Alkene Reactions
3- Oxidation Reactions

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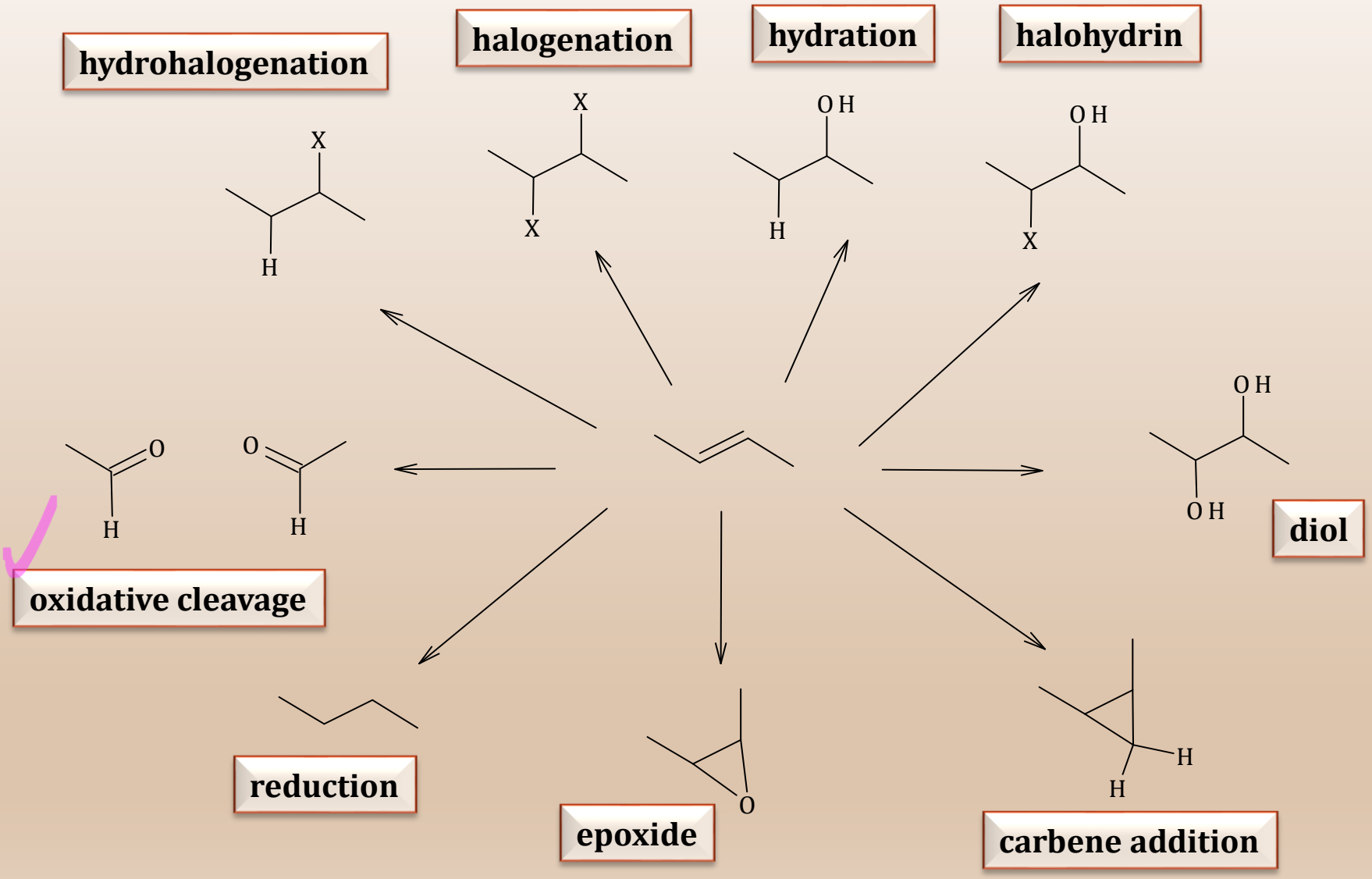
All Reactions

✓ *Covered in this power point.*



Oxidation of Alkenes (oxidative cleavage)

The double bond of alkenes can be cleaved (broken) by strong oxidizing agents.

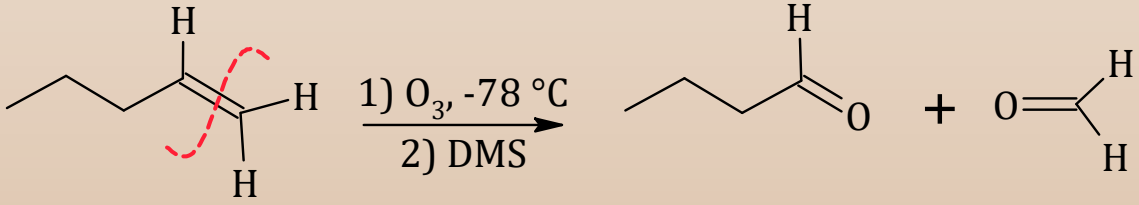
The products are oxidized to give aldehydes, ketones or carboxylic acids, depending on the nature of the alkene and strength of the oxidizing agent. We will learn two reagents here, ozone and potassium permanganate. Ozone is the weaker oxidizing agent.

