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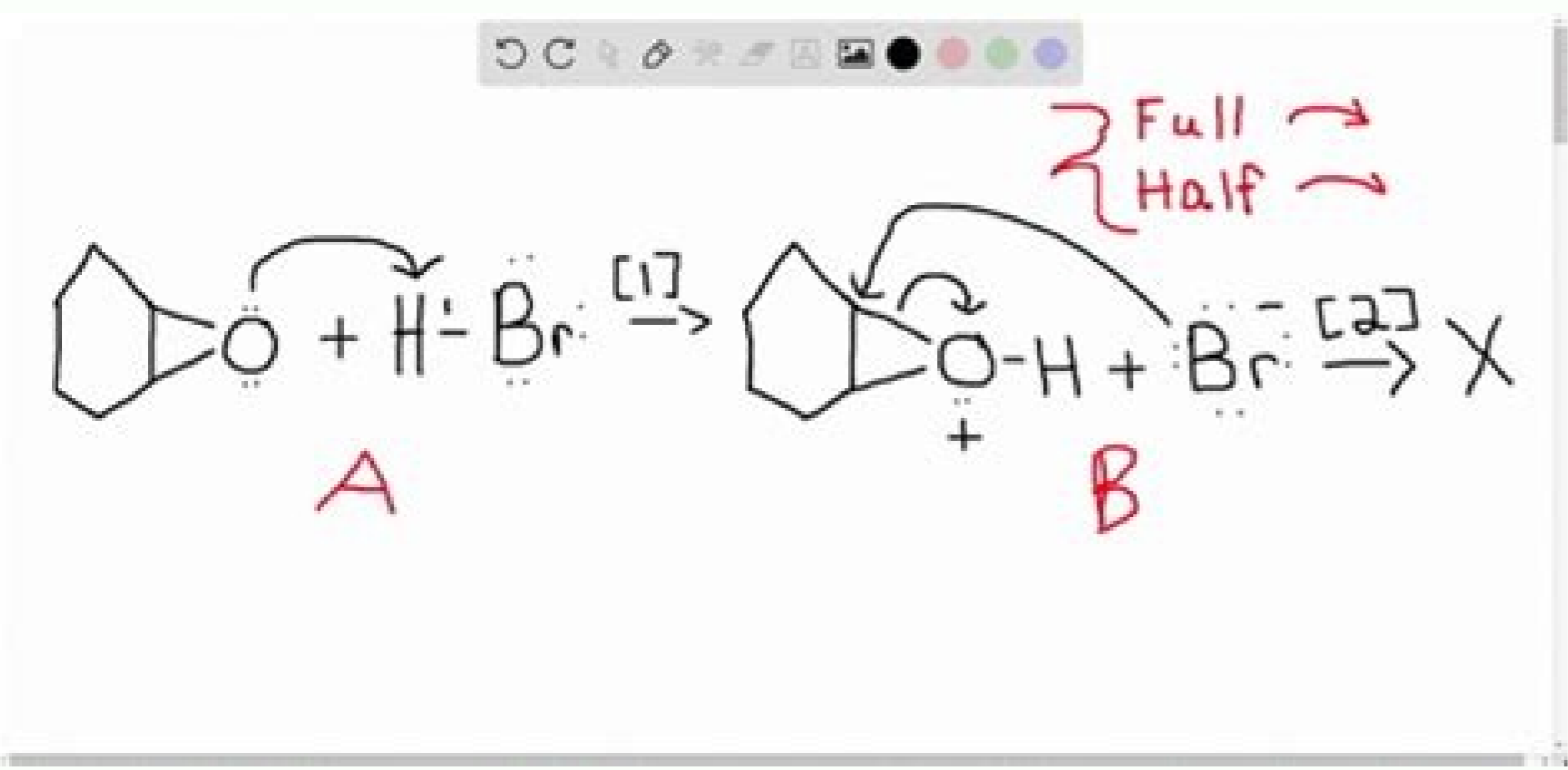
Chemical Reactions

