BRAILLE CODE FOR CHEMICAL NOTATION
1997

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Example 2.5-4: (spatial structure requiring a runover locator)
2.6 Spatial Material. Structures occupying more than one print line and having a vertical relationship are spatial arrangements. In braille, spatial material must be preceded and followed by a blank line.

*Embedded.* When spatial expressions are embedded in narrative text, the portions of narrative text which occur on the same braille line as the spatial structure must be aligned with the main line of the structure.

*Displayed.* In displayed spatial expressions, the leftmost symbol must begin two cells to the right of the current margin. EXCEPTION: It is permissible to start a structure that occupies much space both horizontally and vertically (e.g., a ring structure or a spatial structure of a very large molecule), in cell 1 in order to avoid a runover. (See Example 4.4.3-21.) This exception should be used sparingly.

*Identified.* When a spatial structure or expression is identified by a number or letter (as in an example or set of exercises), the identifier must be placed at the top line of the structure in braille. One column of blank cells must be left between the identifier and the left-most symbol of the structure. If by placing the identifier on a separate line it is possible to get the complete structure across the page, this may be done. In this case, a blank line must be left between the identifier and the spatial structure.

*Chemical Equations.* When a chemical equation consists of a spatial element and a linear element separated by a sign of operation (usually a plus sign), the linear element, along with the sign of operation, must be placed so that it is not in direct contact with any branch of the spatial structure either vertically or diagonally. A clear blank cell must be left between the beginning (or end) of the linear element and a vertical or diagonal branch of the spatial structure to prevent direct contact. (See Example 4.2.3-4.) Moreover, a diagonal portion of the spatial structure may not "overlap" the linear element either above or below even if this could be done without making direct contact. However, no clear blank cell is necessary if the placement of the linear portion does not make direct vertical or diagonal contact with a branch of the spatial structure. (See Examples 4.2.5-2, 4.8-2.)

A linear element may be placed adjacent to a ring structure or to a horizontal portion of a spatial structure if that is the print format and if the linear portion can be brailled so that no part of it is in direct contact with a vertical or diagonal branch of the spatial structure. (See Example 4.2.6-3.)

If it is necessary to place a linear portion of an equation so far distant from the main line of a spatial structure that it is difficult to locate, the enlarged transcriber's grouping symbols may be used and the linear material top-adjusted to the grouping symbols. (See Example 2.6-4.)
Example 2.6-1: (embedded spatial expression)

not contribute equally. The hybrid is estimated to be 10 percent
\( ^+:C:O:\cdot^- \), 20 percent each \( :C:O^+ \) and \( :C:O^- \), and 50 percent
\( :C:O:^+ \). The electronegativity difference is discussed in the

Example 2.6-2: (displayed spatial expression)

That for an atom of chlorine is
\[
\cdot\text{Cl}: \\
\]

When these atoms react, sodium atoms become sodium ions. The electron-dot symbol for a sodium ion is

\( \text{Na}^+ \)

The chlorine atoms become chloride ions, which have the electron-dot symbol

\( :\text{Cl}:- \)

These ions form the compound sodium chloride. The electron-dot formula for sodium chloride may be written as

\( \text{Na}^+ :\text{Cl}:- \)

or as a simpler ionic formula, \( \text{Na}^+\text{Cl}^- \).
BRAILLE CODE FOR CHEMICAL NOTATION

1. \texttt{it \# an atom \# reacts \#}
2. \texttt{y}
3. \texttt{\textbackslash \textbackslash}
4. \texttt{\textbackslash \textbackslash}
5. \texttt{\textbackslash \textbackslash}
6. \texttt{\textbackslash \textbackslash}
7. \texttt{\textbackslash \textbackslash}
8. \texttt{\textbackslash \textbackslash}
9. \texttt{\textbackslash \textbackslash}
10. \texttt{\textbackslash \textbackslash}
11. \texttt{\textbackslash \textbackslash}
12. \texttt{\textbackslash \textbackslash}
13. \texttt{\textbackslash \textbackslash}
14. \texttt{\textbackslash \textbackslash}
15. \texttt{\textbackslash \textbackslash}
16. \texttt{\textbackslash \textbackslash}
17. \texttt{\textbackslash \textbackslash}
18. \texttt{\textbackslash \textbackslash}
19. \texttt{\textbackslash \textbackslash}
20. \texttt{\textbackslash \textbackslash}
21. \texttt{\textbackslash \textbackslash}
22. \texttt{\textbackslash \textbackslash}
23. \texttt{\textbackslash \textbackslash}
24. \texttt{\textbackslash \textbackslash}
25. \texttt{\textbackslash \textbackslash}

NEW PAGE
Section 2.6 (cont.)

