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Aldehydes and ketones are reduced to alkanes by hydrazones in the presence of bases. Kishner and Wolff reported this method in 1911 and 1912 respectively. The early reported steps were to add the pre-formed hydrazone to hot solid KOH or to heat it to 160~200 in a sealed tube with sodium ethoxide/ethanol. Wolff-Kishner reduction sometimes forms rearrangement products. Wolff-Kishner reduction is complementary to Clemmensen reduction, which reacts under acidic conditions. Therefore, Wolff-Kishner reduction is the most commonly used. Other improvements under milder conditions include reactions in the presence of base t-BuOK, in DMSO, and at room temperature. Reagents: Hydrazine (NH2NH2, hydrate or anhydrous); strong base (e.g., NaOH, KOH, or sodium ethoxide); high-boiling solvent (e.g., ethylene glycol, diethylene glycol, or DMSO). Reactants: Aldehydes or ketones.Products: Alkanes (conversion of C=O to -CH2- group).Related reaction, Curtius reaction, Curti Wolff-Kishner reduction proceeds via a deprotonation-hydrazone formation-decomposition pathway. A critical feature of this mechanism is the concerted elimination of N2, which drives the reaction thermodynamically and avoids reversibility. Hydrazone Formation: The carbonyl compound reacts with excess hydrazine to form a hydrazone intermediate. This step typically occurs under reflux in a polar solvent. Deprotonation and Rearrangement: Under strongly basic conditions, the hydrazone undergoes deprotonation to generate a resonance-stabilized diazenide intermediate. Heating at elevated temperatures (often 180-220 C) facilitates the elimination of nitrogen gas, producing a carbanion. Protonation: The carbanion is quenched by a proton source (often water or the solvent), yielding the final alkane product. Experimental TipsThe original method of operation of hydrazone will reduce the temperature, resulting in a long reaction time (50-100 hours), and the need to use excess base and solvent. Huang-Minlon modification: After the hydrazone is generated, the water and excess hydrazine are removed in time by distillation. The reaction temperature can be shortened to 3-6 hours. This improvement not only improves the yield, but also allows the use of hydrazine hydrate and water-soluble base (KOH or NaOH). Esters, lactones, amides and lactams will hydrolyze under this reaction condition. Wolf-Kishner conditions are not suitable for the reduction of sterically hindered ketones (sterically hindered aldehydes or ketones require higher reaction temperatures) and are not suitable for the reduction of ,-unsaturated ketones. In the latter case, the main product is pyrazole. Another modification of the Wolf-Kishner reduction is to form p-toluenesulfonylhydrazone, which is then reduced with reagents such as borane or metal hydrides (NaBH4, NaBH3CN). ,-unsaturated ketones are reduced using this modification to form double bond migration products. Application Examples of Wolff-Kishner ReductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductionExample 1: In the mid-stage enantioselective total synthesis of cyathane diterpenoids, Birch reductive methylation, and carbon enables of the cyathane diterpenoids, Birch reductive methylation, and carbon enables of the cyathane diterpenoids, Birch reductive methylation, and carbon enables of the cyathane diterpenoids, Birch reductive methylation, and carbon enables of the cyathane diterpenoids, Birch reductive methylation, and carbon enables of the cyathane diterpenoids, Birch reductive methylation, and carbon enables of the cyathane diterpenoids, Birch reductive methylation, and the cya reactions to provide a 5-6-7 tricyclic core with two anti-oriented all-carbon quaternary stereocenters at the junction of the C6 and C9 rings. [2]Example 2: Shun Wang et al. combined photoredox catalysis with the Wolff-Kishner reaction to achieve polarized difunctionalization of carbonyl compounds via a free radical-carbanion relay sequence. [3]Fig 2. Synthetic examples via Wolff-Kishner reduction reaction. Related Products References Jie Jack Li. Name Reactions-A Collection of Detailed Mechanisms and Synthetic Applications, Sixth Edition, 2021, 583-585. Wu, Guo-Jie, et al. The Journal of Chemistry, 2019, 84(6), 3223-3238. Wang, Shun, et al. Journal of the American Chemical Society. 