1. (16) Provide an acceptable name (IUPAC or traditional), formula (including correct charge when necessary), or symbol, as appropriate, for each example given below.

- Sodium bicarbonate
- Quicklime
- Manganese
- Ru
- Cesium superoxide
- Pentaamminechlorochromium(III) ion
- Perchloric acid
- PH₃

2. (24) Complete and balance the chemical equations for the processes given below (some are from your laboratory experiments). If no reaction occurs, write ‘NR’. Assume that all are carried out at less than 100°C.

- NO + H₂O ---------> CO + H₂O
- HNO₂ + H₂NSO₃H -------> Hg₂Cl₂ + NH₃
- Cd²⁺ + H₂S ---------> P₄O₁₀ + H₂O

3. (5) Silver(I) ion binds more tightly to crown thioethers (sulfur analogs of crown ethers) than to crown ethers. What does this imply with regard to the hardness or softness (in a Lewis acid/base sense) of Ag⁺? Provide a brief rationale for your answer.

4. (10) Bi(V) is a much more powerful oxidizing agent than P(V), As(V), or Sb(V). Likewise, Pb(IV) is a much more powerful oxidant than other group 14 elements in their +4 oxidation states, and a similar effect is seen in group 13 [i.e. Tl(III) is a strong oxidant, In(III) is not]. Two factors are the major contributors to all of these properties. Briefly describe the two factors and the manner in which they affect the aforementioned oxidation potentials.

5. (15) Write a reasonably detailed summary of everything that you know about the binary hydrogen compounds of nitrogen. For full credit, your answer need not contain every single fact that was covered in class or in the textbook, but it should display a reasonably broad awareness of the major aspects of the topic. (Thus, the answer that “I know nothing about this topic”, even if true and correct, will receive no credit.)

6. (15) Draw Lewis structures of all of the stable oxides of nitrogen.

7. (15) Draw neat, clear diagrams of all of the possible octahedral isomers, including any enantiomeric pairs, of Cr(en)₂F₂⁺. The most efficient way to draw these is to first draw a set of xyz coordinate axes, then place the ligand atoms at the six positions at the ends of the axes. If any of the isomers are enantiomers, so indicate. Points will be subtracted if any structures are inadvertently repeated, so be careful in your analysis.

8. (5) Iodide ranks very low in the spectrochemical series (i.e. is a ligand which produces a particularly weak ligand field). Provide a brief explanation of the major cause or causes of this effect.

9. (10) In the preparation of chiral tris(phenanthroline)cobalt(III), all of the precursor, tris(phenanthroline)cobalt(II), is precipitated as one enantiomer by the resolving agent [ (+)-antimony tartrate ion], even though the tris(phenanthroline)cobalt(II) in solution is racemic. Provide a brief mechanistic explanation of why the reaction proceeds in this manner.

10. (5) Which would you expect to be the more effective bridging ligand for electron transfer between two transition metal complexes, cyanide or fluoride? Provide a brief rationale for your answer.

11. (10) List (a) the number of valence electrons associated with each chemical species given below, and (b) the number of unpaired electrons (if any) associated with each.

   a) Ni²⁺, square planar
   b) Ti⁴⁺, any geometry
   c) Cu(II), tetrahedral
   d) Co(III), strong octahedral field
   e) Carbon monoxide

   # valence e⁻ # unpaired e⁻

12. (10) Given the half-reactions and electrochemical reduction potentials below, calculate the standard free energy change associated with the dissolution of silver iodide in water.

   \[ \begin{align*}
   \text{Ag}_{(aq)}^+ + e^- & \rightarrow \text{Ag}_{(s)} \quad E^\circ = +0.80 \text{ v} \\
   \text{AgI}_{(s)} + e^- & \rightarrow \text{Ag}_{(s)} + \text{I}^-_{(aq)} \quad E^\circ = -0.152 \text{ v}
   \end{align*} \]

   \[ F = 96.5 \text{ k J/V} \]