (E)  $Fe(CO)_5$ 

 21. Which one of the following molecules possesses an  $S_4$  axis?

(A) allene (B) ethylene (C) hydrazine (D) benzene (E) ferrocene

22. Which one of the following oxides is the most acidic?

 (A)  $Na_2O$  (B)  $B_2O_3$  (C)  $Al_2O_3$  (D)  $P_2O_5$  (E)  $SO_3$ 

23. Using the information below:



What is the most stable oxidation number of vanadium in an acid solution?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

24. Which one of the following elements has the largest metallic radius?

(A) Ca (B) Co (C) Cr (D) Cs (E) Cu

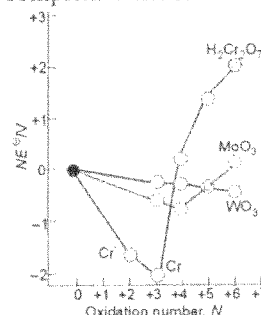
25. Which one of the following elements has the highest first ionization energy?

(A) S (B) Sb (C) Si (D) Sn (E) Sr

26. All of the following solids have rock-salt structures. Which one of them has the highest melting point?

(A) CaO (B) MgO (C) LiF (D) NaCl (E) KBr

27. Which one of the following solids is not considered to be a semiconducting material?

 (A) GaN (B) CdS (C) SiC (D)  $CaF_2$  (E) Si


二 閱讀題目內容後，回答各小題答案於答案卷上 (20% total)

 From a reaction between 3-hexyne and  $AuCl$  in  $CH_2Cl_2$ , a new monomeric compound A is isolated. A displays the following data:

$^1H$ NMR	$^{13}C$ NMR	Elemental Analyses
$\delta$ 1.23 ppm, triplet, $J = 7.2$ Hz	$\delta$ 14.7 ppm	C: 22.91%
$\delta$ 2.61 ppm, quartet, $J = 7.2$ Hz	$\delta$ 15.2 ppm	H: 3.20%
	$\delta$ 86.4 ppm	

- Used the data to draw a structure for A. Discuss why you propose this structure. (6%)
- Count the number of valence electrons for A. (2%)
- Discuss the bonding between the hydrocarbon fragment and the metal center in A. (4%)
- Is the C3-C4 bond length in A longer or shorter than a  $C \equiv C$  bond? Why? (4%)
- Predict the angles of  $\angle C2-C3-C4$  and  $\angle C3-C4-C5$  in A. Explain your reasons. (4%)

 Reference: *Inorg. Chem.*, 2009, 48 (2), 423-425

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