Oxidation of Alkenes (oxidative cleavage) - O_3

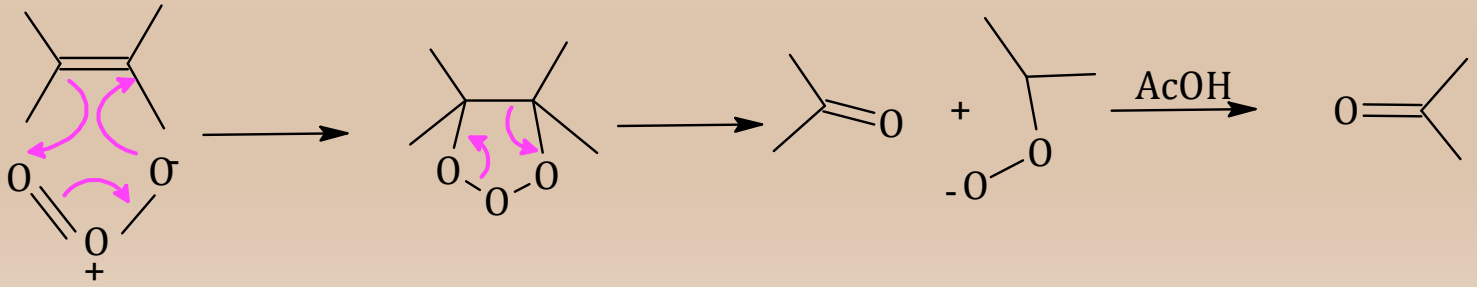
Cleavage of alkenes with ozone and workup with zinc in acetic acid (or dimethyl sulfide: DMS $(CH_3)_2S$) leads to less oxidized carbons than products from cleavage with hot $KMnO_4$ (next slide).

Substituted alkenes give ketones on ozonolysis.

Alkenes with H on the double bond will give an aldehyde on ozonolysis.



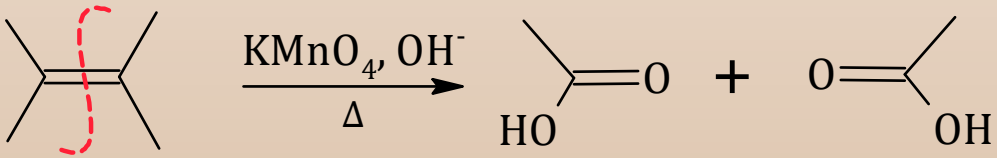
- Mechanism

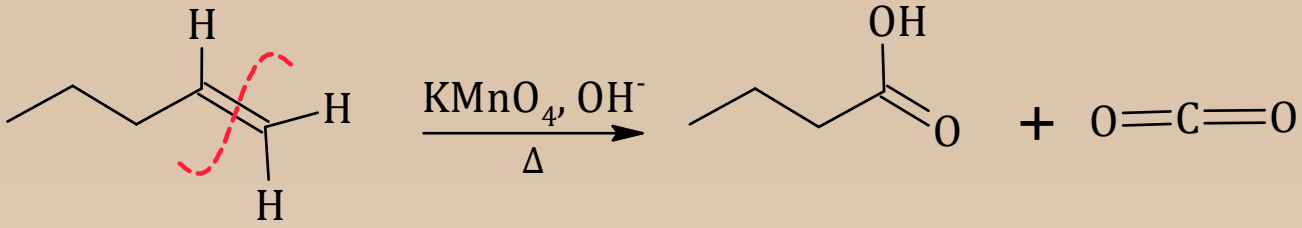


Oxidation of Alkenes (oxidative cleavage) - $KMnO_4$

$KMnO_4$ is a powerful oxidizing agent that cleaves the double bond and oxidizing them to give carbon dioxide, carboxylic acids (alkenes with hydrogens on it) and ketones (substituted alkenes) as products.

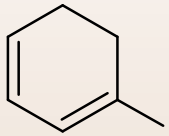
- Terminal alkenes give CO_2 with $KMnO_4$.
- The structure of an alkene can be determined by studying the products formed after oxidative cleavage.
- This reaction is also a good ***QUALITATIVE TEST.***