A. Balance the following chemical reactions:

- $\text{NaH} + \text{CaOH} \rightarrow \text{CaH}_2 + \text{NaOH}$
- $\text{N}_2 + \text{H}_2 \rightarrow \text{NH}_3$
- $\text{NaOH} + \text{P}_2\text{O}_5 \rightarrow \text{NaPO}_3$
- $\text{Pb(OH)}_2 + \text{HI} \rightarrow \text{PbI}_2 + \text{H}_2\text{O}$
- $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- $\text{H}_2\text{O}_2 + \text{Ba(OH)}_2 \rightarrow \text{Ba(OH)}_2 + \text{H}_2\text{O}$
- $\text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- $\text{Li}_2\text{O} + \text{H}_2\text{SO}_4 \rightarrow \text{Li}_2\text{SO}_4 + \text{H}_2\text{O}$
- $\text{HBr} + \text{AgNO}_3 \rightarrow \text{AgBr} + \text{HNO}_3$
- $\text{P}_4 + \text{H}_2\text{O}_2 \rightarrow \text{P}_2\text{O}_5 + \text{H}_2$

B. Identify the type of reaction as synthesis, decomposition, single-replacement, double-replacement, and combustion.

- $\text{Na}_2\text{SO}_4 + 2\text{KOH} \rightarrow 2\text{NaOH} + \text{K}_2\text{SO}_4$ _____
- $\text{Fe} + \text{PbSO}_4 \rightarrow \text{PbSO}_4 + \text{Fe}$ _____
- $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ _____
- $2\text{Al} + 3\text{H}_2\text{SO}_4 \rightarrow 2\text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2$ _____
- $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ _____

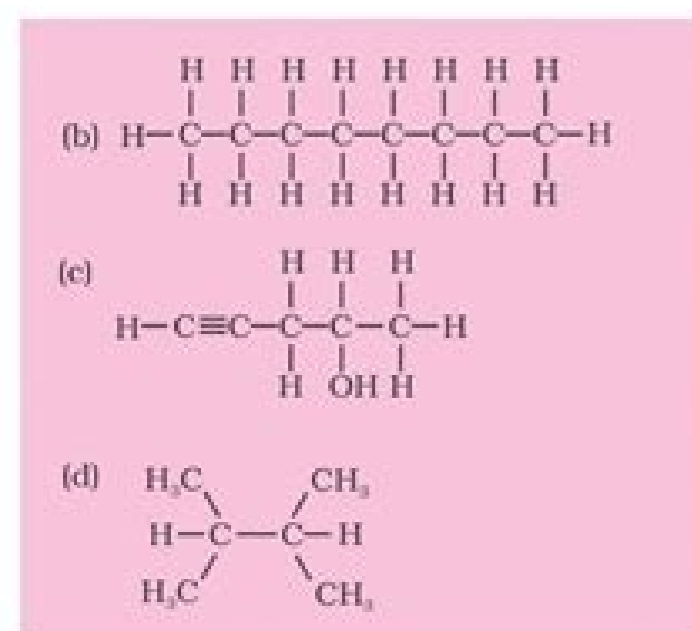


REACTIONS OF ALKENES

NOTES:

- 1) NBS = N-bromosuccinimide
- 2) Other catalysts may be used for hydrogenation, eg. Pd/C.
- 3) Addition of a carbene can also be achieved using CHCl_3 , KOH. This specifically forms a **dichlorocarbene**.

Handwritten notes on chemical reactions, including a reaction scheme for the synthesis of an alkene from an alcohol and a list of reagents for various transformations.



12.3.2 Three-Dimensional Representation of Organic Molecules

The three-dimensional (3-D) structure of organic molecules can be represented on paper by using certain conventions. For example, by using solid (—) and dashed (---) wedge formula, the 3-D image of a molecule from a two-dimensional picture can be perceived. In these formulas the solid-wedge is used to indicate a bond projecting out of the plane of the paper, towards the observer. The dashed-wedge is used to depict the bond projecting out of the plane of the paper and away from the observer. Wedges are shown in such a way that the broad end of the wedge is towards the observer. The bonds lying in plane of the paper are depicted by using a normal line (—). 3-D representation of methane molecule on paper has been shown in Fig. 12.1.