2020, 142(16), 7524-7531. Online Inquiry Please contact us if you have questions, answer live polls, and get your doubts cleared - all while the class is going onLearning isn't just limited to classes with our practice section, mock tests and lecture notes shared as PDFs for your revisionOne subscription gets you access to all our live and recorded classes to watch from the comfort of any of your devices In this organic chemistry tutorial, you will learn about the WolffKishner reduction reaction and its mechanism. You will also see some examples of molecules undergoing the WolffKishner reductions. The German chemist Ludwig Wolff and the Russian chemist Nikolai Kishner reduction in 1912 and 1911, respectively. In the WolffKishner reduction in alkane. More specifically, the reduction in volves the conversion of a carbonyl group (C=O) into a methylene group (CH2). Figure 1. The WolffKishner Reduction of a Ketone into an Alkane This reaction occurs in high temperatures (100200C) and under basic conditions. To choose which reaction to use, one must assess the sensitivity of ones substrates: The WolffKishner reduction favors acid-sensitive substrates, while the Clemmensen reduction favors base-sensitive ones. The WolffKishner reduction favors base-sensitive ones. The WolffKish react with aldehydes or ketones under mildly acidic conditions. In such a reaction, hydrazone by the role of a nitrogen nucleophile. Figure 2. The Transformation of hydrazone is as follows: First, the hydrazone by the role of a nitrogen nucleophile. steps facilitated by the acidic environment follow. Next, water leaves, forming a C=N double bond. The resulting intermediate is then deprotonated, yielding hydrazone. Figure 3. The Mechanism of the Formation of Hydrazone Under basic conditions, hydrazone Under basic conditions, hydrazone Under basic conditions, hydrazone. reaction. Figure 4. The Reduction of a Hydrazone into an Alkane The mechanism of the reduction of hydrazone is as follows: First, the basic environment deprotonates the NH2 of the hydrazone, forming a resonance-stabilized intermediate. Then, the negatively charged carbon of that intermediate is protonated. After NH loses a proton, nitrogen gas leaves, forming a carbanion (a carbon with an unshared pair of electrons). Finally, the carbanion is protonated and becomes an alkane. It is important to note that the expulsion of nitrogen gas out of the solution as bubbles forces the reaction to completion (per Le Chateliers Principle), giving a very good product yield. Figure 5. The Mechanism of the Reduction of Hydrazone In this example, we will reduce butanone (or ethyl methyl ketone) into butane (or n-butane). Notice how the hydrazone has two diastereomeric forms. This is because butanone is asymmetrical. Figure 6. The WolffKishner Reduction of Butanone into Butanone into Butanone into Butanone into Butanone into isobutyrophenone into isobutyrophenone into isobutyrophenone into isobutyrophenone into isobutyrophenone into Butanone into isobutyrophenone into isobutyrophenone into isobutyrophenone into isobutyrophenone into Butanone into isobutyrophenone into isobutyrophenone into Butanone in benzene. Notice again how the asymmetry of isobutyrophenone results in two diastereomeric hydrazones. Figure 6. The WolffKishner Reduction of Isobutyrophenone into Isobutyl Benzene Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit, provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Aldehydes and ketones can be converted to a hydrazine derivative by reaction with hydrazine. These two steps can be further converted to the corresponding alkane by reaction with base and heat. These two steps can be combined into one reaction called the Wolff-Kishner Reduction which represents a general method for converting aldehydes and ketones into alkanes. Typically a high boiling point solvent, such as ethylene glycol, is used to provide the high temperatures needed for this reaction to occur. Note! Nitrogen gas is produced as part of this reaction. Formation of the strong N=N triple bond provides the driving force for the reaction. 1) Deprotonation of Nitrogen2) Protonation of the Carbon3) Deprotonation of Nitrogen4) Protonation of Carbon 1) Please draw the products of the following reactions. Answers1) Last updated: March 21st, 2025 | The Wolff-Kishner, Clemmensen, and Other Fun ReductionsIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner, Clemmensen, and Other Fun ReductionsIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionThe Clemmensen, and Other Fun ReductionsIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionThe Clemmensen, and Other Fun ReductionsIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionThe Clemmensen reductionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionThe Clemmensen reductionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionThe Clemmensen, and Other Fun ReductionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionThe Clemmensen reductionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including: The Wolff-Kishner reactionSIn this post we go through 4 ways of reducing C=O to CH2 including C=O to CH2 including C=O to CH2 including C=O to CH2 including C=O and reductionBut first: why