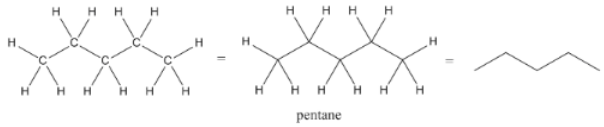
4.8: Line Drawings

Line drawings

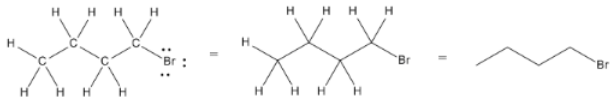
Lewis structures can tell us a lot about how atoms come together to make molecules. They can also be cumbersome, especially if we are dealing with very large molecules. Drawing a line instead of a pair of dots for bonding pairs of electrons makes it easier to draw structures. There are other abbreviations that are helpful in some situations.

Because organic chemistry is based on the compounds of carbon, we would have to draw the letter C over and over again unless we had a shortcut. In line structures, we drop the label "C" for the carbon atoms. Anytime there is a joint between two bonds (drawn as a vertex in a zig-zag line), the atom attached to that bond is assumed to be a carbon unless written otherwise.



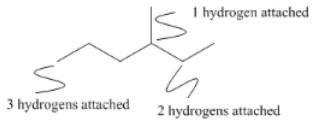
pentane

The atom at the end of a zig-zag line would also be a carbon, unless it is explicitly written as another atom.



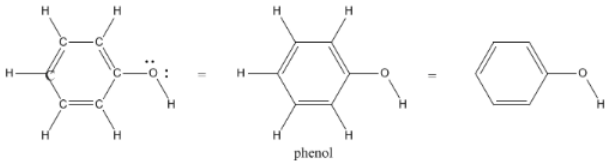
1-bromobutane

Taken even further, we will omit the hydrogens from our structures, since the compounds of carbon almost always contain hydrogen as well. Since we know carbon has a valence of four, we always know how many hydrogen atoms are attached to each carbon in order to reach that valence. A carbon with two bonds drawn in must have two hydrogens on it. A carbon with only one bond drawn to it must have three hydrogens.



Breakdown of a skeletal structure. Three hydrogens are attached to a terminal carbon. Two hydrogens are attached to a carbon surrounded by two other carbons. One hydrogen is attached to a carbon with bonds to three other carbons.

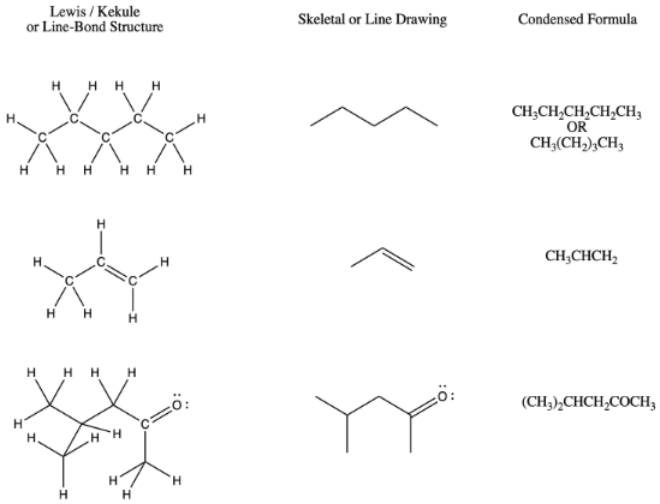
Note that the hydrogens are not normally omitted if they are attached to heteroatoms (atoms other than carbon, such as oxygen or nitrogen).



phenol

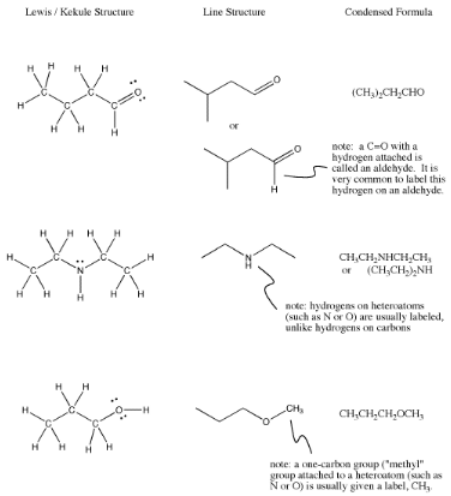
You will also note that lone pairs are frequently left out when we use line structures, so you will have to add them back in to think about Lewis structures. Adding the lone pairs back to the heteroatoms in line structures is a good habit to get into, because later in the course we will be very concerned with keeping track of where all the electrons are.