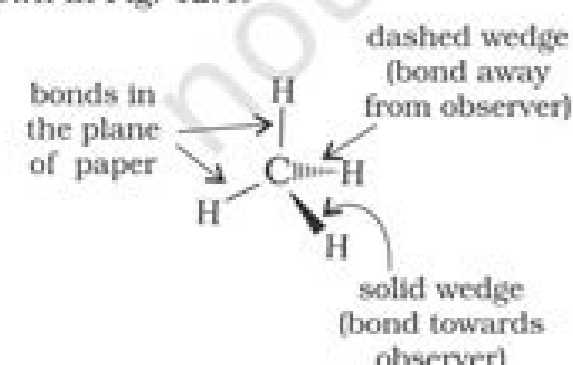


Fig. 12.1 Wedge-and-dash representation of CH_4

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Molecular Models

Molecular models are physical devices that are used for a better visualisation and perception of three-dimensional shapes of organic molecules. These are made of wood, plastic or metal and are commercially available. Commonly three types of molecular models are used: (1) *Framework model*, (2) *Ball-and-stick model*, and (3) *Space filling model*. In the *framework model* only the bonds connecting the atoms of a molecule and not the atoms themselves are shown. This model emphasizes the pattern of bonds of a molecule while ignoring the size of atoms. In the *ball-and-stick model*, both the atoms and the bonds are shown. Balls represent atoms and the stick denotes a bond. Compounds containing C=C (e.g., ethene) can best be represented by using springs in place of sticks. These models are referred to as *ball-and-spring model*. The *space-filling model* emphasises the relative size of each atom based on its van der Waals radius. Bonds are not shown in this model. It conveys the volume occupied by each atom in the molecule. In addition to these models, computer graphics can also be used for molecular modelling.

