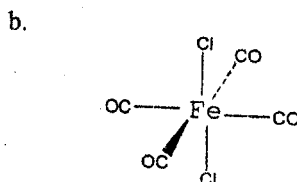
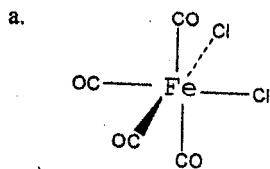


科目：無機化學

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- For the $3p_z$ and $4d_{xz}$ hydrogen-like atomic orbitals, sketch the following: (9 points, 3 points each)
 - The radial function R .
 - The radial probability function $a_0 r^2 R^2$.
 - Contour maps of electron density.
- Name two superacids, two Lewis acids, and two Bronsted-Lowry bases. (6 points)
- Draw the structure and determine the point group of the following compounds. (9 points, 3 points each)
 - Chloroethane (staggered conformation).
 - Sulfur molecule.
 - 1,1'-dichloroferrocene.
- For the following molecules, determine the number of IR-active C-O stretching vibrations: (10 points, 5 points each)



C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma_v'(yz)$		
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

參考用

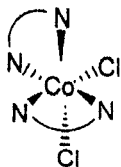
D_{4h}	E	$2C_4$	C_2	$2C_2'$	$2C_2''$	i	$2S_4$	σ_h	$2\sigma_v$	$2\sigma_d$		
A_{1g}	1	1	1	1	1	1	1	1	1	1	R_z	$x^2 + y^2, z^2$
A_{2g}	1	1	1	-1	-1	1	1	1	-1	-1		$x^2 - y^2$
B_{1g}	1	-1	1	1	1	1	-1	1	1	-1	(R_x, R_y)	xy
B_{2g}	1	-1	1	-1	-1	1	-1	1	-1	1		(xz, yz)
E_g	2	0	-2	0	0	2	0	-2	0	0	z	
A_{1u}	1	1	1	1	1	-1	-1	-1	-1	-1		
A_{2u}	1	1	1	-1	-1	-1	-1	-1	1	1	(x, y)	
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		

注意：背面有試題

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5. The isomeric ions NSO^- (thiazate) and SNO^- (thionitrite) ions have been reported by S. P. So. (6 points, 3 points each)
- On the basis of the resonance structures of these ions, predict which would be more stable?
 - Sketch the approximate shapes of the π and π^* orbitals of these ions.
6. Name two types of commercial applications of semiconductors and their working principles. (10 points)
7. Several interhalogens undergo autoionization in the liquid phase and have been studied as nonaqueous solvents. Examples are shown below, and please write the following equations. (8 points)
- $\text{BrF}_3 \rightleftharpoons$
 - $\text{I}_2\text{Cl}_6 \rightleftharpoons$
8. Determine the total numbers of electrons for the following organometallic compounds. Show your electron additions one by one. (10 points)
- $\text{CpNi}(\text{NO})$
 - $(\text{PPh}_3)_2\text{Ir}(\text{CO})\text{Cl}(\text{NO})^+$
 - $\text{Cp}_2\text{Cr}_2(\text{NO})_4$
 - $(\text{CO})_5\text{CrC}(\text{OCH}_3)(\text{C}_6\text{H}_5)$
 - $\text{Cp}_2\text{Ta}(\text{CH}_3)(\text{CH}_2)$
9. $\text{HCo}(\text{CO})_4$ is an excellent catalyst in the hydroformylation process. Please write the catalytic cycle for the process at high temperature and pressure. (10 points)
- $$\text{R}_2\text{C}=\text{CH}_2 + \text{CO} + \text{H}_2 \rightarrow \text{R}_2\text{CHCH}_2\text{CHO}$$
10. Compare the relative bond length of V-C in $\text{V}(\text{CO})_6$ and $\text{V}(\text{CO})_6^-$. Why is that? (8 points)
11. Determine the chirality label for the complex shown. (6 points)



12. A molecule of formula $\text{Cr}(\text{CO})_2(\text{CN})_2\text{Br}_2$ has been prepared. In its IR spectrum, it shows two bands attributable to C-O stretching, but only one band attributable to C-N stretching. What is the most likely structure of this molecule? (8 points)

注：背面有試題

參考用