Below is a summary, showing the relationship between Lewis/Kekule structures, line structures and condensed formulae for a few different compounds.



Lewis structures, skeletal structures, and condensed formulas for pentane, propene, and 4-methyl-2-pentanone.

Remember, in phenol, the hydrogen attached to oxygen was labeled in the line structure. Sometimes there are exceptions in line structures, in which atoms that you might not think about labeling usually do get labels. The most common exceptions are shown below.



Lewis structures, line structures, and condensed formulas of 3-methylbutanal, diethyl amine, and 1-methoxypropane.

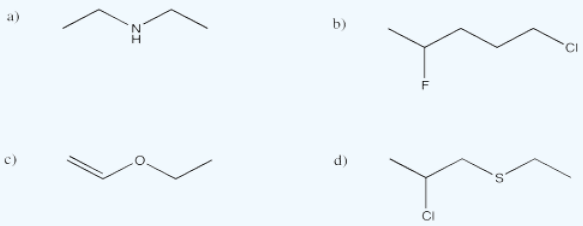
? Exercise 4.8.1

Translate the following condensed formulae into line drawings.

a) $CH_3CH_2NHCH_2CH_3$ b) $CH_3CHFCH_2CH_2CH_2Cl$

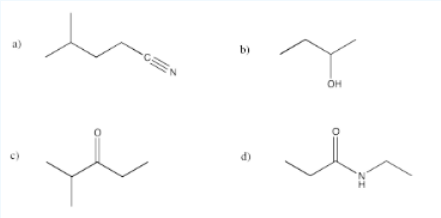
c) $CH_2CHOCH_2CH_3$ d) $CH_3CHClCH_2SCH_2CH_3$

Answer



Exercise 4.8.2

Translate the following structures into condensed formula.



Answer a

Answer b

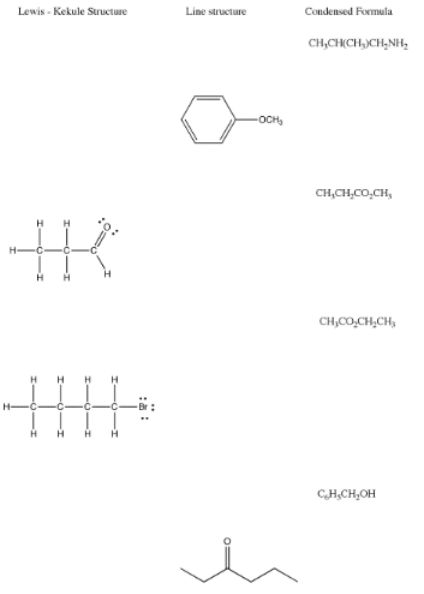
Answer c

Answer d

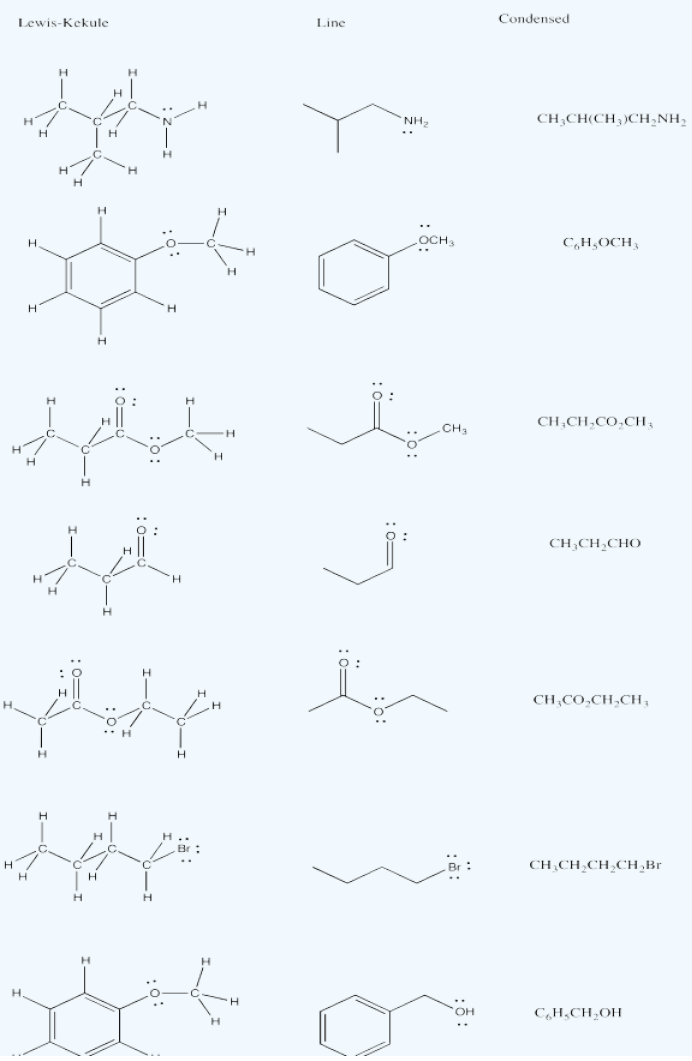
Answer a(CH3)2CHCH2CH2CNAnswer bCH3CH2CH(OH)CH3Answer c(CH3)2CHCOCH2CH3Answer dCH3CH2CONHCH2CH3

