系所組別： 化學系

考試科目： 無機化學

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

I. 40% 單選題，每題答對得四分，答錯扣一分。

1 Which molecule has the smaller ionization energy?
(A) O_2 (B) CN (C) N_2 (D) CO (E) F_2

2. Which compound has the smallest bond angle?
(A) NH_3 (B) NF_3 (C) NCl_3 (D) PF_3 (E) PCl_3

3. Which term symbol is unlikely for V atom?
(A) ^4F (B) ^4P (C) ^4S (D) ^2D (E) ^2P

4. Which are the number of unpaired electrons for B_2, $[Cr(CN)_6]^{4-}$ and $[Fe(H_2O)_6]^{3+}$ respectively?
(A) 0, 2, 1 (B) 0, 4, 5 (C) 2, 2, 5 (D) 2, 4, 1 (E) 2, 4, 5

5. Which of the following bases has the largest affinity in gas phase?
(A) OH^- (B) CH_3O^- (C) $C_2H_5\text{-}O^-$ (D) i-Pr-O^- (E) t-Bu-O^-

6. Which of the following is the lattice point of a hexagonal close packing structure?
(A) $\left(\frac{1}{3},\frac{2}{3},\frac{1}{2}\right)$ (B) $\left(\frac{1}{2},\frac{1}{3},\frac{1}{2}\right)$ (C) $\left(\frac{1}{3},\frac{1}{2},\frac{1}{2}\right)$ (D) $\left(\frac{2}{3},\frac{1}{2},\frac{1}{3}\right)$ (E) $\left(\frac{1}{2},\frac{2}{3},\frac{1}{2}\right)$

7. Which of the following solid would have the greatest lattice energy?
(A) $CaBr_2$ (B) SrO (C) CsF (D) CsI (E) $BaSO_4$

8. Predict the number of stereoisomers and pair of enantiomers for complex with formula, Ma_2b_2cd. (M=metal; a, b, c, d = monodentate ligands)
(A) 6, 2 (B) 7, 2 (C) 7, 3 (D) 8, 2 (E) 8, 3

9. Choose the one that shows the strongest Jahn-Teller distortion.
(A) $Ti(H_2O)_6^{3+}$ (B) CrF_6^{3-} (C) MnF_6^{3-} (D) CoF_6^{3-} (E) $Co(CN)_6^{3-}$

10. *trans*-$[Co(en)_2(OH)Cl]^+ + OH^- \rightarrow [Co(en)_2(OH)_2]^+ + Cl^-$ The substitution reaction is believed to proceed by "dissociation mechanism" with trigonal bipyramid structure as the intermediate. What is the percent of the Λ-*cis*-$[Co(en)_2(OH)_2]^+$ product?
(A) 3/12 (B) 4/12 (C) 5/12 (D) 6/12 (E) 7/12

(背面仍有題目,請繼續作答)

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II. 60% 非選擇題。

1 Draw structure and determine the point group for each of the following molecules. 10%
(a): P_2I_2 (b): NO_4^{3-} (c): $S_2O_8^{2-}$ (d): $Mn_2(CO)_{10}$ (e): $Fe_2(CO)_9$

2. (a) Give the reducible representation Γ for all motions of the NH_3. 2%
(b) Reduce Γ to its irreducible representations. 3%
(c) Classify the irreducible representations into transitional, rotational, and vibrational modes. 3%
(d) Which vibrational modes are infrared active? 2%

C_{3v}	E	$2C_3$	$3\sigma_v$		
A_1	1	1	1	z	x^2+y^2, z^2
A_2	1	1	-1	R_z	
E	2	-1	0	$(x,y)(R_x,R_y)$	$(x^2-y^2)(xz,yz)$

3. (a) Sketch the energy level diagram to express the relationship between the HOMO, LUMO, absolute electronegative (χ_{abs}) and absolute hardness (η) for Cl_2. 6%
(IE=11.6 eV, EA=2.4 eV).
(b) Show the (1 1 0) and (0 1 0) crystal faces for a cubic crystal. 4%

4. (a) Use the molecular orbital theory to describe why the spectrochemical series (10 Dq size) has the order of $CO > NH_3 > F^-$ 6%
(b) Classify the following configuration as A, E, or T in complexes having O_h symmetry. Some of these configurations represent excited state. 4%
(i) t_{2g}^6 (ii) $t_{2g}^3e_g^3$.

5. (a) Select the best choice for each of the following: 4%
(i) The longest N-N bond: N_2, $(CO)_5Cr{:}N{\equiv}N{:}$ or $(CO)_5Cr{:}N{\equiv}N{:}Cr(CO)_5$
(ii) Higher energy Cr-C stretching bands in IR: $Cr(CO)_5(PF_3)$ or $Cr(CO)_5(PCl_3)$
(b) Draw the structure for products of the following reactions: 4%
(i) $[Pt(PPh_3)_4]^{2-} + 2Br^- \rightarrow$
(ii) $[PtCl_4]^{2-} + 2PMe_3 \rightarrow$
(c) Predict whether these complexes would be labile or inert and explain your choices. 4%
(i) potassium hexaiodomangnate(IV)
(ii) hexammineiron(II) chloride
(d) Count number of the electrons for the complex $[(C_5H_5)Cr(NO)_2]_2$. 2%

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6. The compound $(C_5H_5)_2Fe(CO)_2$ has interesting NMR behavior shown below. The ^1H NMR shows two singlets of equal area at room temperature. At lower temperature, the peak at 4.5 ppm remains constant, the other peak at 5.7 ppm spreads and then splits into new peaks near 3.5 and between 5.9 and 6.4 ppm.

(a) Sketch the structure for $(C_5H_5)_2Fe(CO)_2$. 2%

(b) Proposed a mechanism to explain this NMR behavior. 4%