EXAM 1 study guide

Organic Chemistry 2e chapters 1-3

**DAY 1, Terms to know**:

Sections 1.1-1.8 Isomers, valence electrons, octet rule, lone pair, ion, formal charge, subshell, orbital, electronegativity, polarity, node, wavefunction sign, wavesign, electron configuration, orbital diagram, atomic orbital, molecular orbital, bonding, antibonding

**DAY 1, Specific outcomes and skills that may be tested on exam 1:**

Sections 1.1-1.8

* Be able to predict the number of bonds each relevant atom typically has.
* Be able to explain how the energy changes as covalent bonds get stretch or compressed and WHY and why there is an optimal length for each covalent bond between atoms.
* Be able to determine the number of protons, neutron, and electrons in an atom, and how many electrons are valence electrons.
* Be able to draw Lewis structures for molecules including molecules with heteroatoms and with single, double, and/or triple bonds with the most reasonable location for all bonding pairs of electrons and all lone pairs.
* Be able to calculate formal charge for any atom given how many bonds and how many lone pairs it has. Given an atom with a formal charge shown, know how to determine how many bonding and lone pair electrons are around it.
* Be able to count electrons around an atom to determine whether an atom has a complete octet and also count electrons around an atom to determine the formal charge of an atom.
* Be able to explain the difference between an energy level, subshell, and orbital.
* Be able to determine the relative electronegativity of atoms based on periodic trends.
* Be able to determine the relative polarity of individual bonds.
* Be able to explain how the shapes of the orbitals vary for s and p orbitals.
* Be able to describe how electrons have wave properties and how the wavesign squared gives the shapes of the orbitals and location of greatest electron density.
* Be able to explain how the wavesign is different from the charge.
* Be able to identify and/or describe where the nodes are for the orbitals in the first and second energy levels as well as the 3s.
* Be able to write electron configurations and orbital diagrams
* Be able to describe how both constructive and destructive interference work for wavefunctions and how they yield bonds and antibonds with specific shapes including both pi and sigma bonds.
* Be able to explain how atomic orbitals overlap and that the number of molecular orbitals that result is equal to the number of atomic orbitals overlapping.
* Be able to explain how electrons are more stable in the bonding MO than in the antibonding and two reasons why that relate to electronic repulsions and attractions.
* Be able to explain how each bonding MO is lower in energy than the nonbonding by the same quantity that anitbonding MO is greater in energy than nonbonding.
* Be able to draw the bonding and antibonding energies for small molecules involving two atoms bonding and how having electrons in the bonding and antibonding orbitals relates to the octet rule and how entropy plays into the likelihood of bonds forming.
* Be able to explain that molecular orbitals may have many nodes and assymetrical shapes, but 1 orbital can still only hold a maximum of 2 electrons.

**DAY 2, Terms to know**:

Sections 1.9-1.11 hybridized atomic orbitals, steric number, degenerate orbitals, pi bond, sigma bond, electron group geometry, molecular geometry, induction, dipole moment

**DAY 2, Specific outcomes and skills that may be tested on exam 1:**

Sections 1.9-1.11

* Be able to predict what type of hybridization atomic orbitals will undergo for an atom depending on the bonding and steric number of the atom.
* Be able to explain how the ratio of s and p orbitals mixed into the hybrid atomic orbitals affects the shape and energy of the resulting hydridized orbitals.
* Be able to draw a picture showing the overlapping of the correct atomic orbitals for small molecules with 8 atoms or less including molecules with single, double, and triple bonds.
* Be able to predict where molecules will have pi bonds and sigma bonds between atoms.
* Be able to predict the steric number, hybridization, electron group geometry, molecular geometry, and approximate bond angle for atoms within molecules.
* Be able to determine the direction of dipole moment for a molecule and rate its approximate magnitude.
* Be able to describe how molecular geometry affects polarity or dipole.

**DAY 3, Terms to know**:

Sections 1.12-1.13, 2.1-2.2 dipole-dipole, Hydrogen bonds, London dispersion forces, Lewis structure, Condensed formula, molecular formula, bond line structure, heteroatom

**DAY 3, Specific outcomes and skills that may be tested on exam 1:**

Sections 1.12-1.13, 2.1-2.2

* Be able to predict for a molecule what type of intermolecular attractions it can have toward other molecules and know the relative strengths of such attractions or forces.
* Be able to explain how and which physical properties and intermolecular organization are affected by the strength of intermolecular forces.
* Be able to translate between Lewis structures and bond-line structures and vice versa, and be able to draw bond-line structures with the proper bond angles.
* Given a bond-line structure, be able to count the correct number of carbon and hydrogen atoms.
* Be able to recognize that single bonds can rotate between atoms and be able to recognize whether two structures represent identical molecules or isomers.
* Be able to draw bond-line structures for molecules with heteroatoms including the proper lone pairs and bond angles.

