


Chapter 13

Organic Chemistry

1. What is the difference between saturated and unsaturated hydrocarbons?

Alkanes contain only single bonds and are saturated hydrocarbons because they cannot react with hydrogen to produce more C-H bonds. However, multiple (double or triple) bonds are unsaturated because an H₂ molecule can add across a multiple bond to form two C-H bonds. For example, ethene can be hydrogenated to ethane: $\text{H}_2\text{C}=\text{CH}_2 + \text{H}_2 \rightarrow \text{H}_3\text{C}-\text{CH}_3$. Thus, alkenes are unsaturated. Molecules with many double bonds (polyenes) are said to be polyunsaturated.

3. How do condensed structures and skeletal structures differ?

C-H bonds are not shown explicitly in either. However, the carbon and hydrogen atoms are shown in a condensed structure, whereas only the C-C bonds are shown in a skeletal structure. The condensed and skeletal structures of ethane are: $\text{H}_3\text{C}-\text{CH}_3$ and , respectively.

5. Why are alkenes more reactive than alkanes? Are alkenes Lewis acids or Lewis bases? Explain.

The π electrons in alkenes are Lewis bases, which is why alkenes are more reactive than alkanes.

7. Determine the molecular formulas (see text for skeletal structures):

- a) C_{10}H_8 b) $\text{C}_8\text{H}_{17}\text{NO}$ c) $\text{C}_6\text{H}_{10}\text{O}$ d) $\text{C}_7\text{H}_{10}\text{O}$

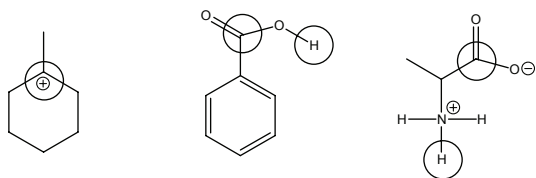
9. Name the following alkanes and alkenes (see text for skeletal structures):

- a) 2-methyl-4-ethylheptane b) 2,5-dimethylheptane c) cis-3-hexene d) trans-2-pentene

11. Identify the functional groups (see text for skeletal structures):

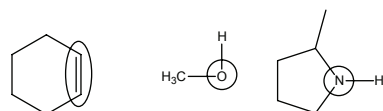
- a) carboxyl b) hydroxyl (alcohol) c) amine

13. Identify the Lewis acid sites in the following species:



Lewis acid sites are atoms with less than four electron regions that are attached to more electronegative atoms. Positive formal charge increases their strength. Hydrogens attached to oxygens or to nitrogens with positive formal charge are acidic. Carbon only has three bonds if it has positive formal charge.

15. Identify the Lewis base sites in the following molecules:



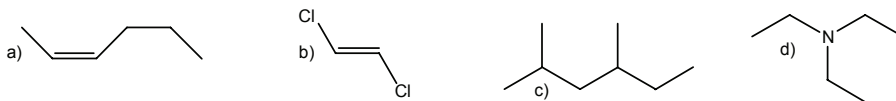
Lone pairs and pi electrons are Lewis base sites. Oxygen and nitrogen obey the octet rule, but lone pairs are frequently omitted when drawing skeletal structures.

17. Name the following compounds (see text for skeletal structures):

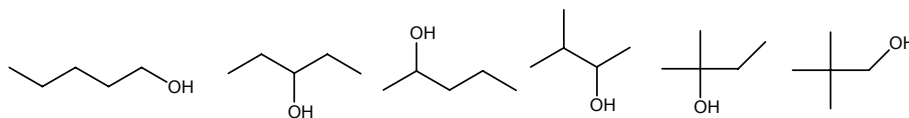
- a) cis-2-pentene b) 2-pentanol c) propanoic acid

19. Draw skeletal structures for the following:

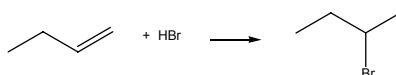
- a) cis-2-hexene b) trans-1,2-dichloroethene c) 2,4-dimethylhexane d) triethylamine



21. Use skeletal structures to show six constitutional isomers of $\text{C}_5\text{H}_{12}\text{O}$ that are alcohols.



23. Predict the product of the reaction in the text

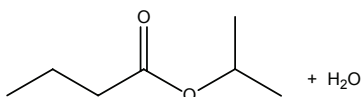


HBr adds across the double bond (hydrohalogenation). The H atom goes to the carbon with the most H atoms.

