Workshop #1

Structure

1. As we will soon learn, under certain reaction conditions it is possible to react hydrocarbons to give all possible monochloro derivatives as products, i.e. where one C-H bond is replaced by a C-Cl bond. The following isomers with the formula C_5H_{12} were reacted under these conditions to produce products with the formula $C_5H_{11}Cl$. Using various physical methods such as fractional distillation or gas chromatography (GC) it is possible to separate all of the possible $C_5H_{11}Cl$ isomers derived from each C_5H_{12} isomer. Draw Kekulé structures (i.e. use lines for electron pair bonds) for each C_5H_{12} isomer with the following properties.

   a. A C_5H_{12} isomer that gives three $C_5H_{11}Cl$ derivatives.

   b. A C_5H_{12} isomer that gives four $C_5H_{11}Cl$ derivatives.

   c. A C_5H_{12} isomer that gives only one $C_5H_{11}Cl$ derivative.

   d. Do any other C_5H_{12} isomers exist and, if so, how many $C_5H_{11}Cl$ derivatives can be formed from each of them?

   e. Based on your answer to (c), can you think of a C_8H_{18} hydrocarbon that can give only one possible $C_8H_{17}Cl$ derivative? Draw the structure of this hydrocarbon and its monochloro derivative.

2. An experimental technique called ^{13}C Nuclear Magnetic Resonance (NMR) Spectroscopy allows chemists to tell how many different kinds of carbons there are in a molecule and whether the carbons are primary (1°, $-CH_3$), secondary (2°, $-CH_2-$), tertiary (3°, $-CH-$), or quaternary (4°, C with no H's directly attached). Draw Kekulé structures for C_6H_{12} compounds that have the following kinds of carbon atoms. Also, identify the carbon atoms on each structure as either 1°, 2°, 3°, or 4° and decide which, if any, of the carbon atoms are geometrically equivalent to each other.

   a. C_6H_{12} isomer(s) having only single bonds and only secondary carbons.

   b. C_6H_{12} isomer(s) having only single bonds, and primary, secondary, and tertiary carbons.

   c. C_6H_{12} isomer(s) having only single bonds, and only primary, secondary, and quaternary carbons.

   d. C_6H_{12} isomer(s) having only single bonds, and primary, secondary, tertiary, and quaternary carbons.

3. Three dicarboxylic acids, **A**, **B**, and **C**, all share the formula $C_2H_2(CO_2H)_2$. They are all catalytically hydrogenated (add H_2 in the presence of a catalyst) to give dicarboxylic acids with the formula $C_2H_4(CO_2H)_2$. Hydrogenation of both **A** and **B** gives the same dicarboxylic acid **D**. Compound **C** hydrogenates to form compound **E**. Propose structures for compounds **A**-**E**. **Explain your reasoning.**

OBSERVATIONS **DEDUCTIONS**