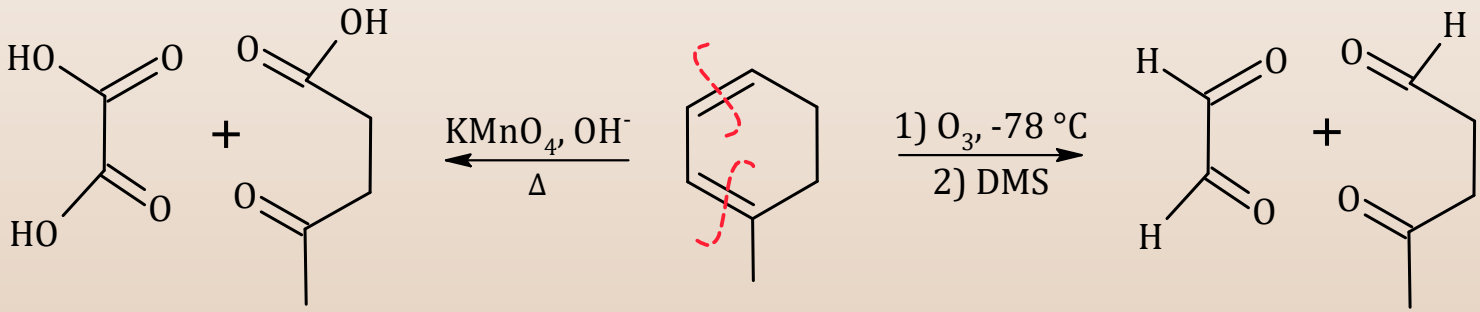


Solved Problem: Determining products of oxidative cleavage

1) What are the products on ozonolysis and KMnO3 oxidation of the following alkene?

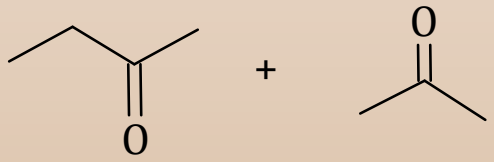


ANSWER

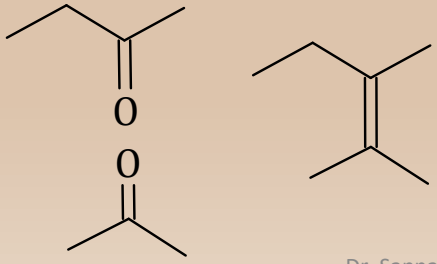


Solved Problem: Finding structure from oxidative cleavage

2) What is the alkene that gives the following two products on ozonolysis?

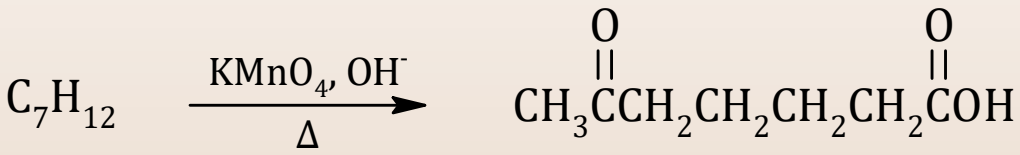


ANSWER: Only ketones are formed so alkene must be all substituted with carbons.

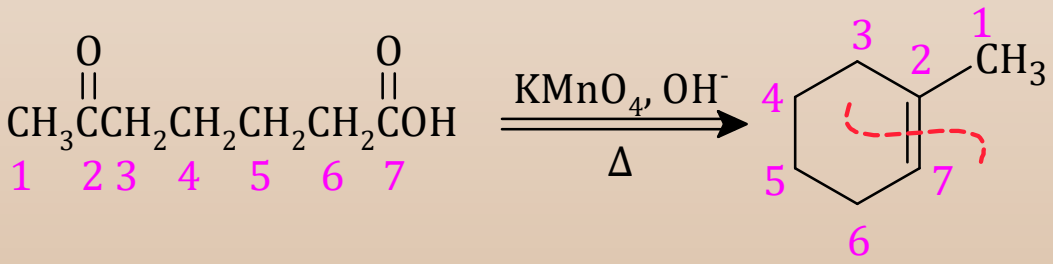


Solved Problem: Finding structure from oxidative cleavage

An unknown alkene with formula C_7H_{12} yields only the following product on oxidation with hot $KMnO_4$.



ANSWER: Since no carbons are missing in the product, the alkene must be part of a ring in the original molecule. Carboxylic acids suggests an alkene with hydrogens.



Qualitative Tests

Qualitative tests are specific tests done to identify a functional group. The tests are generally monitored visually by observing color change, precipitate formation or effervescence (gas production).

Here are the qualitative tests to help identify alkenes. Neither of these tests are absolute for alkenes since alkynes can also give similar results but if we know the degree of unsaturation and some other information to help rule out alkynes, then these are very good tests for alkenes.

For alkenes:

- Addition of Bromine – Dark red Br_2 liquid is added to an alkene and as reaction progresses the color will disappear since bromine is adding to the alkene. Disappearance of red color is the positive test for alkenes.
- Addition of $KMnO_4$ – $KMnO_4(aq)$ is a purple solution. Since it oxidizes the alkene, it itself gets reduced during the reaction to give MnO_2, which is brown color precipitate. So disappearance of purple color and appearance of brown ppt is positive for alkenes.

Key Words/Concepts

- Oxidative Cleavage
- Ozonolysis
- Qualitative Analysis