Section 1: Structure and Bonding in Alkanes

Basics of Structure and Bonding

Typical Exam Type Problems and their Answers

(1) For each of the following molecules, draw the Lewis structure, predict all of the bond angles, predict any medium or short bond lengths, and then give the hybridizations around the atoms with stars (*).

\[
\begin{align*}
&H \\
&H C C C N^* \\
&F \\
&--- --- --- --- --- --- \\
&H H \\
&O C C C O C C F^* \\
&H
\end{align*}
\]
(2) For following molecular formulae, draw three (3) of the structural isomers. Be sure that you show all atoms and bonds for each structural isomer.

\[ \text{C}_6\text{H}_{12} \]

\[ \text{C}_6\text{H}_9 \]
\( \text{C}_4\text{O}_9\text{H}_{10} \)

\( \text{C}_4\text{O}_2\text{H}_8 \)
\[ C_5N\text{H}_{13} \]

\[ C_4\text{NH}_5 \]
C₆H₆

C₅H₁₀
(3) For the following molecules, circle each non-Alkane functional group and name it.
(4) Draw three different molecules having each of the following functional groups (show all atoms).

Alkane

Alkene
Alkyne

Arene
(5) For each of the following structures or names, give an IUPAC name or draw the correct structure (including all atoms), as required.

3-methylpentane

\[
\text{CH}_3 - \text{CH}_2 - \overset{1}{\text{CH}_2} - \overset{2}{\text{CH}_2} - \overset{3}{\text{CH}_3}
\]

4-ethylnonane
cyclopentane
4-n-propyl octane

iso propyl cyclo butane

2,3,3,4-tetra methyl heptane
(6) For each of the following reactions, fill in the correct product (clearly indicating all atoms around the reacting centers) or give the reagent required to carry out the reaction.

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_3 & \xrightarrow{\text{O}_2} \_ \_ \\
\text{CH}_4 & \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \\
\text{butane} & \xrightarrow{\text{O}_2} \_ \_ \\
\end{align*}
\]
Section 1: Structure and Bonding in Alkanes

Basics of Structure and Bonding

Typical Exam Type Problems and their Answers

(1) For each of the following molecules, draw the Lewis structure, predict all of the bond angles, predict any medium or short bond lengths, and then give the hybridizations around the atoms with stars (*).

![Lewis structure 1](image1)

![Lewis structure 2](image2)
Actually, the rectangle imposes angles of 290° on the three C's and the O.
The image contains multiple chemical structures with angles and bond types indicated. Here is a textual representation of the structures:

1. \( \text{Se}^+ \text{C} = \text{O} \) with bond angles of 120°.
2. \( \text{C} - \text{C}^* \) with bond angles of 109.5°.
3. \( \text{N} \equiv \text{C} - \text{C}^* \equiv \text{C} - \text{O} \) with bond angles of 120°.
4. \( \text{F} \) bonded to the structure.

The image also contains a note: "Actually: Aromatic as all C-C bonds in ring equivalent."
Actually:
the geometry of
the square
implies 90°
there.

Actually:
the geometry
of the triangle
implies 180°
there.
(2) For following molecular formulae, draw three (3) of the structural isomers. Be sure that you show all atoms and bonds for each structural isomer.

\[ \text{C}_6 \text{H}_{12} \]

\[ \text{C}_6 \text{H}_4 \]

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(3) For the following molecules, circle each non-Alkane functional group and name it.

- Alcohol (actually a phenol)
- Amine
- Alkyne
- Amide
- Ester
- Carboxylic acid
(4) Draw three different molecules having each of the following functional groups (show all atoms).

**Alkane**

![Alkane structures](image)

**Alkene**

![Alkene structures](image)
Alkyne

\[ \text{Alkyne} \quad H - C = C - \text{H} \]

\[ \text{H} - \text{C} = \text{C} - \text{H} \]

\[ \text{H} - \text{C} = \text{C} - \text{C} = \text{C} - \text{H} \]

Arene

\[ \text{Arene} \]

\[ \text{etc etc etc} \]
(5) For each of the following structures or names, give an IUPAC name or draw the correct structure (including all atoms), as required.

3-methylpentane

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \\
\end{align*}
\]

3,3-dimethylhexane

4-ethylnonane

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \\
\end{align*}
\]
cyclopentane

\[
\begin{align*}
&CH_2-CH_2 \\
&CH_3-CH_3
\end{align*}
\]

1,1-dimethylcyclobutane

\[
\begin{align*}
&CH_3-CH_2-CH-CH_3-CH_3 \\
&CH_3-CH_3
\end{align*}
\]

3-isopropylpentane
4-n-propyl octane

iso propyl cyclo butane

2,3,3,4-tetra methyl heptane
3,3-diethyl-2,4,4-trifluorohexane

1,1,2,2,3,3-hexachlorocyclopropane

2-Bromo-3-chloropentane
(6) For each of the following reactions, fill in the correct product (clearly indicating all atoms around the reacting centers) or give the reagent required to carry out the reaction.

$$\text{CH}_3\text{CH}_2\text{CH}_3 + O_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$$

$$\text{CH}_4 + \frac{1}{2}O_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$$

$$\text{butane} + O_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$$