

11.7 Addition Reactions

The commercial process of hydrogenation is used to convert the double bonds in vegetable oils to saturated fats such as those in margarine.



Learning Goal Draw the condensed structural formulas and give the names for the organic products of addition reactions of hydrogenation and hydration of alkenes.

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Addition Reactions

In alkenes and alkynes, the double and triple bonds are

- very reactive, adding H—H and H—OH to the carbons in the double or triple bond
- easily broken, providing electrons to form new bonds

TABLE 11.7 Summary of Addition Reactions

Name of Addition Reaction	Reactants	Catalysts	Product
Hydrogenation	Alkene + H ₂	Pt, Ni, or Pd	Alkane
Hydration	Alkene + H ₂ O	H ⁺ (strong acid)	Alcohol

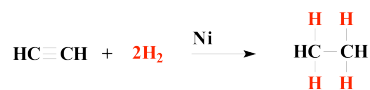
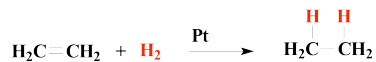
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Hydrogenation

In **hydrogenation**,

- hydrogen atoms add to the carbon atoms of a double bond or triple bond
- a catalyst such as Pt, Ni, or Pd is used to speed up the reaction



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Study Check

Write an equation for the hydrogenation of 1-butene using a platinum catalyst.

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Solution

Write an equation for the hydrogenation of 1-butene using a platinum catalyst.

$$\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3 + \text{H}_2 \xrightarrow{\text{Pt}} \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$$

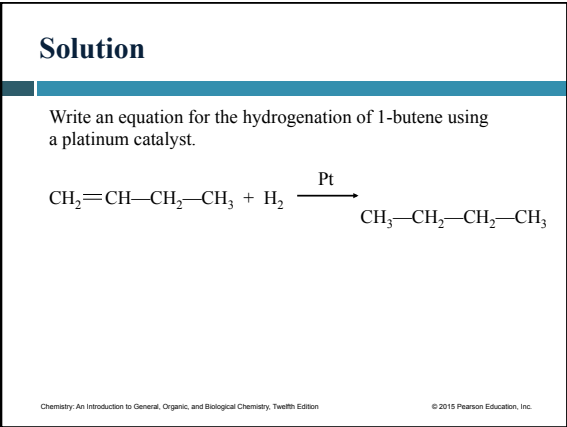
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Hydrogenation of Oils

Adding H₂ to double bonds in vegetable oils produces

- compounds with higher melting points
- solids at room temperature, such as margarine, soft margarine, and shortening


$$\text{CH}_3-(\text{CH}_2)_7-\underset{\text{H}}{\text{C}}=\underset{\text{H}}{\text{C}}-(\text{CH}_2)_7-\text{C}(=\text{O})\text{OH} + \text{H}_2 \xrightarrow{\text{Pt}} \text{CH}_3-(\text{CH}_2)_7-\text{CH}_2-\text{CH}_2-(\text{CH}_2)_7-\text{C}(=\text{O})\text{OH}$$

Oleic acid (found in olive oil and other unsaturated fats)

Stearic acid (found in saturated fats)


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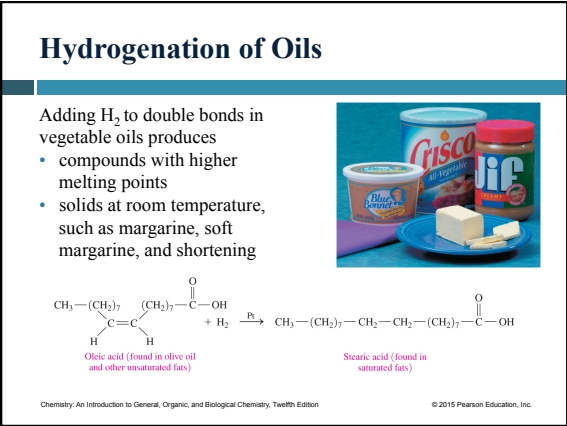
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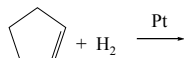
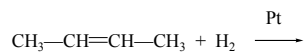


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Study Check

Write the product of each the following:

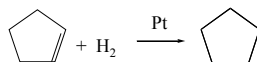
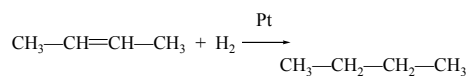


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Solution

Write the product of each the following:



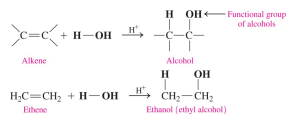
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Hydration Reactions

In hydration reactions, an alkene reacts with water, H—OH , to form an alcohol, and

- a hydrogen atom (H—) from water forms a bond with the carbon atom in the double bond with more hydrogen atoms
- the —OH from water forms a bond with the second carbon atom in the double bond with fewer hydrogen atoms
- is catalyzed by a strong acid such as H_2SO_4

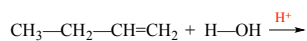
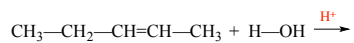


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Study Check

Predict the product of the addition of H—OH to each of the following alkenes:

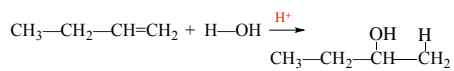
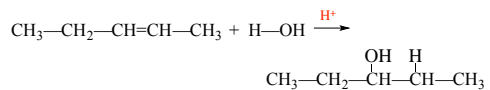


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Solution

Predict the product of the addition of H—OH to each of the following alkenes:



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