9.2.4. Building an Alkene Spacer by the Wittig Reaction: Synthesis of 4-[2-(4-Nitrophenyl)ethenyl]benzonitrile

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![Chemical structure diagram]

<table>
<thead>
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<th>Number of sessions (duration of each session)</th>
<th>Hazard level</th>
<th>Difficulty level</th>
<th>Level of study</th>
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<td>2 (3 h)</td>
<td>Moderate</td>
<td>Medium</td>
<td>Intermediate</td>
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**Class names** Benzyl halides, phosphorus ylides, aldehydes, alkenes

**Concepts involved** Wittig reaction, double bond formation, spectroscopic characterization, E/Z isomers, E/Z isomeric ratio

**Chemicals needed** 4-Nitrobenzaldehyde, 4-(bromomethyl)benzonitrile, triphenylphosphine, potassium tert-butoxide, toluene, THF, diethyl ether, dichloromethane, methanol, anhydrous magnesium sulfate

**Equipment and experimental techniques involved** Heating mantle or oil bath with magnetic stirring, Büchner funnel, reflux apparatus, rotary evaporator, structural analysis (NMR, IR, MS)

**Keywords** Aldehydes, alkenes, phosphorus ylides, precipitation, spectroscopic characterization, Wittig reaction

**Background**

The Wittig reaction was discovered by George Wittig (Nobel Prize in Chemistry in 1979) in 1954. The Wittig reaction is one of the most common and valuable methods for the formation of alkenes, starting from a carbonyl compound and a primary or secondary alkyl halide. The reaction involves the formation of an alkene from an aldehyde or a ketone using a phosphorus ylide derivative, \( \text{R}_2\text{C}^-\text{P}^-\left(C_6\text{H}_5\right)_3 \). This latter species is obtained from a nucleophilic substitution reaction of an alkyl halide by triphenylphosphine, followed by deprotonation of the...