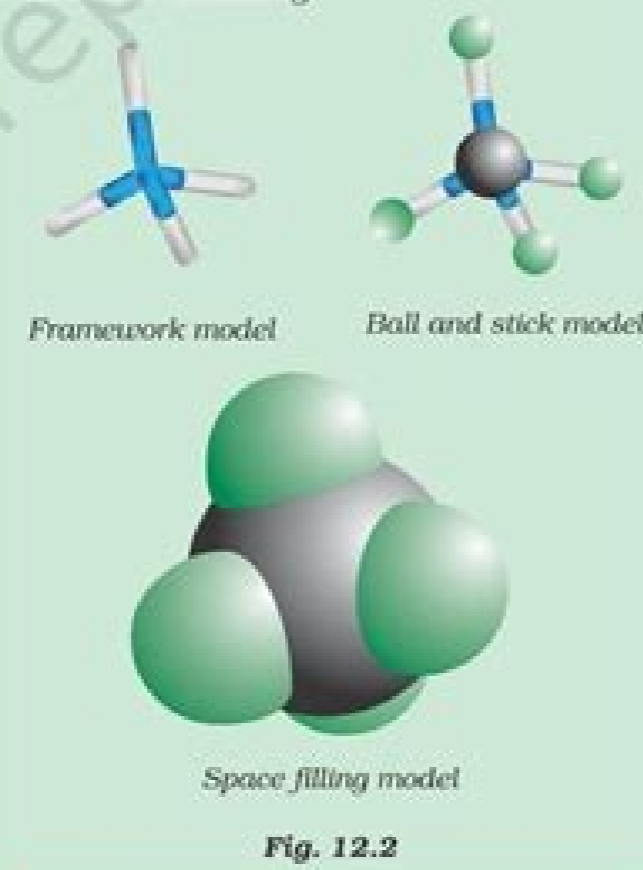


Fig. 12.2

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Coupling l Lawesson's Reagent Leuckart Thiophenol Reaction Luche Reduction m Malonic Ester Synthesis Mannich Reaction Markovnikov's Rule McMurry Reaction Meerwein-Ponndorf-Verley Reduction Myers' Modification of the Ramberg-Bäcklund Reaction Myers-Saito Cyclization Michael Addition Michaelis-Arbuzov Reaction Mitsunobu Reaction Miyaura Borylation Reaction Modified Julia Olefination Mukaiyama Aldol Addition n Nazarov Cyclization Nef Reaction Negishi Coupling Newman-Kwart Rearrangement Nitroaldol Reaction Nozaki-Hiyama Coupling Nucleophilic Substitution (S_N1 / S_N2) o O'Donnell Amino Acid Synthesis Ohira-Bestmann Reagent Olefin Metathesis Oppenauer Oxidation Overman Rearrangement Oxy-Cope Rearrangement Ozonolysis p Paal-Knorr Furan Synthesis Paal-Knorr Pyrrole Synthesis Paal-Knorr Thiophene Synthesis Passerini Reaction Paterno-Büchi Reaction Pauson-Khand Reaction Pechmann Condensation Petasis Reaction Peterson Olefination Pinacol Coupling Reaction Pinacol Rearrangement Pinner Reaction 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Dihydroxylation v Van Leusen Imidazole Synthesis Van Leusen Oxazole Synthesis Van Leusen Reaction Vicarious Nucleophilic Substitution Vilsmeier Reaction w Wacker-Tsuji Oxidation Weinreb Ketone Synthesis Wenker Synthesis Willgerodt-Kindler Reaction Williamson Synthesis Wittig-Hörner Reaction Wittig Reaction [1,2]-Wittig Rearrangement [2,3]-Wittig Rearrangement Wohl-Ziegler Reaction Wolff-Kishner Reduction Wolff Rearrangement Woodward cis-Hydroxylation Woodward Reaction Wurtz Reaction Wurtz-Fittig Reaction x y Yamauchi Esterification z Why are there Name Reactions? Name reactions honor the discoverers of groundbreaking chemical reactions or refinements of earlier known transformations in the way that many scientists have their names attached to an effect or a phenomenon, an equation, a constant, etc. In some cases, the person whose name is associated with the reaction was not the first to discover the reaction, but instead managed to popularize it. Reaction names can also simply describe the reaction type, often by using the initials or referring to structural features. As an example, a very important field in chemical synthesis is carbon-carbon bond formation, and a great many name reactions exist that describe such transformations. In this field, the development of a procedure for using organomagnesium compounds by Victor Grignard led to totally new addition reactions that expanded the scope of organic synthesis tremendously. In a historical twist, Grignard was not the first to use such reagents but rather simplified the procedure by generating the highly reactive reagent in situ. This popularized the use of the related transformations, which had previously been quite tedious as the sensitive organomagnesium reagents needed to be prepared separately and stored. What we now know as Grignard reagents are most often used in additions to carbonyl compounds that provide alcohols or other products in high yields, and this process is nowadays referred to as the Grignard reaction. In another important case, many C-C bond forming reactions are promoted by palladium catalysis, which results in a more efficient use of reagents and more readily accessible conditions. An example is the synthesis of biaryl moieties, substructures that occur frequently in compounds of interest in medicinal chemistry. As an indication of how useful these reactions are, the named reactions for many variants of these palladium-catalyzed biaryl coupling reactions became current within just a few years after discovery, even during lifetime of the respective authors, such as (Makoto) Kumada, (John Kenneth, or J.K.) Stille and (Akira) Suzuki coupling. Other chemists, who develop specific variants or improvements or hybrid conditions, have their names appended as in the Kumada-Tamao-Corriu coupling. In addition to the use of the names of chemists, we also have groundbreaking reactions that come to be known by abbreviations of a descriptive name, such as "RCM" (ring-closing metathesis) or INOC (intramolecular nitrile oxide cyclization). We seldom use the name of the chemist who developed RCM (Robert Grubbs) to refer to the reaction, but his contribution is instead acknowledged by applying his name to the ruthenium-catalysts used. Thus, we speak of the "Grubbs catalyst" or "2nd generation Grubbs catalyst". Besides names such as "RCM", some frequently used reactions are named for structural features of the precursor or product. Examples include the "aldol reaction" ("aldol" is an abbreviation of a compound that contains both aldehyde and alcohol functionalities) or the "pinacol rearrangement". Why must we learn dozens (or hundreds!) of name reactions? As mentioned above, name reactions are used to refer to groundbreaking reactions or the associated mechanisms or principles that are worthwhile knowing and keeping straight. Just as physicians must learn the names of organs and geologists the names of minerals, chemists or students of chemistry use name reactions as a way to organize their knowledge and communicate about chemical transformations. In laboratory discussions, people very often use name reactions to refer to experiments they are running or the chemical problems they are investigating. The name reaction is a type of shorthand that avoids the need to give a lengthier explanation of the features of a particular transformation of interest. Mentioning the name reaction allows a knowledgeable listener to bring to mind the possible substrates, reaction conditions, or mechanistic details. Everyone in the field is expected to know a basic set of name reactions by heart, and this makes discussions less time-consuming. In this way, name reactions have become part of the shared vocabulary of organic synthesis chemists. When meeting a fellow chemist, for example at a conference or during a job interview, it is possible to make an initial assessment of your listener's level and depth of expertise and experience by referring to an exotic name reaction. Such recognition can signal that a listener (or job candidate) has command of a particular area of chemistry. This means that he or she would be capable of understanding details of the synthetic routes in the work described, and could possibly develop alternatives.

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