INORGANIC CHEMISTRY -FINAL EXAM

December 16, 1997

Name _____

Instructions: *There are 11 questions worth a total of 200 points. You have until noon to finish the exam. A periodic table with electronegativities, a symmetry flow chart, and two scratch pages are included at the end of the exam. These may be detached from the exam if you wish. Place all answers on the exam pages, the scratch pages will not be graded. Show all work where appropriate!*

GOOD LUCK AND HAVE A HAPPY HOLIDAYS!

1.   For the following molecules and ions,

A) Predict the correct idealized VSEPR geometries [16 pts]
B) Determine the hybridization of the central atom [8 pts]
C) Determine the symmetry point group   [16 pts]

$GaCl_2^+$

AsH_3

KrF_3^+

SiF_6^{2-}

2.   Potassium reacts with oxygen to give potassium superoxide, KO_2.

A) Draw a molecular orbital diagram of the superoxide ion, O_2^-, indicating which orbitals are occupied by electrons. [10 pts]

B) How many unpaired electrons are in O_2^- ? [5pts]

C) What is the oxygen-oxygen bond order?   [5 pts]

3.   Generate all symmetry <u>operations</u> associated with a C_4 rotation axis passing through a horizontal mirror plane. What point group does this create? [10 pts]

4.   The standard unit cell for a cubic closest packed structure is face centered cubic. Nickel is one metal which has a cubic closest packed structure. Given that nickel has a metallic radius of 125 pm, calculate the following.(Hint: the closest contact between nickel atoms is between the face centered nickel and the corners)

A.) The unit cell length [10 pts]

B) the unit cell volume [5 pts]

C) the calculated density of nickel [5 pts]

5.   The mineral corundum, Al_2O_3, has a hexagonal closest packed arrangement of oxide ions with the aluminum ions filling octahedral holes. What fraction of the octahedral holes in the lattice are filled by aluminum ions? What is the coordination geometry of the aluminum ions? [15 pts]

6.   An electrically conducting solution is produced when $AlCl_3$ is dissolved in the basic polar solvent CH_3CN. Give formulas for the most likely conducting species and describe their formation using Lewis acid-base concepts. [15 pts]

7.   The Goldschmidt classification of minerals make the distinction between those metals which are found predominately as oxide ores (oxophilic) and those found predominately as sulfide ores (chalcophilic).

      A.) Give two examples of oxophilic metals and their ores, and two examples of chalcophilic metals and their ores. [10 pts]

      B.) What is the chemical basis of the Golschmidt classification? [10 pts]

8. For the following classes of element- hydrogen compounds, explain the nature of the element-hydrogen bonding, give one specific example, and of one application. [20 pts]

A) saline hydrides

b) interstitial hydrides

c) boron hydrides (use diborane ,B_2H_6, to explain the bonding)

d) p block element hydrides (groups 14-17)

9. For the following questions, insert the symbol (or name) of the Group 1, Group 2, or Group 13 element which best fits the description. [20 pts]

a)   This element has an oxide called "lime"   _____
b)   The simple hydride of this element is a covalent polymer   _____
c)   This element has been used as a rodent poison   _____
d)   One allotrope contains icosohedra of this element   _____
e)   Lightweight alloys of this element are used in battleships   _____
f)   This alkali metal forms mostly the peroxide on reaction with oxygen _____
g)   In combination with arsenic, this element forms a valuable semiconductor _____
h)   This radioactive element is a byproduct of uranium refining   _____
i)   The nitrate of this element is known as saltpeter   _____
j)   A radioactive isotope of this element is concentrated in dairy milk _____

10. White phosphorous, P_4, can react with oxygen to form two oxides, P_4O_6 and P_4O_{10}. What are the structures of these two oxides and how are they related to the structure of P_4? [10 pts]

11. Complete the following reactions, showing all products. [10 pts]

$Mg_3N_2 + H_2O$

$NH_4NO_3 + heat$

$Sb_2S_3 + Fe$

$CaCO_3 + HCl$

$ZnS + O_2$