might you want to do this? Well, its a key component in a common little synthesis problem I like to call The Great Friedel-Crafts Workaround. Table of Contents 1. The Great Friedel-Crafts Workaround. benzylic C-H bonds are unusually weak, and can be converted relatively easily (and selectively!) to CBr or CO bonds.Today were going to go in the reverse direction of the benzylic carbon, notably reduction of ketones (C=O) to alkyl (CH2). This is particularly important because of the Great Friedel-Crafts Workaround. Whats that, you ask?You may recall that Friedel-Crafts alkylation of benzene with propyl chloride results in isopropylbenzene, not propyl benzene. The Great Friedel-Crafts Workaround solves this issue. We begin with a Friedel-Craftsacylation, which proceeds without rearrangement, and follow by reducing the ketone down to CH2.So how can we reduce the ketone strong base (KOH) as the reducing agent in the presence of strong base (KOH) in a high-boiling protic solvent (ethylene glycol, HO-CH2CH2-OH, boiling point 197 C). The driving force for the reaction is the conversion of hydrazine to nitrogen gas. This is not exactly a gentle process; heating to almost 200 C is required to make the reaction occur at a reasonable rate. [Note 1] The first step is formation of a hydrazone from the ketone (hydrazones are a cousin of imines, which we cover later in the course). Hydrazine (NH2NH2) adds to the carbonyl, and following a series of proton transfer steps, water is expelled. Click here to see an image of the mechanism for hydrazone formation. (link to image)Once the hydrazone is formed, the real action in the Wolff-Kishner begins!3. Mechanism Of The Wolff-Kishner ReactionThe NH2 of the hydrazone is reasonably acidic (pKa about 21) and can be deprotonated by strong base at a high enough temperature (the base is likely the conjugate base of ethylene glycol, not KOH). This deprotonated by strong base at a high enough temperature (the base is likely the conjugate base of ethylene glycol, not KOH). carbon. With the caveat that resonance forms dont really exist, it can be helpful to imagine forming the resonance form of this species with a nitrogen-nitrogen double bond, which , after deprotonation by base, decomposes irreversibly to give nitrogen gas and a carbanion (i.e. a negatively charged carbon). Protonation of the carbon completes the process. Hover for full arrow-pushing mechanism or click on this link. 4. The Clemmensen Reduction. The reductant here is zinc amalgam (Zn-Hg) which is used under acidic conditions; one method calls for the presence of aqueous HCl, for example: This process works best for aromatic ketones; non-aromatic ketones; non-aro zinc amalgam.5. Why Would You Prefer The Wolff-Kishner over a Clemmensen, or vice versa, but here are some things to think about. The Wolff-Kishner is done under strongly basic conditions using high heat in a polar protic solvent. The Clemmensen is performed in strongly acidic conditions. If you have a protecting group somewhere which can be removed with acid, such as an acetal or silvl ether, consider an alternative. Two other methods deserve mention, although you might not seen them covered until later in the course when ketone chemistry is addressed.6. A Third Method For Carbonyl Reduction: Catalytic Hydrogenation The first is catalytic hydrogenation, i.e. using a metal catalytic hydrogenation, i.e. using a metal catalytic hydrogenation used for reducing alkenes and alkynes, but it can also be used for ketones if you crank on it enough (i.e. higher temperatures, with higher pressure of H2). One subtle tweak in conditions, sometimes not mentioned, is that platinum on carbon (Pt-C) or platinum on carbon (Pt-C) or platinum oxide (PtO2) is often used instead of palladium (Pd). Normally, reduction of ketones usually stops at the alcohol stage. adjacent to an aromatic ring)reduction with can occur further to the alkane (recall that bonds at benzylic positions tend to be easier to break, since the adjacent aromatic ring can donate electron density to them).7. Reduction of ThioacetalsThe second method that sees use is conversion of the ketone to a thioacetal with HS-CH2CH2-SH and a Lewis acid such as BF3. [Note 2] This is followed by treating the thioacetal with a reducing agent known as Raney Nickel: its a form of finely divided nickel containing adsorbed hydrogen that cleaves C-S bonds to give C-H bonds, through a somewhat mysterious process also thought to involve free-radicals. [See: Reagents Raney Nickel]Unlike the Clemmensen and catalytic hydrogenation, thioacetal/Raney nickel method isnt limited merely to benzylic ketones. It can be used to completely disappear an aldehyde or ketone, as was part of the strategy in Woodwards synthesis of erythromycin.8. A Workaround ExampleWith