Part I 與 Part II 分開作答　答案須清楚標示題號

Part I: (Total score 50%)

A: Multiple Choices 多選題(答錯倒扣)填答於答案紙上 (20%)

1. Which of the following term symbols belong to the electronic configuration of f^2

   (a) ^3H (b) ^3G (c) ^1F (d) ^1D (e) ^1P

2. Which of the following molecules or ions have sp^3 hybridization and formal charge of +1 for the central atom:

   (a) NO_3^- (b) BF_4^- (c) $S_2O_3^{2-}$ (d) ICl_2^+ (e) ClO_3^-

3. Among the following diatomic molecules, which of them have multiple bonds

   (a) B_2 (b) C_2 (c) Li_2 (d) O_2^+ (e) F_2

4. Two fragments are isolobal if their highest energy orbitals have the same symmetry, similar energies and the same electron occupation. Which of the following fragments conform with isolobal analogy:

   (a) CH (b) CH_2 (c) $Co(CO)_3$ (d) $Co(CO)_4$ (e) $HFe(CO)_3$

B:

5. Using the character table of D_{3h} shown below, derive irreducible representations for the three σ bonds of BF_3, and using projection operator method to find the group orbitals for each representation. 10%

6. Olefin metathesis is now a day an important process for the preparation of various organic compounds and polymers. Cyclohexene undergoes Ring Opening Metathesis Polymerization (ROMP) with a catalyst R_3Al/WCl_6 producing a polymer. Draw structure of the product and write a mechanism of polymerization. 10%

7. Explain briefly the following terms: 10%

   (a) Spectrochemical series (b) phosphorescence (c) oxidative addition (d) amphoterism (e) Hund's rule

Part II: (Total score 50%)

8. Give proper explanations for the following observation. (10%)

(a) O_2 is a paramagnetic compound.

(b) $HClO_2$ is a weak acid, while $HClO_4$ is a strong acid

(c) CCl_4 does not react with water, but $SiCl_4$ reacts with water to form SiO_2.

(d) At room temperature, CO_2 is a gas but SiO_2 is a solid.

(e) Diamond is one of the hardest materials, but graphite is often used as a lubricant.

9. Indicate the <u>coordination numbers</u> of the cations and anions in the following solids, and calculate the <u>density</u> for each solid.

(a) sodium iodide (NaCl structure; r_{Na^+} = 102 pm, r_{I^-} = 220 pm; atomic weight of Na = 23.0, atomic weight of I = 126.9) (5%)

(b) cesium bromide (CsCl structure; r_{Cs^+} = 170 pm, r_{Br^-} = 196 pm; atomic weight of Cs = 132.9, atomic weight of Br = 79.9) (5%)

10. Given the reduction potential E_A^0 = 0.771 V for $Fe^{3+} + e^- \rightarrow Fe^{2+}$ (where A represents at $[H^+]$ = 1 M condition) and Ksp = 4.87 x 10^{-17} and 2.79 x 10^{-39} for $Fe(OH)_2$ and $Fe(OH)_3$, respectively.

(a) Write the Nernst equations for the two half reactions: $Fe^{3+} \rightarrow Fe^{2+}$ and $Fe(OH)_3 \rightarrow Fe(OH)_2$. (4%)

(b) What is reduction potential E_B^0 for the $Fe(OH)_3 \rightarrow Fe(OH)_2$ couple (where B represents at $[OH^-]$ = 1 M condition)? (6%)

11. The Mn^{2+}(aq) ion is pale pink, but the MnO_4^- ion is deep purple. Characterize the origins of the transitions and explain the relative intensities. (10%)

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12. Using the descending of symmetry if necessary, find the term symbols for the following electron configurations in octahedral crystal field.　　　(10%)

(a) $t_{2g}^1 e_g^1$　　　　　(b) e_g^2

Correlation table

O_h	C_{2v}
A_{1g}	A_1
A_{2g}	A_2
E_g	$A_1 + A_2$
T_{1g}	$A_2 + B_1 + B_2$
T_{2g}	$A_1 + B_1 + B_2$
A_{1u}	A_2
A_{2u}	A_1
E_u	$A_1 + A_2$
T_{1u}	$A_1 + B_1 + B_2$
T_{2u}	$A_2 + B_1 + B_2$

Character Table

D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$
A_1'	1	1	1	1	1	1
A_2'	1	1	-1	1	1	-1
E'	2	-1	0	2	-1	0
A_1''	1	1	1	-1	-1	-1
A_2''	1	1	-1	-1	-1	1
E''	2	-1	0	-2	1	0

O_h	E	$8C_3$	$6C_2$	$6C_4$	$3C_2$	i	$6S_4$	$8S_6$	$3\sigma_h$	$6\sigma_d$
A_{1g}	1	1	1	1	1	1	1	1	1	1
A_{2g}	1	1	-1	-1	1	1	-1	1	1	-1
E_g	2	-1	0	0	2	2	0	-1	2	0
T_{1g}	3	0	-1	1	-1	3	1	0	-1	-1
T_{2g}	3	0	1	-1	-1	3	-1	0	-1	1
A_{1u}	1	1	1	1	1	-1	-1	-1	-1	-1
A_{2u}	1	1	-1	-1	1	-1	1	-1	-1	1
E_u	2	-1	0	0	2	-2	0	1	-2	0
T_{1u}	3	0	-1	1	-1	-3	-1	0	1	1
T_{2u}	3	0	1	-1	-1	-3	1	0	1	-1

C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma_v'(yz)$
A_1	1	1	1	1
A_2	1	1	-1	-1
B_1	1	-1	1	-1
B_2	1	-1	-1	1

試題隨卷繳回