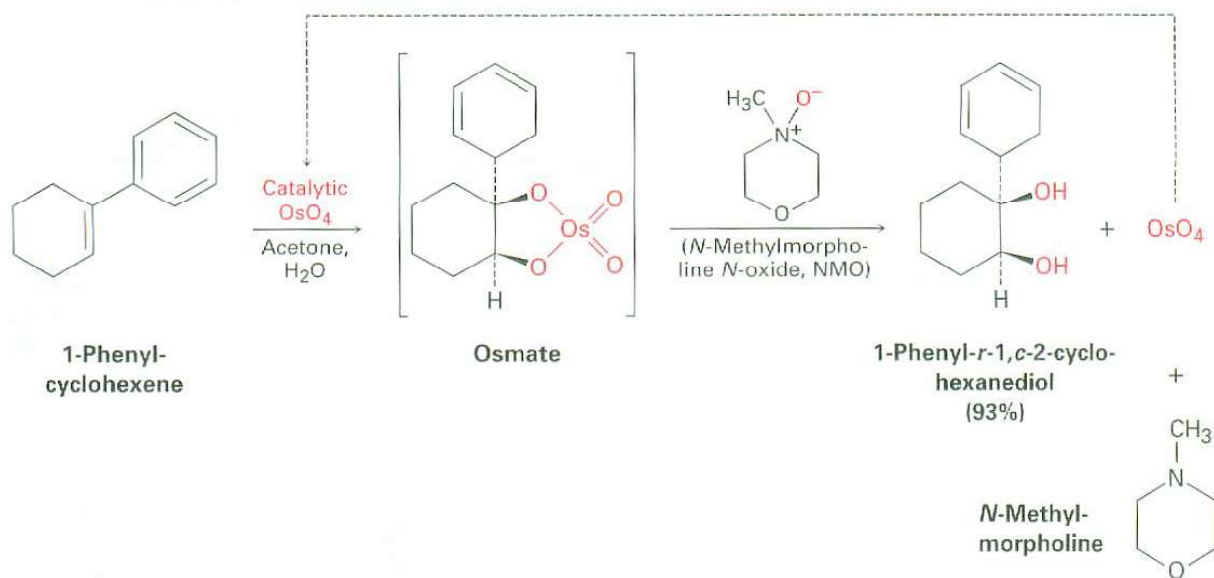


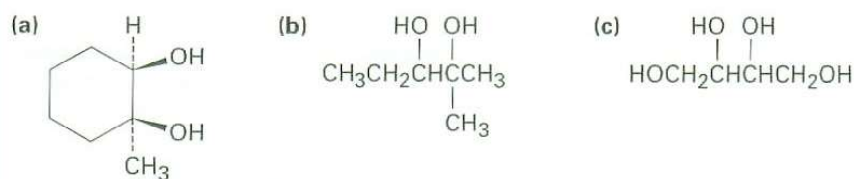
N-methylmorpholine and reoxidized OsO_4 . The OsO_4 then reacts with more alkene in a catalytic cycle.



Note that a *cis*- or *trans*- prefix would be ambiguous when naming the diol derived from 1-phenylcyclohexene because the ring has three substituents. In such a case, the substituent with the lowest number is taken as the reference substituent, denoted *r*, and the other substituents are identified as being *cis* (*c*) or *trans* (*t*) to that reference. When two substituents share the same lowest number, the one with the highest priority by the Cahn–Ingold–Prelog sequence rules (Section 6.5) is taken as the reference. In the case of 1-phenyl-1,2-cyclohexanediol, the $-\text{OH}$ group at C1 is the reference (*r*-1), and the $-\text{OH}$ at C2 is either *cis* (*c*-2) or *trans* (*t*-2) to that reference. Thus, the diol resulting from *cis* hydroxylation is named 1-phenyl-*r*-1,*c*-2-cyclohexanediol, and its isomer resulting from *trans* hydroxylation would be named 1-phenyl-*r*-1,*t*-2-cyclohexanediol.

Problem 7.14 What product would you expect from reaction of *cis*-2-butene with *meta*-chloroperoxybenzoic acid? Show the stereochemistry.

Problem 7.15 How would you prepare each of the following compounds starting with an alkene?

