EXAM 2 study guide

Organic Chemistry 2e chapters 4-6

**DAY 8, Terms to know**:

Sections 4.1-4.3 Hydrocarbons, saturated, unsaturated, alkane, alkyl group, substituent, parent chain, locant, cyclic, bicyclic, constitutional isomers

**DAY 8, Specific outcomes and skills that may be tested on exam 2:**

Sections 4.1-4.3

* Be able to name hydrocarbons using the IUPAC system.
* Be able to draw hydrocarbons structure given the IUPAC name.
* Be able to identify some alkyl groups and small molecules discussed in class by their common names.
* Be able to use proper prefixes when naming molecules such as iso, di, tri, tetra, etc.
* Be able to name bicyclic compounds
* Given a formula, be able to draw all possible constitutional isomers.
* Given two structures, be able to determine whether they are identical, constitutional isomers, or have no relationship.

**DAY 9, Terms to know**:

Sections 4.4-4.12 reactivity, stability, potential energy, heat or enthalpy, combustion, rotational conformations, sawhorse representation, Newman projection, VSEPR theory, dihedral or torsional angle, eclipsed, staggered, torsional strain, anti, gauche, steric hindrance, ring strain, angle strain, chair and boat conformations of cyclohexane, axial positions, equatorial positions

**DAY 9, Specific outcomes and skills that may be tested on exam 2:**

Sections 4.4-4.12

* Given the relative stability or potential energy of reactants and products, be able to predict whether a reaction will release energy or absorb energy and how that change will affect the temperature.
* Be able to describe how the heat of combustion for a molecule relates to its stability.
* Be able to explain how the properties of hydrocarbons relates to the number of carbons in the molecule and WHY (see day 9 slides 4-6).
* Be able to translate the structure of a molecule from one three dimensional representation to another including, wedge/dash, sawhorse, and Newman projection.
* Be able to draw Newman projections representing various dihedral angles for rotational conformations.
* Be able to explain (from both a VSEPR and MO perspective) how the dihedral angle affects the stability of different rotational conformations creating torsional strain.
* For a given molecule, be able to draw a 3D representation of both the lowest and highest energy rotational conformations in any of the following formats (wedge/dash, sawhorse, and Newman projection)
* Be able to explain WHY angles that deviate from the optimal angle cause angle stain and how that affects stability, reactivity, and energy of combustion.
* Be able to explain why cyclic hydrocarbons with various ring sizes have varying degrees of ring strain invoking both angle strain and torsional strain in your argument.
* Be able to explain for any given ring structure why it will either adopt a flat or nonflat structure (for example the chair conformation of cyclohexane)
* Be able to analyze all of the factors in the chair and boat conformations of cyclohexane that affect the stability of the molecule.
* Be able to draw a proper chair including the correct positioning of all of the axial and equatorial groups.
* Be able to explain why groups in the axial position generally destabilize a molecule compared to the equatorial position.
* Given a cyclohexane molecule (represented with its name, wedge/dash, Haworth, chair, or boat comformation), be able to show BOTH chair conformation by drawing one and doing a chair flip to get the other.

**DAY 10, Terms to know**:

Sections 4.13-4.15, 5.1-5.3 1,3-diaxial strain, cis, trans, stereoisomers, chiral, achiral, superimposable, chiral center or stereocenter, enantiomers, Cahn-Ingold-Prelog system

**DAY 10, Specific outcomes and skills that may be tested on exam 2:**

Sections 4.13-4.15, 5.1-5.3

* Be able to use the cis and trans terminology when naming cyclic alkanes.
* Be able to explain the difference between constitutional isomers and stereoisomers and recognize examples of each.
* Be able to use the cis and trans terminology when identifying stereoisomeric alkenes.
* Be able to identify all chiral centers in a molecule.
* Be able to identify a pair of molecules as either, identical, constitutional isomers, enantiomers, diastereomers, or no relationship.
* Be able to use the Cahn-Ingold-Prelog system to identify every chiral center as either R or S.
* Be able to use proper R or S notation in the naming of chiral molecules using the IUPAC system.

**DAY 11, Terms to know**:

Sections 5.4-5.9, 6.1 plane-polarized light, optical activity, specific rotation, configuration vs conformation, levorotatory, dextrorotatory, racemic mixture, enantiomeric excess, meso compound, Fischer projection, chiral resolving agent, affinity chromatography, Enthalpy, homolytic, heterolytic, cleavage, bond dissociation energy, the system, the surroundings, reaction coordinate diagram, exothermic, endothermic