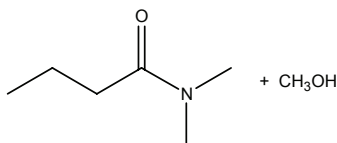
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25. Draw the skeletal structures of the products of the following reactions:

a) The reaction of a carboxylic acid and an alcohol is called esterification (see text for reactants).



b) The reaction of an ester and amine yields an amide (see text for reactants).



27. Define *polymer*. Why is nylon 66 called a *condensation polymer*?

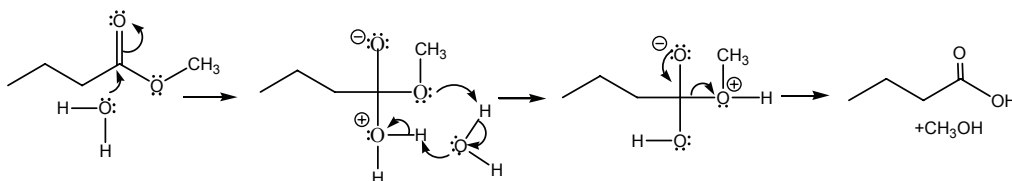
Polymers are large molecules formed by covalent bonding between many monomer units.

Nylon 66 is condensation polymer because the polymerization reaction produces another product (CH_3OH).

29. Name five common polymers and describe their uses.

See Table 13.1

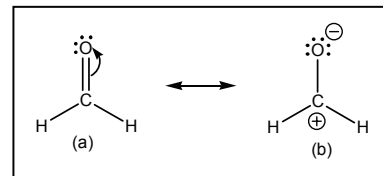
31. An important reaction of esters is the reverse of the esterification reaction shown in Figure 13.26. In this reaction, an ester reacts with water to produce a carboxylic acid and an alcohol. Write a step-wise mechanism for the reaction shown in the margin.



33. Hydrogen chloride can add to formaldehyde (H_2CO).

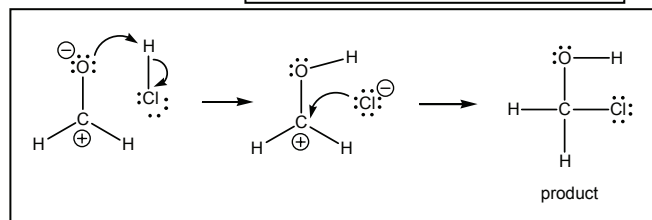
a) Draw the Lewis structure of formaldehyde.

b) Draw the resonance form of formaldehyde that accounts for its reactivity.



c) Use arrows to suggest how the HCl might attack formaldehyde.

d) Draw the Lewis structure of the reaction product.



35. The double helix of DNA is held together by interactions between base pairs. Draw the base pairs and explain why they are “pairs”.

See Figure 13.39 of the text. They are pairs because of the perfect match of the hydrogen-bonding sites.

37. Identify each of the following pairs of molecules (see text) as constitutional isomers, stereoisomers, or identical:

- | | |
|--|---|
| a) constitutional – different arrangements of CH_3 groups | b) constitutional – very different connectivities |
| c) stereoisomers – enantiomers (mirror images). | d) stereoisomers - enantiomers |
| e) identical – both are 1-butene | d) Geometric. CH_3 groups can be cis or trans. |

39. Indicate whether or not each of the following molecules has a stereoisomer? For those that do, indicate whether the isomer is a geometrical isomer or an enantiomer.

- | | |
|---|--|
| a) Geometric. Cl and OH can be cis or trans | b) Enantiomer. Central carbon atoms are stereocenters. |
| c) No. Cl is always cis and trans to a CH_3 group. | d) Enantiomer. Carbon with only one H is a stereocenter. |