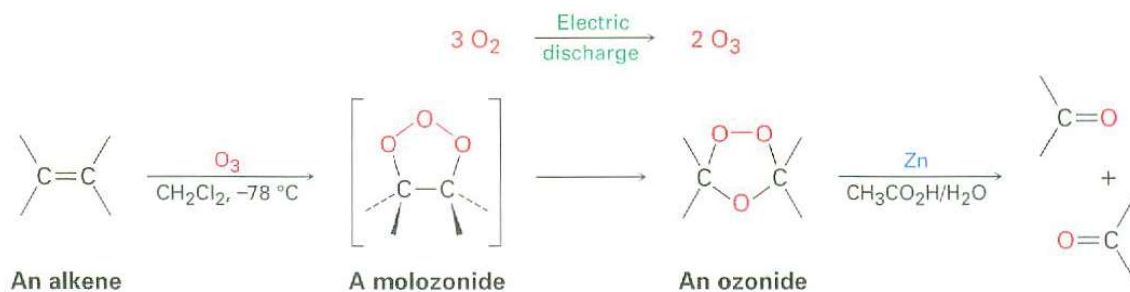


7.9 Oxidation of Alkenes: Cleavage to Carbonyl Compounds

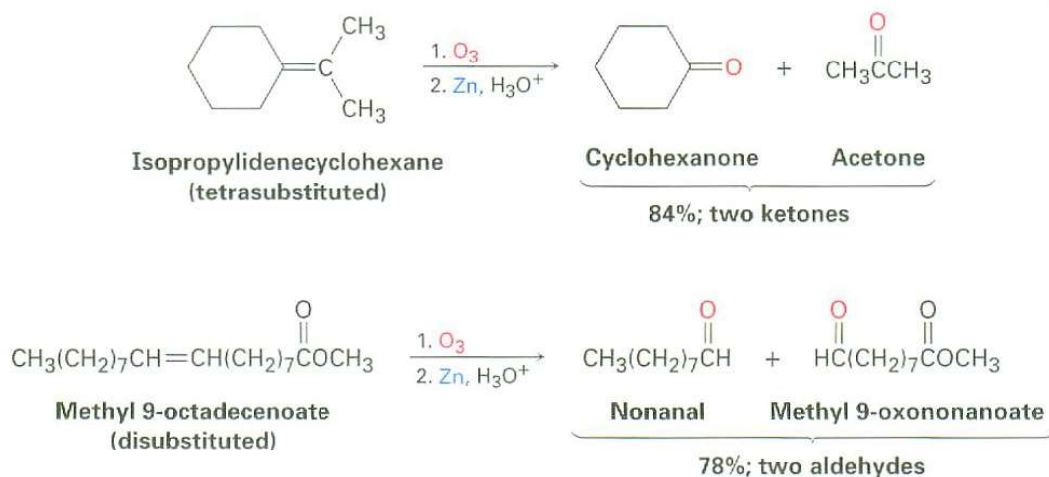
ThomsonNOW Click *Organic Interactive* to use a web-based palette to predict products from the oxidation of alkenes.

In all the alkene addition reactions we've seen thus far, the carbon–carbon double bond has been converted into a single bond but the carbon skeleton has been left intact. There are, however, powerful oxidizing reagents that will cleave $\text{C}=\text{C}$ bonds and produce two carbonyl-containing fragments.

Ozone (O_3) is perhaps the most useful double-bond cleavage reagent. Prepared by passing a stream of oxygen through a high-voltage electrical discharge, ozone adds rapidly to an alkene at low temperature to give a cyclic intermediate called a *molozone*. Once formed, the molozone then spontaneously rearranges to form an **ozonide**. Although we won't study the mechanism of this rearrangement in detail, it involves the molozone coming apart into two fragments that then recombine in a different way.



Low-molecular-weight ozonides are explosive and are therefore not isolated. Instead, the ozonide is immediately treated with a reducing agent such as zinc metal in acetic acid to convert it to carbonyl compounds. The net result of the ozonolysis/reduction sequence is that the $C=C$ bond is cleaved and oxygen becomes doubly bonded to each of the original alkene carbons. If an alkene with a tetrasubstituted double bond is ozonized, two ketone fragments result; if an alkene with a trisubstituted double bond is ozonized, one ketone and one aldehyde result; and so on.



Several oxidizing reagents other than ozone also cause double-bond cleavage. For example, potassium permanganate ($KMnO_4$) in neutral or acidic solution cleaves alkenes to give carbonyl-containing products. If hydrogens are present on the double bond, carboxylic acids are produced; if two hydrogens are present on one carbon, CO_2 is formed.

