

國立臺灣師範大學 100 學年度碩士班招生考試試題

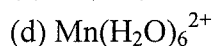
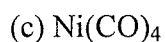
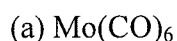
科目：無機化學

適用系所：化學系

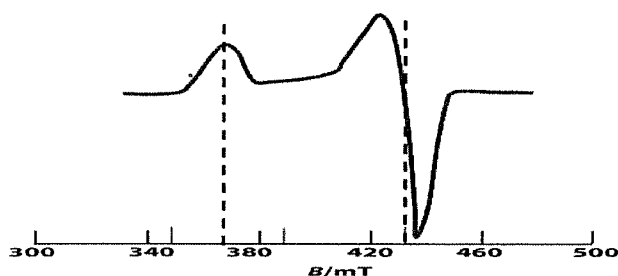
注意：1.本試題共 3 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

1. With two types of monodentate ligands, A and B, coordinate to a metal ion and form octahedral structure, write down all the possible complexes and sketch the structure(s) for each complex. You must assign point groups to each structure. (20 points)

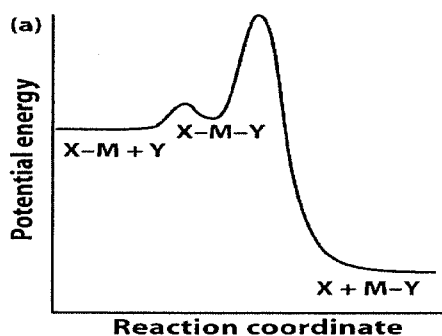
2. Sketch the *d*-orbital spilling for the following complexes. Make sure you have labeled the orbitals and filled in the electrons. (20 points)



3. EPR spectrum can give information about the shape of a molecule. A complex has EPR spectrum as following. What is the molecular shape? (5 points)



4. A substitution reaction has reaction potential profile as shown below. What is the possible reaction mechanism? (5 points)



5. Give explanations of the following phenomena: (6 points)

(a) The electron configuration of Cr is $[\text{Ar}]4s^13d^5$ rather than $[\text{Ar}]4s^23d^4$

(b) The electron configuration of Ti is $[\text{Ar}]4s^23d^2$, but that of Cr^{2+} is $[\text{Ar}]3d^4$

國立臺灣師範大學 100 學年度碩士班招生考試試題

6. The second ionization energy of He is almost exactly four times the ionization energy (IE) of H, and the third IE of Li is almost exactly nine times the IE of H:

	IE (MJ mol ⁻¹)
$\text{H(g)} \rightarrow \text{H}^{\text{+}}(\text{g}) + \text{e}^{-}$	1.3120
$\text{He}^{\text{+}}(\text{g)} \rightarrow \text{He}^{\text{2+}}(\text{g}) + \text{e}^{-}$	5.2504
$\text{Li}^{\text{2+}}(\text{g)} \rightarrow \text{Li}^{\text{3+}}(\text{g}) + \text{e}^{-}$	11.8149

Explain this trend on the basis of the Bohr equation for energy levels of single electron systems. (4 points)

7. Three isomers having the formula N₂CO are known: ONCN (nitrosyl cyanide), ONNC (nitrosyl isocyanide), and NOCN (isonitrosyl cyanide). Draw the most important resonance structures of these isomers, and determine the formal charges. Which isomer do you predict to be the most stable (lowest energy) form? (10 points)
8. Draw the structure of CAI₄ and give the explanation. (5 points)
9. Determine the point groups for the following compounds (10 points)
- (a) 1,2-Dichloroethane (anti-staggered)
 - (b) Chloroethane (staggered)
 - (c) Ethane (eclipsed)
 - (d) Ethane (staggered)
10. Determine the number of IR-active C-O stretching vibrations of possible Fe(CO)₄(Cl)₂ complexes. (5 points)
11. Predict the reactions of the following hydrogen compounds with water, and explain your reasoning's. (10 points)
- (a) CaH₂
 - (b) HBr
 - (c) H₂S
 - (d) CH₄

國立臺灣師範大學 100 學年度碩士班招生考試試題

Character table for C_{2v} point group

	E	$C_2(z)$	$\sigma_v(xz)$	$\sigma_v(yz)$	linear, rotations	quadratic
A_1	1	1	1	1	z	x^2, y^2, z^2
A_2	1	1	-1	-1	R_z	xy
B_1	1	-1	1	-1	x, R_y	xz
B_2	1	-1	-1	1	y, R_x	yz

Character table for D_{4h} point group

	E	$2C_4(z)$	C_2	$2C'_2$	$2C''_2$	i	$2S_4$	σ_h	$2\sigma_v$	$2\sigma_d$	linears, rotations	quadratic
A_{1g}	1	1	1	1	1	1	1	1	1	1		x^2+y^2, z^2
A_{2g}	1	1	1	-1	-1	1	1	1	-1	-1	R_z	
B_{1g}	1	-1	1	1	-1	1	-1	1	1	-1		x^2-y^2
B_{2g}	1	-1	1	-1	1	1	-1	1	-1	1		xy
E_g	2	0	-2	0	0	2	0	-2	0	0	(R_x, R_y)	(xz, yz)
A_{1u}	1	1	1	1	1	-1	-1	-1	-1	-1		
A_{2u}	1	1	1	-1	-1	-1	-1	-1	1	1	z	
B_{1u}	1	-1	1	1	-1	-1	1	-1	-1	1		
B_{2u}	1	-1	1	-1	1	-1	1	-1	1	-1		
E_u	2	0	-2	0	0	-2	0	2	0	0	(x, y)	