The (n+1) Rule, an empirical rule used to predict the multiplicity and, in conjunction with Pascal's triangle, splitting pattern of peaks in $^1$H and $^{13}$C NMR spectra, states that if a given nucleus is coupled (see spin coupling) to n number of nuclei that are equivalent (see equivalent ligands), the multiplicity of the peak is n+1.

eg. 1:

![Diagram of molecule 1]

The three hydrogen nuclei in 1, H$_a$, H$_b$, and H$_c$, are equivalent. Thus, $^1$H NMR spectrum of 1 has only one peak. H$_a$, H$_b$, and H$_c$ are coupled to no hydrogen nuclei. Thus, for H$_a$, H$_b$, and H$_c$, n=0; (n+1) = (0+1) = 1. The multiplicity of the peak of H$_a$, H$_b$, and H$_c$ is one. The peak has one line; it is a singlet.

eg. 2:

![Diagram of molecule 2]

There are two sets of equivalent hydrogen nuclei in 2:

Set 1: H$_a$
Set 2: H$_b$, H$_c$

Thus, the $^1$H NMR spectrum of 2 has two peaks, one due to H$_a$ and the other to H$_b$ and H$_c$.

The peak of H$_a$: There are two vicinal hydrogens to H$_a$: H$_b$ and H$_c$. H$_b$ and H$_c$ are equivalent to each other but not to H$_a$. Thus, for H$_a$, n=2; (n+1) = (2+1) = 3. The multiplicity of the peak of H$_a$ is three. The peak has three lines; from the Pascal's triangle, it is a triplet.

The peak of H$_b$ and H$_c$: There is only one vicinal hydrogen to H$_b$ and H$_c$: H$_a$. H$_a$ is not equivalent to H$_b$ and H$_c$. Thus, for H$_b$ and H$_c$, n=1; (n+1) = (1+1) = 2. The multiplicity of the peak of H$_b$ and H$_c$ is two. The peak has two lines, from the Pascal's triangle, it is a doublet.
To determine the multiplicity of a peak of a nucleus coupled to more than one set of equivalent nuclei, apply the (n+1) Rule independently to each other.

eg:

There are three set of equivalent hydrogen nuclei in 3:

Set 1: $H_a$
Set 2: $H_b$
Set 3: $H_c$

<table>
<thead>
<tr>
<th></th>
<th>$H_a$</th>
<th>$H_b$</th>
<th>$H_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_a$</td>
<td>geminal; coupling occurs</td>
<td></td>
<td>vicinal; coupling occurs</td>
</tr>
<tr>
<td>$H_b$</td>
<td>geminal; coupling occurs</td>
<td>vicinal; coupling occurs</td>
<td></td>
</tr>
<tr>
<td>$H_c$</td>
<td>vicinal; coupling occurs</td>
<td>vicinal; coupling occurs</td>
<td></td>
</tr>
</tbody>
</table>

peak of $H_a$:

$\text{multiplicity of the peak of } H_a = 2 \times 2 = 4$. To determine the splitting pattern of the peak of $H_a$, use the Pascal’s triangle, based on the observation that, for alkenyl hydrogens, $J_{cis} > J_{gem}$.
The peak of $H_a$ is a doublet of a doublet.

peak of $H_b$:

The multiplicity of the peak of $H_b = 2 \times 2 = 4$. To determine the splitting pattern of the peak of $H_b$, use the Pascal's triangle, based on the observation that, for alkenyl hydrogens, $J_{\text{trans}} > J_{\text{gem}}$.

The peak of $H_b$ is a doublet of a doublet.

peak of $H_c$: 
The peak of \( H_C \) is a doublet of a doublet.

**Contributors**

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