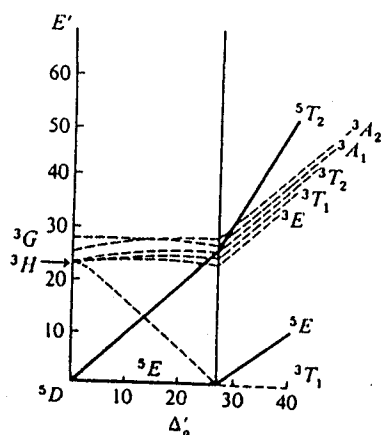


注意：請依序作答

- Diagonal relationships in the periodic table exist in addition to the vertical relationships. For example, Be and Al are similar in some of their properties, as are B and Si. Rationalize why these diagonal relationships hold for properties such as size, ionization energy, and electron affinity. (6%)
- Answer the followings: (25%)
  - The  $N_2O$  molecule is linear and polar. On the basis of the experimental evidence, which arrangement is correct, NNO or NON? Explain your answer.
  - The compound  $BeSO_4 \cdot 4H_2O$  cannot be easily dehydrated by heating. It dissolves in water to produce an acidic solution. How do you account for these observations.
  - The first ionization energy of  $N_2$  (1501 KJ/mol) is greater than the first ionization energy of atomic nitrogen (1402 KJ/mol). Explain.
  - $CsI$  is much less soluble in water than  $CsF$ , and  $LiF$  is much less soluble than  $LiI$ . Why?
  - Carbon monoxide is a very poor Lewis base toward  $H^+$ , but it is an excellent Lewis base toward  $Ni$ . How can  $CO$  be both a strong and weak base?
- $[Cr(H_2O)_6]^{3+}$  ions are pale-green but the chromate ion  $CrO_4^{2-}$  is an intense yellow. Characterize the origins of the transitions and explain the relative intensities. (8%)
- The complexes  $[Mn(H_2O)_6]^{2+}$ ,  $[Fe(H_2O)_6]^{3+}$ , and  $[MnCl_4]^{2-}$  all have magnetic moment of nearly 5.92 BM. What does this tell you about the geometric and electronic structures of these complexes? Why is the spin-only formula so precise in these cases? (10%)
- The graph given below is one of the Tanabe-Sugano diagrams. To which electron configuration does it belong? What does the vertical line in the center of the plot represent? (6%)



(背面仍有題目,請繼續作答)

6. (a). Suppose that you are given a series of metal-tricarbonyl compounds having the respective symmetries  $C_{2v}$ ,  $D_{3h}$ , and  $C_s$ . Without consulting reference material, which of these should display the greatest number of CO stretching bands in the IR spectrum? Explain. (5%)
- b). The IR spectrum of  $Rh_2I_2(CO)(PPh_3)_2$  has CO stretches at 2061 and 2005  $cm^{-1}$ . Suggest a structure consistent with this. (5%)
7. Magnetic measurements on the ferrite  $CoFe_2O_4$  indicate 3.4 spin per formula unit. Suggest a distribution of cations between octahedral and tetrahedral sites that would satisfy this observation. (6%)
8. Consider the following data:
- $$Co^{3+} + e^- \rightarrow Co^{2+} \quad E^\circ = 1.82 \text{ V}$$
- $$Co(en)_3^{2+} \quad K_f = 1.5 \times 10^{12}$$
- $$Co(en)_3^{3+} \quad K_f = 2.0 \times 10^{47}$$
- a). Calculate  $E^\circ$  for the half-reaction  
 $Co(en)_3^{3+} + e^- \rightarrow Co(en)_3^{2+}$  (5%)
- b). Based on your answer to part a, which is stronger oxidizing agent,  $Co^{3+}$  or  $Co(en)_3^{3+}$ ? (2%)
- c). Use the crystal field model to rationalize the result in part b. (5%)
9. Find the number and symmetry species of the Raman and infrared active vibrations of  $BCl_3$  ( $D_{3h}$ ). (8%)

$D_{3h}$	E	$2C_2$	$3C_2$	$\sigma_h$	$2S_3$	$3\sigma_v$		
$A_1'$	1	1	1	1	1	1	$R_z$ (x, y)	$x^2 + y^2, z^2$
$A_2'$	1	1	-1	1	1	-1		$(x^2 - y^2, xy)$
$E'$	2	-1	0	2	-1	0	z ( $R_x, R_y$ )	$(xz, yz)$
$A_1''$	1	1	1	-1	-1	-1		
$A_2''$	1	1	-1	-1	-1	1		
$E''$	2	-1	0	-2	1	0		

10. With what organic compound is each of the following isolobal? (9%)

