

CHE 450G Practical Inorganic Chemistry Exam
October 4, 2007

Exam instructions. The point value for each question is shown in parenthesis next to it. There are 8 questions. Answer all questions in your answer booklet.

1. (5) Indicate the oxidation state of the central metal ion in each of the following complex ions:
 $[\text{ZnBr}_4]^{2-}$
 $[\text{Co}(\text{NH}_3)_5(\text{SO}_4)]^+$

2. (10) Diagram the electronic configuration of the central metal of each of the following ions from the viewpoint of the crystal field theory: $[\text{Pd}(\text{NH}_3)_4]^{2+}$, $[\text{Zn}(\text{NH}_3)_4]^{2+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$. Which of these will show color in solution? Explain your answer in detail to receive full credit.

3. (5) An aqueous solution of iron (II) sulfate is paramagnetic. When an excess of cyanide ion is added to the solution it becomes diamagnetic. Explain this behavior. Justify your answer with reference to appropriate crystal field stabilization energy diagrams.

4. (15) Assign each molecule or ion to the proper point group.
 - i) linear C_4 (equal bond lengths)
 - ii) stannous chloride
 - iii) staggered ethane
 - iv) eclipsed ethane
 - v) toluene (C_7H_8 , aromatic)

5. (20) A D_2 character table without the characters is given below. Using the basis functions at the right side of the table, fill in the characters.

D_2 Groups

| D_2 | E | $C_2(z)$ | $C_2(y)$ | $C_2(x)$ | | | |
|------------------|-----|----------|----------|----------|----------|-----------------|-----------------------|
| A | | | | | | x^2, y^2, z^2 | xyz |
| B_1 | | | | | z, R_z | xy | $z^3, z(x^2 - y^2)$ |
| B_2 | | | | | y, R_y | xz | $yz^2, y(3x^2 - y^2)$ |
| B_3 | | | | | x, R_x | yz | $xz^2, x(x^2 - 3y^2)$ |
| $\Gamma_{x,y,z}$ | 3 | -1 | -1 | -1 | | | |

6. (15) Determine the symmetries of the total representation of all degrees of freedom, translation, rotation and the normal modes of vibration of phosphine (PH₃). List all that are ir active. Support your answer with direct reference to the character table.
7. (15) Decompose the reducible representation 6 0 0 in the point group C_{3v} into a sum of irreducible representations. Write the product E x E in this group as a sum of irreducible representations.
8. (15) Name and describe the characteristics (color, approximate melting point, use) of the three different types of glass presented in our laboratory glass blowing program.

| C _{3v} | E | 2C ₃ | 3σ _v | | | |
|--------------------|---|-----------------|-----------------|--|--|--|
| A ₁ | 1 | 1 | 1 | z | x ² + y ² , z ² | z ³ , x(x ² - 3y ²) |
| A ₂ | 1 | 1 | -1 | R _z | | y(3x ² - y ²) |
| E | 2 | -1 | 0 | (x, y), (R _x , R _y) | (x ² - y ² , xy)(xz, yz) | (xz ² , yz ²), [xyz, z(x ² - y ²)] |
| Γ _{x,y,z} | 3 | 0 | 1 | | | |