## TEST THREE SKILLS/OBJECTIVES / OUTCOMES / COMPETENCIES

- The list should not be viewed as exhaustive; anything that is addressed in the notes and is not designated either in the notes or in the lectures as "not test responsible" should be considered to be fair game for test assessment.

| | | **TEST THREE: Aldehydes, Ketones, and Enolate Chemistry** | **Self-Assessment** | **Graded Assessment** |
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| 18 | Ketones and Aldehydes | 1. Nomenclature: Draw and name aldehydes and ketones, including in the context of multifunctional molecules where decisions about which groups are treated as substituents are necessary; or, given a name, be able to draw the structure.<br>2. Physical Properties: Predict and rank relative boiling points and solubilities of carbonyl compounds relative to other organic structures.<br>3. Carbonyl Synthesis: Process reactions for synthesis of ketones or aldehydes from alcohols, alkenes, alkynes, carboxylic acids, nitriles, acid chlorides, or aromatic compounds. This could involve predicting a product, specifying a starting material, designating an appropriate reactant, or proposing an effective synthesis. Single-step or multistep reactions may be involved.<br>4. Carbonyl Reactions: Predict the products for reactions (including multi-step reactions) of ketones and aldehydes with the following types of compounds:<br>a. Hydride reducing agents (NaBH4, LiAlH4)<br>b. Organomagnesium reagents (Grignard reagents)<br>c. HCN<br>d. Water under acid or base conditions (reversible hydrate formation)<br>e. Alcohols (reversible hemiactal and acetal formation, including cyclic hemiacetals and acetals; and the reverse reactions involving acetal hydrolysis)<br>f. Amines (reversible aminol and imine formation, including cyclic aminols and imines, and the reverse reaction involving imine hydrolysis)<br>5. Mechanisms: Be able to draw mechanisms for carbonyl reactions listed above, including the reverse reaction, including those involving rings. Major mechanisms include addition (anionic or acid-catalyzed), elimination, and substitution reactions.<br>6. Demonstrate/apply understanding of whether a mechanism is anionic or cationic.<br>7. Rank the relative reactivities of aldehydes, ketones, and esters.<br>8. Demonstrate understanding/application of protection and deprotection procedures.<br>9. Chemical Tests: Identify structure based on tests (including DNP and Tollens Tests)<br>10. Draw the starting materials that would react to produce a given product.<br>11. Synthesis Design: Given a starting chemical, suggest reactants or sequences of reactions/reactants that could transform the starting material into a target product.<br>12. Retrosynthesis: Design syntheses of targets, given a restricted pool of allowed starting materials. (Presumably involving carbonyls.) | 1. In-lecture problems<br><br>2. Practice sets online<br><br>3. Practice Tests<br><br>4. Sapling homework problems<br><br>5. Book practice problems | Sapling homework<br><br>Quiz<br><br>Test 3<br><br>Final Exam |
| 22 | Alpha Substitutions and Condensations of Enols and Enolate | 13. Acid-Base: Predict and rank acidities and basicities of ketones, esters and 1,3-dicarbonyl compounds relative to other acids and bases; predict when acid/base reactions will or won't be product favored; apply understanding of equilibria.<br>14. Predict when bases (hydroxide, alkoxide, versus LDA) will afford "complete" versus "small equilibrium" versus zero population of enolate anion<br>15. Predict the products (multi-reactions sequences may be involved) when enolate anions react with the following electrophiles:<br>• Proton (racemization, reversible enol formation)<br>• Halogen (including polyhalogenatin)<br>• Alkyl halides (including usage of LDA as base)<br>• Aldehydes/ketones (aldol reaction resulting in beta-hydroxy carbonyls; aldol condensations resulting in enones; including intramolecular versions)<br>• Esters (Claisen reactions, including intramolecular versions)<br>16. Mechanisms: Draw mechanisms for each of the above reactions<br>17. Predict the product for reactions (including multistep reactions) involving carbonyls and phosophorus ylides (Wittig reaction)<br>18. Process reactions involving 1,3-dicarbonyls, including ester hydrolysis and thermal decarboxylation of 1,3-carbonyl acids.<br>19. Process keto-enol equilibration and mechanism, and rank amounts of enol.<br>20. Chemical Tests: Identify possible structures for a chemical given a chemical formula and chemical test results (including Iodoform, DNP and Tollens Tests)<br>21. Draw the starting materials that would react to produce a given product.<br>22. Synthesis Design: Given a starting chemical, suggest reactants or sequences of reactions/reactants that could transform the starting material into a target product. (Presumably either involving enolate chemistry. Synthesis of alkenes via aldol condensation or Wittig reaction will also be a priority skill.)<br>23. Retrosynthesis: Design syntheses of targets, given a restricted pool of allowed starting materials. | 1. In-lecture problems<br><br>2. Practice sets online<br><br>3. Practice Tests<br><br>4. Sapling homework problems<br><br>5. Book practice problems | Sapling homework<br><br>Test 3<br><br>Final Exam |