**DAY 11, Specific outcomes and skills that may be tested on exam 2:**

Sections 5.4-5.9, 6.1

* Be able to explain the (+) and (-) notation and how they refer to the rotation of plane-polarized light and NOT the R or S configuration specifically.
* Given percentages of R and S in a mixture, be able to determine the enantiomeric excess
* Given the enantiomeric excess and the optical rotation observed for a pure enantiomer, be able to determine the %R and %S in a mixture.
* Be able to determine if a molecule with chiral centers is chiral overall or whether it is achiral and a meso compound.
* Be able to describe the methods of determining whether a molecule is chiral or achiral including locating chiral centers, looking for a plane a symmetry, measuring its optial rotation, and seeing if it is superimposable on its mirror image.
* Be able to convert back and forth between wedge/dash structure and Fischer projections for molecules with 1 chiral carbon.
* Be able to use Fischer projections to determine whether pairs of molecules are enantiomers or diastereomers.
* Be able to recognize in a molecule that if only one rotational conformation of the molecule is achiral, then the molecule overall is achiral
* Be able to describe how chiral resolving agents work and how chiral affinity columns work to separate pairs of enantiomers.
* Be able to explain how and why the potential energy is changed when bonds break and how that affects the temperature of the surroundings.
* Be able to explain how and why the potential energy is changed when bonds form and how that affects the temperature of the surroundings.
* Be able to explain how and why the potential energy is changed when weak bonds break and are replaced by strong bonds and how that affects the temperature of the surroundings.
* Be able to explain how and why the potential energy is changed when strong bonds break and are replaced by weak bonds and how that affects the temperature of the surroundings.
* Be able to describe how the temperature of the surroundings is affected for both exothermic and endothermic reactions.

**DAY 12, Terms to know**:

Sections 6.2-6.6 entropy, vibrational motion, rotational motion, translational motion, spontaneous, free energy, exergonic, endergonic, dynamic equilibrium, equilibrium constant, thermodynamics, kinetics, reaction rate, activation energy, rate law, order of reaction, temperature, transition state, intermediate, Hammond Postulate

**DAY 12, Specific outcomes and skills that may be tested on exam 2:**

Sections 6.2-6.6

* Be able to describe the three main types of molecular motion.
* Given molecular structures, the state of matter, and the temperature, be able to determine which should have greater entropy.
* Be able to assess the entropy change for the system, the surroundings, and the universe for given process.
* Be able to describe the relationship between the enthalpy change for the system and the entropy change for the surroundings and what impact there is on spontaneity or the degree to which the process is product favored.
* Given enough information to determine the change in enthalpy for the system and the change in entropy for the system, be able to determine how a temperature change will affect spontaneity or the degree to which the process is product favored.
* Be able to explain why reactions eventually reach equilibrium rather than forming 100% reactants or 100% products based on thermodynamic arguments involving the entropy of the universe.
* Be able to explain why reactions eventually reach equilibrium rather than forming 100% reactants or 100% products based on kinetic arguments involving collision theory.
* Be able to describe the difference between thermodynamics and kinetics.
* Be able to give reasonable units for a reaction rate and describe what reaction rate is.
* Be able to list the following factors that affect reaction rate and explain in detail HOW they affect rate: The concentrations of the reactants, The Activation Energy, The Temperature, Geometry and Sterics, The presence of a catalyst.
* Given information about how the initial rate changes when the reactant concentration changes, be able to determine the order with respect to that reactant.
* Given the order with respect to a reactant, be able to determine how the rate will change when the concentration of a reactant changes.
* Be able to explain WHY activation energy is necessary and why some reactions have greater activation energy than others.
* Be able to explain how the reaction rate is affected by the magnitude of the Eact.
* On a given reaction coordinate diagram, be able to point out the energy differences that affect the thermodynamic characteristics of the reaction and what effect temperature changes have.
* On a given reaction coordinate diagram, be able to point out the energy differences that affect the kinetic characteristics of the reaction and what effect temperature changes have.
* For a reaction coordinate diagram with more than one pathway, be able to predict how a temperature change might favor one pathway over the other (see slide 6-38).
* Be able to explain what is happening during a transition state and how and why that affects the potential energy.
* Be able to use the Hammond Postulate to predict something about the structure of a transition state and whether it will look more similar to the reactants or to the products.
* Be able to draw a reaction coordinate diagram for a given reaction correctly labeling the chart.
* Be able to correctly associate the shape of a reaction coordinate diagram with whether the reaction is exothermic or endothermic or whether the reaction is exergonic or endergonic depending on whether potential energy or free energy is plotted on the y-axis.

**DAY 13, Terms to know**:

Sections 6.7-6.12 nucleophile, electrophile, Nucleophilic Attack, Loss of a Leaving Group, Proton Transfers (Acid/Base), Rearrangements, hyperconjugation

**DAY 13, Specific outcomes and skills that may be tested on exam 2:**

Sections 6.7-6.12

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

* Given a molecule, be able to identify all of the nucleophilic sites and rank them in terms of their strength as a nucleophile.
* Given a molecule, be able to identify all of the electrophilic sites and rank them in terms of their strength as an electrophile.
* Given reaction arrows, be able to identify Nucleophilic Attack, Loss of a Leaving Group, Proton Transfers (Acid/Base), and carbocation Rearrangements.
* Given one of the following terms: Nucleophilic Attack, Loss of a Leaving Group, Proton Transfers (Acid/Base), carbocation Rearrangement, be able to draw a reaction and correct arrows showing the corresponding electron movement.
* Be able to list the rules for arrow pushing and use them properly when drawing mechanisms.
* NEVER draw arrows that would give an atom in the 2nd row of the periodic table more than 8 valence electrons, and never draw an atom in the 2nd row of the periodic table with more than 8 valence electrons.
* Be able to explain how the intramolecular nature of carbocation rearrangements allows them to occur with relatively fast reaction rates.
* Given a reaction mechanism with arrows drawn incorrectly, be able to identify the incorrect arrows and replace them with reasonable arrows.