A number known as degree of unsaturation or index of hydrogen deficiency can be defined for any organic molecule. (In this writing, the symbol \( x \) is used to denote degree of unsaturation.)

\[
x = \# \text{ rings} + \# \text{ double bonds} + 2\# \text{ triple bonds}
\]

(If the molecule is resonance stabilized, this formula applies to the major resonance form.)

If the structural formula of a compound is not known, but the molecular formula is, the degree of unsaturation of the compound can be calculated using the following general formula.

\[
C_nH_m
\]

\[
n = \# \text{ carbon atoms in the molecule}
\]

\[
m = 2n + 2 + \# \text{ nitrogen atoms} + \# \text{ phosphorus atoms} - \# \text{ halogen atoms}
\]

\[
x = \frac{m - \# \text{ hydrogen atoms in the molecule}}{2}
\]

(This method is limited to organic compounds containing carbon, hydrogen, oxygen, sulfur, nitrogen, phosphorus, and halogens, which are the most common elements in naturally occurring organic compounds.)
eg. 1:

\[
\text{M. F. } \quad \text{C}_6\text{H}_{10}\text{O}
\]

\[
\text{C}_n\text{H}_m = \text{C}_6\text{H}_{2(6)} + 2 = \text{C}_6\text{H}_{14}
\]

\[
x = \frac{14 - 10}{2} = 2
\]

eg. 2:

\[
\text{M. F. } \quad \text{C}_6\text{H}_6
\]

\[
\text{C}_n\text{H}_m = \text{C}_6\text{H}_{2(6)} + 2 = \text{C}_6\text{H}_{14}
\]

\[
x = \frac{14 - 6}{2} = 4
\]

eg. 3:

\[
\text{CH}_3\quad \text{C} = \text{N}
\]

\[
\text{M. F. } \quad \text{C}_2\text{H}_3\text{N}
\]

\[
\text{C}_n\text{H}_m = \text{C}_2\text{H}_{2(2)} + 2 + 1 = \text{C}_3\text{H}_7
\]

\[
x = \frac{7 - 3}{2} = 2
\]

eg. 4:
\[ \text{M. F. } \text{CH}_3\text{Br} \]
\[ C_nH_m = C_1H_{n(1)} + 2 \_ 1 = \text{CH}_3 \]
\[ x = \frac{3 - 3}{2} = 0 \]

**eg. 5:**

\[ \begin{array}{c}
\text{S} \\
\text{CH}_3 \\
\text{C} \\
\text{CH}_3 \\
\end{array} \]

\[ \text{M. F. } \text{C}_3\text{H}_8\text{S} \]
\[ C_nH_m = C_3H_{2(3)} + 2 = \text{C}_3\text{H}_8 \]
\[ x = \frac{8 - 6}{2} = 1 \]

**eg. 6:**

\[ \begin{array}{c}
\text{CH}_3 \\
\text{P} \\
\text{CH}_3 \\
\text{CH}_3 \\
\end{array} \]

\[ \text{M. F. } \text{C}_3\text{H}_9\text{P} \]
\[ C_nH_m = C_3H_{2(3)} + 2 + 1 = \text{C}_3\text{H}_9 \]
\[ x = \frac{9 - 9}{2} = 0 \]

**eg. 7:**
M. F. $\text{C}_2\text{H}_6\text{SO}$

$C_nH_m = C_2H_{2(2)} + 2 = C_2H_6$

$x = \frac{6 - 6}{2} = 0$

eg. 8:

M. F. $\text{C}_{18}\text{H}_{15}\text{OP}$

$C_nH_m = C_{18}H_{2(18)} + 2 + 1 = C_{18}H_{39}$

$x = \frac{39 - 15}{2} = 12$

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**Contributors**

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