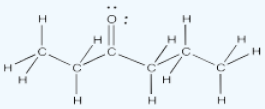
Exercise 4.8.3

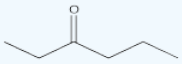
Try filling in the missing line drawing, Lewis / Kekule structures or condensed formulae in each line of the table below.


Lewis - Kekule Structure
Line structure
Condensed Formula
CH3CH(CH3)CH2NH2
OCH3
CH3CH2CO2CH3
CH3CO2CH2CH3
Br
C6H5CH2OH
O

Answer


Lewis-Kekule
Line
Condensed
CH3CH(CH3)CH2NH2
C6H5OCH3
CH3CH2CO2CH3
CH3CH2CHO
CH3CO2CH2CH3
CH3CH2CH2CH2Br
C6H5CH2OH



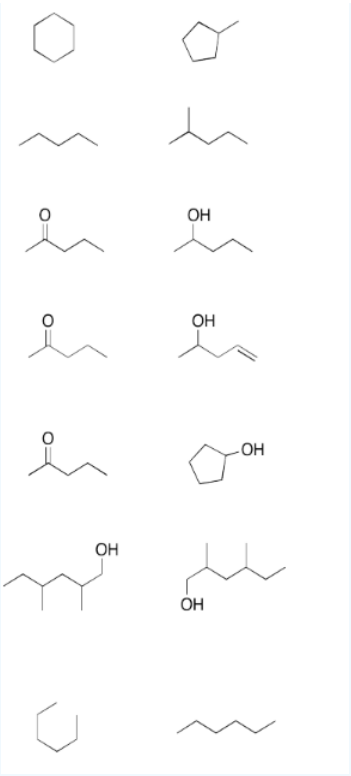


$CH_3CH_2COCH_2CH_2CH_3$

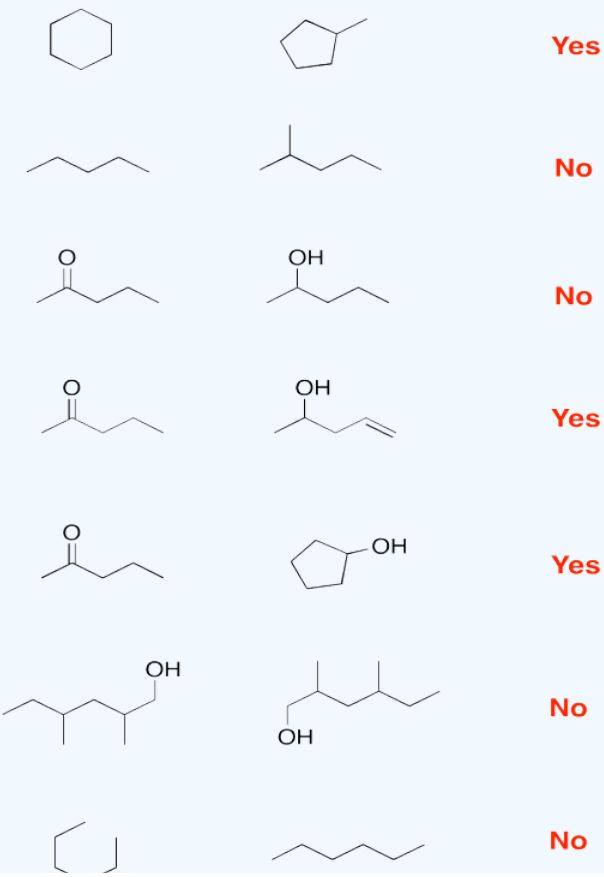
Answer

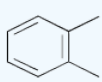
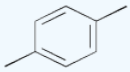
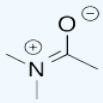
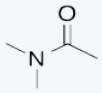
Exercise 4.8.4

Look at the following pairs of compounds. Are the compounds constitutional isomers? (Hint: You may need to add in all hydrogens)



Answer





Yes


No

Answer