Chapters 5-9: Study Guide

Review prior knowledge

- Be able to calculate the molecular weight of a compound using a periodic table.
- Given the mass of a substance, be able to determine the number of moles.
- Given the moles of a substance, be able to determine the mass.
- Be able to use Avogadro's number to determine the number of molecules or atoms in a sample given the number of moles.
- Given the number of atoms or molecules, be able to determine the number of moles.

Chapter 5

Molecular composition and formulas

- Be able to explain the difference between a molecular formula and an empirical formula.
- Know the definition of percent composition.
- Be able to determine the empirical formula given the mass percent of components.
- Be able to use percent composition to get the mass of a component in a sample.
- Interpret the results of a elemental analysis (% composition data); be able to find the empirical formula of a sample.
- Be able to determine molecular formula when given molecular weight and empirical formula.

Chapter 6

Introduction to Bonding

- Know what is meant by valence electrons.
- Be able to write the Lewis dot structure for an atom.
- Be able to explain the difference between a molecular formula and an empirical formula

Ionic bonding

- Recognize if a compound will be ionic or molecular.
- Know what the measure of the strength of an ionic bond is.
- Know what lattice energy is.
- Be able to write formulas for simple ionic compounds.
- Know how to name ionic compounds.

Covalent bonding

- Know the rules of valence and how they can be used to form simple molecules.
- Know how to name simple covalent compounds.
- Know the names, formulas and charges of common polyatomic ions (Table 6-6-1).
- Be able to recognize the type of bonding in molecules (ionic, covalent or both).
- Know the meaning of bond dissociation energy (BDE).
- Be able to predict the trend in bond length and strength based on bond order.

Chapter 7

Electronegativity and Bond Polarity

- Be able to compare and predict the relative electronegativity of elements.

- Recognize polar chemical bonds.
- Rank chemical bonds from least to greatest polarity.

Draw Lewis Structures & Formal Charge
- Given a chemical formula, be able to draw the Lewis structure using the octet rule.
- Correctly illustrate multiple bonds with a Lewis structure.
- Be able to give the number of valence electrons, bonding electrons, and nonbonding electrons or lone pairs in a molecule.
- Be able to determine the formal charge of an atom in a Lewis structure.
- With similar Lewis structures, use formal charge to decide which structure is better.

Draw Lewis Structures, Resonance, and exceptions to octet rule
- Recognize when a molecule has resonance and be able to draw the resonance structures.
- Recognize molecules that have exceptions to the octet rule.
- Understand the reasons for the exceptions to the octet rule (including when it is possible or likely for these exceptions to occur).
- Be able to make connections between Lewis structures and properties (like bond length and strength).
- Rank bond length and strength using Lewis structures.

Chapter 8
VSEPR
- Understand that VSEPR theory is based on the repulsion of electron pairs.
- Be able to use a Lewis structure to determine the electron domain geometry (EDG) of a molecule or ion.
- Know the names and characteristic bond angles associated with electron domain geometries for 2, 3, 4, 5, and 6 electron domains.
- Be able to predict molecular shape (molecular geometry, MG) from a Lewis structure.
- Know the names and characteristic bond angles associated with molecular geometries for molecules with 2, 3, 4, 5, and 6 electron domains.
- Be able to use VSEPR concepts to predict approximate bond angles.
- Know the effect of lone pairs and double bonds on bond angles.
- Be able to determine bond angles and molecular shape about a central atom given a Lewis structure with more than one central atom.
- Be able to determine the bond angles and shapes about atoms in organic molecules.

Polarity
- Given only the molecular formula for a simple molecule, be able to determine if a molecule is polar.
- For molecules with more than one central atom, determine polarity given the Lewis structure or structural formula.
- For analogous molecules, be able to rank polarity from strongest to weakest.
- Given molecular structures of organic molecules, predict the polarity of molecule.

Chapter 9
Hybrid Orbitals

- Know what is meant by the term "hybrid orbitals" and how to name them.
- Using the electron domain geometry be able to predict the type of hybrid orbitals used by an atom when it forms covalent bonds.
- Know the shape (geometry) of the hybrid orbitals found in molecules with 2, 3, 4, 5, and 6 electron domains.
- Given a Lewis structure, be able to predict the type of hybrid orbitals used by the atoms for bonding.
- Given an organic molecule, be able to identify the hybrid orbitals on any atom in the structure.

Valence bond theory

- Know what is meant by σ and π bonds and what orbital overlap means, and how covalent bonds are formed.
- Be able to identify σ and π bonds given a molecular structure (Lewis structure) or orbital diagram.
- Given the structure of a molecule (an organic molecule) be able to tell how many σ and π bonds are present.
- Understand how valence bond theory can be used to explain bonding in structures with resonance.
- Be able to determine if delocalized π bonding (resonance) exists in a molecule.
- Connect the concept of delocalized π bonding to the properties of molecules with resonance, including aromatic hydrocarbons (benzene).

Exam 2 Survival Skills

KNOW HOW TO ...

Basic skills:

- using the periodic table read the number of valence electrons in an atom or an ion
- use Avogadro's number and the mole
- draw Lewis structures, including resonance structures, and molecules that have atoms that do not follow the octet rule

Chemical Formulas and Composition

- know how interpret chemical formulas
- convert from molecular quantities to gram quantities (molecular weights in amu and g/mol, mole) and back
- calculate percentage composition and empirical formula; compare to molecular formula

Inorganic nomenclature:

- name common monoatomic anions, and acids they are derived from
- name common cations
- name common salts
- name simple binary inorganic compounds

Bonding:

- recognize ionic compounds
- know what is meant by lattice energy
- be able to rank ionic compounds in order of increasing lattice energy
- be able to rank ionic compounds in order of melting points
- explain electronegativity trends across the periodic table
- use electronegativity to decide bond polarity
- apply correlations between bond lengths or bond multiplicity and bond strengths
- explain electronegativity trends across the periodic table
- draw Lewis structures for covalently bonded species
- assign formal charges to atoms in Lewis structures
- decide on the "best" Lewis structure for a given molecule
- draw resonance structures
- use electronegativity to decide bond polarity
- draw Lewis structures, including resonance structures, for molecules that have atoms that do not follow the octet rule
- calculate formal charges
- compare formal charges and to real charge separation, based on electronegativity of the bonded atoms
- apply correlations between bond lengths or bond multiplicity and bond strengths

Electronic and molecular structure:

- apply VSEPR to analyze 3D electronic structure of molecules based on electron domains from Lewis structure
- apply VSEPR to predict 3D molecular structure based on electron-pair structure, and predict the disposition of non-bonding pairs
- identify and name electron-pair and molecular geometries based on Lewis structure
- explain bond angles based on VSEPR structures
- apply corrections to the structure, taking into account relatively larger sizes of non-bonding and multiple-bonding electron domains
- understand real charge separation, based on electronegativity of the bonded atoms
- evaluate direction and magnitude of bond dipoles, and dipole moments for diatomic molecules
- analyze molecular polarity in terms of electronegativity of the atoms involved, and its VSEPR structure
- estimate size and direction of molecular net dipole moments based on analysis of bond and lone- pair dipoles

Electronic and molecular structure:

- explain bonding in terms of atomic or hybridized orbital overlap
- understand the basic hybridization schemes (sp^3, sp^2, sp) from the point of view of their origins (how do they form) and the resulting 3D shapes
- identify hybridization schemes leading to specific electron-pair geometries.
- identify hybridization of atoms in Lewis structures
- explain relation between the hybridization schemes and the bond angles
- describe σ and π bonds and how are the made by the overlap of the component orbitals
- understand the relation between resonance and delocalized π bonding