<table>
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<th>Topic</th>
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<tr>
<td><strong>13 Nuclear Magnetic Resonance Spectroscopy</strong></td>
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<tr>
<td>13.1 Nuclear Spin States</td>
<td>Energy states and their orientation; spin #’s; units for magnetic field;</td>
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<td>13.2 Orientation of Nuclear Spins in an Applied Magnetic Field</td>
<td>effect of nuclear spins in magnetic fields</td>
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<td>13.3 Nuclear Magnetic Resonance</td>
<td>concept of resonance; signals; diamagnetic current; shielding-deshielding; ppm &amp; TMS</td>
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<td>13.4 An NMR Spectrometer</td>
<td>basic parts</td>
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<td>13.5 Equivalent Hydrogens</td>
<td>be able to label classify; upfield &amp; downfield</td>
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<td>13.6 Signal Areas</td>
<td>integration and its use</td>
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<td>13.7 Chemical Shift</td>
<td>electronegativity effects; hybridization and diamagnetic effects; ring current</td>
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<td>13.8 Signal Splitting and the (n + 1) Rule</td>
<td>application and use</td>
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<td>13.9 The Origins of Signal Splitting</td>
<td>theory of splitting and recognition of patterns (s, d, t, etc); multiple splittings</td>
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<td>13.13 Interpretation of NMR Spectra</td>
<td>Major functional groups; splitting patterns; multiple splitting</td>
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<td><strong>15 Organometallic Compounds</strong></td>
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<td>15.1 Organomagnesium and Organolithium Compounds</td>
<td>Rxns with carbonyls &amp; epoxides <em>(Mechanism)</em></td>
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<td>15.2 Lithium Diorganocopper (Gilman) Reagents, Coupling with halides</td>
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<td>15.3 Carbenes and Carbenoids</td>
<td>Insertion reactions: carbene &amp; dihalocarbenes; Simmons-Smith rxn</td>
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<td><strong>16 Aldehydes and Ketones</strong></td>
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<td>16.1 Structure and Bonding</td>
<td>Polarity properties; bond characteristics</td>
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<td>16.2 Nomenclature</td>
<td>trivial names of compounds on slides; basic nomenclature</td>
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<td>16.3 Physical Properties</td>
<td>solubility trends; BP &amp; or MP trends</td>
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<td>16.4 Reactions</td>
<td>Reaction theme: addition to give tetrahedral intermediate</td>
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<td>16.5 Addition of Carbon Nucleophiles</td>
<td>Grignards; R-Li; acetylide; cyanide-use of cyanohydrins <em>(mechanisms)</em></td>
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<td><strong>CUT-OFF for XM 1</strong></td>
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<td>16.6 The Wittig Reaction</td>
<td>use with carboxyls</td>
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<td>16.7 Addition of Oxygen Nucleophiles</td>
<td>Hydrates; hemi-acetal; acetal formation &amp; hydrolysis; <em>(mechanisms)</em></td>
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<td>16.8 Addition of Nitrogen Nucleophiles</td>
<td>imines and enamines-formation and hydrolysis; <em>(mechanism)</em></td>
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<td>16.9 Keto-Enol Tautomerism</td>
<td>acidity of α hydrogens (significance)</td>
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<td>16.10 Oxidation</td>
<td>RHO &amp; ROH-use of all Cr⁶⁺ reagents; Silver oxide;O₂</td>
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<td>16.11 Reduction</td>
<td>metal hydride reductions; cat H₂; Clemmenson; Wolff-Kishner</td>
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<td>16.12 Reactions at an α-Carbon</td>
<td>racemization-<em>(mechanism)</em>; halogenation, acidic &amp; basic conditions-<em>(mechanism)</em></td>
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