CHM 301 Chapter Learning Outcomes and Recommended Book Questions

Chapter 1 (sections 1-3, 6-10)

- Identify the number of protons, neutron, and electrons in an atom or an isotope
- Relate the connection between isotopes and mass spectrometry
- Classify atomic orbitals using quantum numbers
- Rationalize how atomic orbitals vary in size and relative energy
- Interpret ionization energy trends for atoms and ions

Questions: 5, 11, 17, 24, 34, 35

Chapter 2 (all sections)

- Use Lewis structures to deduce information about bonding
- Identify compounds which are isoelectronic
- Evaluate if a molecule contains polarity
- Characterize the shape and stereochemistry of a molecule

Questions: 2, 6, 10, 19, 20, 22, 26, 28, 31a, b

Chapter 3 (all sections)

- Explain the definition and application of symmetry elements and operations for a given molecule
- Determine the point group of a given molecule and make sense of its character table
- Describe the types of and determine the degrees of freedom in a given molecule
- Construct reducible and irreducible representations
- Relate the selection rules for IR and Raman active to apply to experimental scenarios

Questions: 2, 8, 9, 10, 12, 14, 16, 22, 26, 28, 31, 33, 43

Chapter 4 (all sections)

- Gain familiarity with different types of spectroscopy (MS, IR, NMR, EPR, X-Ray) in the context of inorganic complexes
- Examine basic spectroscopic data and how its interpretation leads to structural information about inorganic complexes

Questions: 10, 11, 14, 19, 23, 31, 35, 36, 37, 47, 49, 59, 65

Chapter 5 (all sections)

- Construct simple diagrams to explain the hybridization of atomic orbitals
- Based on the structure and symmetry of the molecule identify the hybridized orbitals of the central atom
- Create MO diagrams (including the use of the LGO approach) for simple polyatomic molecules based on symmetry and character tables
- Identify the HOMO, LUMO, bonding, non-bonding, anti-bonding, sigma and pi orbitals on an MO diagram
- Describe the connectivity between symmetry, structure, and bonding

Questions: 4, 5, 7, 10, 13, 15, 17, 22, 23a, 26, 27

Chapter 6 (sections 1-2, 8-12, 15-17)

- Recognize metallic and ionic compounds are ordered as lattice structures
- Identify common types of packing in spheres and predict their coordination number
- Explain band theory of metals and how it relates to electrical conductivity
- Describe basic semiconductor types
- Gain familiarity with the construction of unit cells
- Relate enthalpy with predicted product formation

Questions: 1, 2, 6, 9, 11, 19, 21, 23, 30

Chapter 7 (sections 11-13)

- Determine conjugate acids and bases for compounds
- Make sense of hard soft acid base theory to predict/interpret chelation of ligands

Questions: 16, 27, 28, 32, 35, 37

Chapter 8 (sections 1-2, 4, 7)

- Determine oxidation states of atoms in reactions
- Manipulate data to determine relationships between electrochemical potentials, equilibrium, and free energy
- Identify redox and disproportionation processes

Questions: 2, 5, 9, 15, 28, 31, 35

Chapter 9 (sections 1, 4-9, 12-17)

- Predict product formations in non-aqueous media
- Explain the general theory of and uses for ionic liquids and supercritical fluids

Questions: 4, 17, 19, 23, 24

Chapter 19

- Determine the oxidation state, d electron count, and geometry of the metal in a complex
- Identify isomerization and chirality in metal complexes
- Interpret spectral data to deduce structural and electronic properties of metal complexes

Questions: 7, 8, 10, 11, 12, 15, 18, 20, 25, 28 a,b

Chapter 20 (skip sections 6, 12, 13)

- Identify the structures of common ligands

- Understand and apply basic crystal field theory to rationalize and/or predict filling of the d orbitals in metal complexes
- Label complexes as diamagnetic, paramagnetic, ferromagnetic, and antiferromagnetic
- Interpret data to deduce structural and electronic properties of metal complexes
- Explain and apply the terms strong field ligand, weak field ligand, σ donor, π donor, MLCT, LMCT

Questions: 3, 5, 6, 8, 20, 21, 26, 29, 31, 35, 36 a, b, 42

Chapter 24

- Correlate μ and η to relate structure, electron count, and binding modes in metal complexes
- Interpret data to deduce structural and electronic properties of metal complexes
- Determine the oxidation state, d electron count, and geometry of the metal in simple and cluster complexes
- Identify and apply basic inorganic mechanistic modes to describe reactions including ligand association/dissociation, oxidative addition, reductive elimination, migratory insertion, β-hydride elimination
- Identify agostic interactions and metallations, hydrogen abstractions

Questions: 3, 6, 8, 10, 12, 15, 20, 21, 24, 28, 36, 39

Chapter 25

- Label catalytic cycles with individual mechanistic steps and electron counts for the metal species
- Compare and contrast homogenous and heterogeneous catalysis
- Identify basic industrial catalytic processes for feedstock chemicals

Questions: 1, 5, 9a, 18, 24b, 25, 26

Chapter 26

- Identify ligand substitution reactions as associative or dissociative
- Predict product formation using the *trans*-effect
- Describe the fundamental differences between inner- and outer-sphere electron transfer
- Interpret kinetic data to identify reaction mechanisms and thermodynamic parameters

Questions: 3, 6, 8, 10, 14, 18, 21, 24, 25, 26, 29

Chapter 28

- Describe the basic principles of semiconductors, dye-sensitized solar cells (DSC), and organic light emitting devices (OLED)
- Describe the synthetic method for and uses of chemical vapor deposition (CVD)
- Describe the chemical and physical properties of carbon nanotubes

Questions: 5, 6, 8, 17, 21

Chapter 29

- Identify the common trace metals found in biological systems
- Explain why model systems are utilized and their limitations
- Connect traditional experimental and structural/chemical information of discrete transition metal-complexes to bioinorganic systems

Questions: 6, 7, 12, 16, 23, 29