these methods in our toolbox, we can now fill in the vague description reduction over the arrow with something a lot more specific. Heres a concrete example of a Friedel-Crafts Workaround: 9. A Final Note: Reversing Polarity of the substituent. It converts an electron-withdrawingmeta-director (an acyl group) into an electron-donatingortho-, para-director. Well have more to say about this when we address synthesis in aromatic compounds, but just take a gander at these two examples. Two more examples of reversing the polarity of a substituent is reduction of the nitro group and Baeyer-Villiger oxidation of a ketone to an ester. Well cover those next! Notes Note 1. One way of getting around the requirement for high heat in the Wolff-Kishner is to use a strong base like t-BuOK in DMSO, which can be done around room temperature. [Ref: J. Am. Chem. Soc, 1962, 84, 1735.]Note 2., Lewis acids such as BF3 or ZnCl2 are commonly used for this reaction [see this Org Syn reference] although in practice, protic acids such as HCl are perfectly fine if the starting material is an aldehyde or ketone [see this Org Syn reference]In Corey and Seebachs method for making 1,3-dithiane, the starting materials are 1,3-propanedithiol and dimethoxymethane (CH3OCH2OCH3), an equivalent of formaldehyde. BF3, a strong Lewis acid, gave better yields in this procedure than did anhydrous acid, subsequently BF3 seems to be the Lewis acid of choice in organic chemistry textbooks despite the fact that most thioacetal formation reactions seen in introductory courses are from aldehydes or ketones, not acetals. Quiz Yourself! Become a MOC member to see the clickable quiz with answers on the back. Become a MOC member to see the clickable quiz with answers on the back. Become a MOC member to see the clickable quiz with answers on the back. on the back. Become a MOC member to see the clickable quiz with answers on the back. (Advanced) References and Further ReadingChemischen Institut der Universitt Jena: Methode zum Ersatz des Sauerstoffatoms der Ketone und Aldehyde durch Wasserstoff. [Erste Abhandlung.]Wolff, L. Lieb. Ann. Chem. 1912394(1), 86DOI: 10.1002/jlac.19123940107The original paper by Ludwig Wolff on the reduction of aldehydes and ketones with hydrazonesSzmant, H. H.; Harmuth, C. H.J. Am. Chem. Soc.1964, 86(14), 2909DOI:10.1021/ja01068a028A very nice Physical Organic study on the decomposition of hydrazones, involving Hammett plots (a classic tool in Physical Organic Chemistry), determining the relationship between the electron density of the carbonyl Compounds by Modified Wolff-Kishner MethodHuang-MinlonJ. Am. Chem. Soc.1949, 71(10), 3301DOI:10.1021/ja01178a008A one-pot modification for the Wolff-Kishner reaction that involves distilling off the excess water and hydrazine before heating the hydrazine. This results improved yields and significantly shorter reaction times. REDUCTION OF KETONES BY USE OF THE TOSYLHYDRAZONE DERIVATIVES: ANDROSTAN-17 -OL CagliotiOrg. Synth. 1972, 52, 122DOI: 10.15227/orgsyn.052.0122Due to the harsh conditions involved in the standard Wolff-Kishner reduction, a number of variations have been developed with NaBH4 in refluxing methanol (68 C vs. 200 C!).-PHENYLBUTYRIC ACID L. MartinOrg. Synth. 1935, 15, 64DOI: 10.15227/orgsyn.015.0064A reliable, tested procedure for a simple Clemmensen: Reduction that demonstrates how this reaction can be used to reduce a ketone in the presence of a carboxylic acid.Elrik Clemmensen: Reduktion von Ketonen und Alahyden su den entsprechenden Kohlenwaaserstoflbn unter Anwendung von amalgamiertem Zink und Salesaure. Clemmensen, E. Chem. Ber. 1913 46 (2), 1837-1843DOI: 10.1002/cber.19130460292The original paper by Clemmensen on the reduction of aldehydes and ketones with Zn metal in acid. Note that even though this was submitted to a German journal and written in German, Clemmensen was working at Parke-Davis, in the U.S.Two reviews on the Clemmensen Reduction: THE CLEMMENSEN REDUCTIONMartin, E. L.Org. React. 1942, 1, 155DOI: 10.1002/0471264180.or001.07CLEMMENSEN REDUCTIONMartin, E. L.Org. React. 1975, 22, 401DOI: 10.1002/0471264180.or022.03Stereoselective total synthesis of ()-pumiliotoxin C by an aqueous intramolecular acylnitroso DielsAlder approachMasaichi Naruse, Sakae Aoyagi and Chihiro KibayashiJ. Chem. Soc., Perkin Trans. 