STUDY GUIDE FOR EXAM 2

CH 3500: Inorganic Chemistry, Plymouth State University

General Tips:

1. Read the assigned pages from the text and articles listed in the Syllabus.
2. Review the "Suggested Homework" from the syllabus:
   - Ch5: Exercises: 5.3, 5.7, 5.10, 5.11, 5.12, 5.13, 5.15, 5.19, 5.20, 5.22; Problems: 5.2, 5.6, 5.9
   - Ch6: Exercises: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.10, 6.12, 6.14, 6.16; Problems: 6.1, 6.7
   - Ch7: Exercises: 7.2, 7.3, 7.4, 7.5, 7.7, 7.9, 7.10, 7.11, 7.12, 7.15, 7.18, 7.19
   - Ch15: Exercises: 15.1, 15.3, 15.7, 15.9, 15.12, 15.15; Problems: 15.7
   - Ch19: Exercises: 19.2, 19.3, 19.4, 19.5, 19.7, 19.9, 19.11, 19.12
   - Ch25: Exercises: 25.1, 25.2, 25.4, 25.5, 25.6, 25.7, 25.8, 25.10, 25.16, 25.21
3. Review the Problem Sets, including the Answer Keys (available on the website).
4. Prepare your 4×6 notecard. Remember that you will be given constants but not equations.
5. Review the overheads in class and make sure you understand the various figures presented.
6. Review the labs we have done, including relevant reactions and calculations. *Material covered in lab is fair game for exams!*

Study Concepts Checklist

<u>Chapter 5: Oxidation and Reduction</u>

You should be able to:

1. Use and interpret electrochemical quantities and units (V, C, F)
2. Give the temperature, pressure, and temperature at Thermochemical Standard Conditions
3. Assign oxidation states in a redox reaction
4. Identify species that are oxidized and reduced in a redox reaction
5. Balance redox reactions in acid and base
6. Given a Table of Standard Reduction Potentials and/or a Latimer diagram, calculate the reduction potential for a reaction
7. Given a Latimer diagram, write the full half-cell reactions for an oxidation/reduction
8. Calculate the overall reduction potential of a two-step reduction process given the reduction potentials of the two steps
9. Relate reduction potential to Gibb's Free energy and the concept of spontaneity
10. Tell the spontaneous direction of a redox reaction by either being given or calculating the cell potential
11. Couple two reduction reactions in such a way that one will be an oxidation and the reaction overall will occur spontaneously in the forward direction
12. Use the Nernst equation to calculate the cell potential, temperature, or equilibrium conditions when given two of the three
13. Construction a Thermodynamic Cycle for Reduction Potential when given the overall redox reaction or the two half-cell reactions
14. Discuss the components of a Thermodynamic Cycle for Reduction Potential and how they contribute to the Reduction Potential.
15. Use a Thermodynamic Cycle for Reduction Potential to explain the difference in reduction potential for two chemical species
16. Explain trends in Reduction Potential based on one or more components of a

Thermodynamic Cycle for Reduction Potential (eg, Hydration energy)

17. Identify the oxidation/reduction half-cell reactions that can occur in "pure" water (containing only H_2O, H^+, OH^-, and possibly O_2).
18. Give three possible reactions that could occur to a metal in its elemental state when placed into "pure" water.
19. Predict whether a given half-cell reaction will occur spontaneously in "pure" water
20. Explain what is meant by the "Zone of Xtability" in natural waters and be able to use a graph of the Zone of Stability to predict whether a given chemical species (e.g, M or M^+) will be stable in "pure" water.
21. Explain why some reduction potentials change/are dependent on pH and calculate a reduction potential for such a reaction under non-standard pH conditions. Know what the pH is in Standard Conditions!
22. Explain what is meant by "disproportionation" and "comproportionation."
23. Use reduction potentials to predict whether a specific chemical species will comproportionate or disproportionate
24. Relate two equilibrium reactions that differ only by the oxidation state of a reactant and a product. Use the equation that relates equilibrium constants such reactions with the reduction potentials of said reactant and product.
25. Use a Latimer diagram to develop a Frost diagram
26. Use a Frost diagram to identify stable redox species and species that are likely to comproportionate or disproportionate

Chapter 6: Molecular Symmetry

You should be able to:

1. Identify all the symmetry elements of a molecule or a three dimensional object
2. Identify the point group of a molecule or a three dimensional object
3. Use a Character Table to:
   a) Determine the reducible representation of a given basis set (either atomic orbitals or atomic motions)
   b) Identify symmetry species (including orbitals and molecular vibrations) as singly, doubly, or triply degenerate
   c) Derive, by inspection, the irreducible representation components of a reducible representation for representations with *E*=2 or 3
   d) Identify the symmetry species of an orbital (atomic, molecular, or SALC)
   e) Draw SALCs give the simple quantum mechanical formula for it
   f) Verify that a given set of irreducible representations fully comprise a given reducible representation
   g) Identify the translational, rotational, and vibrational components in the reducible representation of a molecule's motions
   h) Identify the IR and Raman active vibrations in a molecule
4. Calculate the number of vibrational modes in a molecule
5. Use the symmetry species for SALCs and atomic orbitals to draw molecular orbital diagrams

Chapter 7: Coordination Compounds

You should be able to:

1. Identify, name, and draw the list of ligands indicated in class
2. Give the name and/or formula for a coordination compound, given one of these or a drawing
3. Draw a coordination compound, given the name or formula
4. Draw a coordination compound in a variety of ways to better illustrate geometries, symmetry elements, etc.
5. Identify the charge on a metal center, given the name, formula, or drawing of a coordination compound
6. Give the number of binding sites for the polydentate ligands in the list indicated in class, or for a ligand given in a drawing
7. Identify a ligand as inner- or outer-sphere
8. Determine the coordination number of a metal center in a coordination compound
9. Name the molecular geometry of a coordination compound up to coordination number 8
10. Identify and/or draw *cis*-, *trans*-, *fac*-, and *mer*- isomers for coordination numbers 4 and 6 (as appropriate)
11. Determine whether a four-coordinate compound is tetrahedral or square planar, based on the number of isomers possible
12. Determine whether a coordination compound is chiral
13. Identify a chiral coordination compound as the Δ or Λ enantiomer
14. Use concepts of thermodynamics and equilibrium to explain reactions of coordination compounds, including interconversion and formation

Chapter 15: Group 15 Descriptive Chemistry

You should be able to:

1. Explain trends in bonding, stability, metallic character, oxidation states, and natural occurrence for Group 15 elements using fundamental characteristics of the atoms

Chapter 19: Descriptive Chemistry of the *d*-block elements

1. Explain trends in bonding, density, metallic character, oxidation states, and natural occurrence for the *d*-block elements using fundamental characteristics of the atoms
2. Give the ground-state electronic configuration of any *d*-block element
3. Explain what is meant by the "group oxidation state" of an element

Chapter 25: Nanotechnology and Nanomaterials

1. Provide a good definition of nanotechnology including the 3 components discussed in class
2. Discuss how and why properties change at the nanoscale
3. Explain what is meant by "top-down" versus "bottom-up" approaches to synthesizing nanomaterials
4. Describe one technique for studying / analyzing / understanding nanomaterials