**DAY 4, Terms to know**:

Sections 2.3-2.10 functional groups, Fischer projection, Haworth projection, resonance

**DAY 4, Specific outcomes and skills that may be tested on exam 1:**

Sections 2.3-2.10

* Be able to identify functional groups in bond-line structures and Lewis structures.
* Given an atom with bonds and lone pairs shown, be able to determine its formal charge.
* Given an atom with bonds and formal charge shown, be able to determine how many lone pairs it has.
* Be able to use solid and dashed wedges to represent the three dimensionality of molecules.
* Be able to use Haworth projections to show the three dimensionality of molecules.
* Be able to recognize that resonance requires the overlapping of consecutive unhybridized p-orbitals on adjacent atoms and that molecular orbitals are created extending across all of the atoms involved in the resonance allowing the electrons to be anywhere in the MO.
* Be able to explain where and why formal charge is spread out in a structure that involves resonance.
* Be able to draw bond-line representations for resonance contributors and a resonance hybrid.
* Be able to explain how resonance makes molecules more stable with respect to the location of the electrons being delocalized and also with respect to the formal charge if there is formal charge.
* Be able to explain the rules for drawing curved arrows showing electron movement, and be able to use such arrows to show electron movement between resonance contributors.
* Be able to describe the 5 main bonding patterns in which resonance exists and use curved arrows to show all reasonable contributors for such structures as well as a resonance hybrid.
* Be able to accurately describe the type of motion that electrons undergo when resonance occurs.

**DAY 5, Terms to know**:

Sections 2.11-2.12, 3.1-3.3 resonance contributor, resonance hybrid, delocalization, conjugation, allyl, vinyl, Bronsted-Lowry acid, Bronsted-Lowry base, conjugate acid, conjugate base, mechanism, strong acid or base, weak acid or base, *K*a, p*K*a, *K*b, p*K*b

**DAY 5, Specific outcomes and skills that may be tested on exam 1:**

Sections 2.11-2.12, 3.1-3.3

* Be able to assess the relative stability of resonance contributors and draw a hybrid that accounts for stability differences in the contributors.
* Be able to correctly predict the hybridization and steric number for atoms that are affected by resonance.
* Given acid and base reactants, be able to predict the products for an acid/base reaction.
* Be able to use curved arrows to show electron movement in acid/base reactions.
* Given a reaction where products are shown, be able to determine which reactant was the acid and which was the base.
* Given a mechanism with curved arrows, be able to identify acid base steps in the mechanism.
* Be able to give the equilibrium expression for an acid or base reaction and show how *K*a, p*K*a, *K*b, and p*K*b are calculated.
* Be able to explain how the value for *K*a, p*K*a, *K*b, and p*K*b related to the strength of a corresponding acid or base.
* Given the p*K*a for an acid, be able to predict whether reactions involving that acid will favor reactants or products at equilibrium and by how much.

**DAY 6, Terms to know**:

Sections 3.4-3.9 SCARIO, protonate, protonation, leveling effect, solvation, counterion, spectator ion, Lewis acid, Lewis base

**DAY 6, Specific outcomes and skills that may be tested on exam 1:**

Sections 3.4-3.9

* Be able to use SCARIO to predict the relative stability of charged molecules. Be aware that some exceptions exist to the order S, C, A, R, I, O.
* Be able to predict the relative strengths of acids or bases based on the concept that stronger or more reactive molecules will be charged to begin with or that they will form charged conjugates that are able to stabilize their charge.
* Based on p*K*a values or on SCARIO, be able to choose an appropriate acid that can protonate a base.
* Based on p*K*a values or on SCARIO, be able to choose an appropriate base that can deprotonate an acid.
* Based on p*K*a values or on SCARIO, be able to choose an appropriate solvent for an acid/base reaction that will not interfere with the reaction.
* Be able to explain how solvation affects reactions and favors one side of an equilibrium.
* Be able to recognize that counterions are present for any molecule that has an overall charge even if the counterion is a spectator and is not involved in the reaction.
* Be able to identify sites on molecules that could act as Lewis acids or Lewis bases.
* Given a reaction, be able to identify any atom acting as a Lewis acid or Lewis base.