1, 1996, 1113-1124DOI: 10.1039/P19960001113Clemmensen reductions can be used in total synthesis due to the mild conditions in this case 34 to 35 is a Clemmensen reduction that selectively reduces a ketone in the presence of an amide. Ans. The wolff-Kishner reduction is preferable when acid-sensitive compounds are being reduced. As a reduction under fundamental conditions, the chemical is unaffected. Ans. There are three fundamental limitations to the Wolff-Kishner Reduction Mechanism. These are listed below: It is not possible to perform the procedure at low temperatures. Sterically hindered ketones cannot be synthesised using this method. Although the Wolff-Kishner Reduction procedure is exclusively used for carbonyl groups, double bond migration occurs when undesirable products, including alpha and beta-unsaturated carbonyls, form. Ans. Typically, primary alcohols are transformed into aldehydes and carboxylic acids by CrO3-based reagents, whereas secondary alcohols are turned into ketones using LiAlH4 to convert the oxidation products to their respective alcohols. Ans. In general, aldehydes are more likely to react than ketones. This is because for the following reasons: There are more positive charges in aldehyde carbons than in ketones due to the electron-donating tendency of alkyl groups. Ketones have two groups of e-donors, while aldehyde carbons than in ketones due to the electron-donating tendency of alkyl groups. Ketones have two groups of e-donors, while aldehyde carbons than in ketones due to the electron-donating tendency of alkyl groups. Ketones have two groups of e-donors, while aldehyde carbons than in ketones due to the electron-donating tendency of alkyl groups. released, culminating in the production of the carbanion. Finally, carbanions react with water to produce hydrocarbons. This organic reaction used to convert an aldehyde or ketone to an alkane using hydrazine, base, and heat (~200 C). Aldehydes and ketones are first converted to a hydrazine derivative by reaction with hydrazine. These hydrazones can be further converted to the corresponding alkane by reaction with base and heat. The reaction converts carbonyl groups to methylene groups. The Wolff-Kishner reduction represents a general method for converting aldehydes and ketones into alkanes. Typically, a high boiling point solvent, such as ethylene glycol, is used to provide the high temperatures needed for this reaction to occur. The driving force for the reaction is the conversion of hydrazine to nitrogen gas. This reaction is used for the reduction of aldehydes and ketones. Other reducible groups, such as carbon-carbon double bonds and nitro groups, usually remain unaffected under the conditions of this reaction [1-5]. Wolff Kishner reduction The history of Wolff-Kishner and German chemist Ludwig Wolff independently discovered the reaction in 1911 and 1912, respectively [4]. An example of Wolff-Kishner reduction, applicable to aromatic compounds, includes the conversion of cyclohexanone to cyclohexanone to cyclohexanone to hydrazine forms the hydrazine to gaseous nitrogen, to yield the corresponding alkane [1-6,8,9]. Wolff Kishner Reduction Mechanism Wolff-Kishner reduction has a broad range of applications [10]. Some of them include, Organic synthesis of multiwalled carbon nanotubeSynthesis of functionalized imidazole substrate There are three significant limitations of the Wolff-Kishner reduction. The reduction requires a high temperature. It cannot be used for sterically hindered ketones. Although the process is specific for carbonyl groups, sometimes migration of the expected mechanism of the reaction when an undesired product like alpha, beta-unsaturated carbonyl compounds are formed in the reaction. Wolff-Kishner reduction is complementary to Clemmensen reduction, which also converts aldehydes and ketones to hydrocarbons. Wolff-Kishner reduction is performed in strongly acidic conditions. If a protecting group is present that can be removed with an acid, such as an acetal or silyl ether, then consider this reductionCarried out in a strongly acidic mediumHydroxide (OH) is attacked Hydroxide (OH) is saved and regenerated Reactions >> Name Reactions The reduction of the carbonyl compound with hydrazine forms the hydrazone, and treatment with base induces the reduction of the carbonyl compound with hydrazone forms the hydrazone. Reduction can effect a similar conversion under strongly acidic conditions, and is useful if the starting material is base-labile. Mechanism of the Wolff-Kishner Reduction Recent Literature Practical Procedures for the Preparation of N-tert-Butyldimethylsilylhydrazones and Their Use in Modified Wolff-Kishner Reductions and in the Synthesis of Vinyl Halides and gem-Dihalides M. E. Furrow, A. G. Myers, J. Am. Chem. Soc., 2004, 126, 5436-5445. En Route to a Practical Primary Alcohol Deoxygenation X.-J. Dai, C.-J. Li, J. Am. Chem. Soc., 2016, 138, 5344-5440. Methyl Hydrazinocarboxylate as a Practical Alternative to Hydrazine in the Wolff-Kishner Reaction P. B. Cranwell, A. T. Russell, C. D. Smith, Synlett, 2016, 27, 131-135.

Wolff-kishner reduction. What is wolff kishner reduction reaction. Wolff-kishner reduction example. Wolff kishner reduction mechanism. Wolff kishner reduction solvent.