Example 2.6-3: (linear adjacent to spatial)

\[
\begin{align*}
\text{HO}^- + & \quad \text{CH}_3 \\
& \quad \text{C} - \text{I} \rightarrow \text{O} \cdots \text{C} \cdots \text{I} \rightarrow \quad \text{CH}_3 + \text{I}^-
\end{align*}
\]

Example 2.6-4: (requires transcriber’s grouping symbols; what appears as a bold dot is a normal electron dot in this text)
2.7 Cancellation. Material containing cancellation with no replacement symbols may be transcribed linearly. (Nemeth Code Rule XI requiring spatial arrangement does not apply in this situation.) (See Example 9.5-6.)
3 CHEMICAL SIGNS AND SYMBOLS

3.1 Chemical Arrows. The braille representation of arrows listed below must be used in place of the ones listed in the Nemeth Code. All other arrows must be transcribed as required by the Nemeth Code.

Up-pointing
  Regular \( \uparrow \)
  Boldface \( \uparrow \)

Down-pointing
  Regular \( \downarrow \)
  Boldface \( \downarrow \)

Bold up-pointing followed by regular down-pointing \( \uparrow \downarrow \)

Regular up-pointing followed by bold down-pointing \( \uparrow \downarrow \)

Regular up-pointing followed by regular down-pointing \( \uparrow \downarrow \)

Vertical or oblique dipole
  Up-pointing \( \uparrow \) or \( \uparrow \)
  Down-pointing \( \downarrow \) or \( \downarrow \)

Half-barb up-pointing followed by half-barb down-pointing \( \uparrow \downarrow \)
Horizontal

Dipole, right-pointing  \(+\rightarrow\) or \(\rightarrow\)  \(\begin{array}{c}
+\\\\\hline
\end{array}\)

Dipole, left-pointing  \(\leftarrow\) or \(\leftarrow\)  \(\begin{array}{c}
-\\\\\hline
\end{array}\)

Crossed arrow  \(\leftrightarrow\)  \(\begin{array}{c}
\times\\\\\hline
\end{array}\)

3.2 Bonds

3.2.1 Electron Dots

Single regular  \(\cdot\)  \(\begin{array}{c}
.\\\\\hline
\end{array}\)

Single bold or hollow  \(\cdot\circ\)  \(\begin{array}{c}
.\\\\\hline
\end{array}\)

Small x  \(\times\)  \(\begin{array}{c}
\times\\\\\hline
\end{array}\)

Pair, regular  \(,:\)  \(\begin{array}{c}
:\\\\\\hline
\end{array}\)

Pair, hollow or bold  \(\cdot\cdot\)  \(\begin{array}{c}
.\\\\\hline
\end{array}\)

Pair, x’s  \(\cdot\cdot\times\)  \(\begin{array}{c}
::\\\\\hline
\end{array}\)

Pair, right or upper bold or hollow, left or lower regular  \(\cdot\circ\)  \(\begin{array}{c}
.\\\\\hline
\end{array}\)

Pair, right or upper x, left or lower regular  \(\cdot\times\)  \(\begin{array}{c}
.\\\\\hline
\end{array}\)

Pair, right or upper regular, left or lower bold or hollow  \(\cdot\circ\)  \(\begin{array}{c}
.\\\\\hline
\end{array}\)
Section 3.2.1

Pair, right or upper regular, left or lower x
\[ \star \quad \cdot \quad \vdash \]

Pair, right or upper bold or hollow, left or lower x
\[ \star \quad \cdot \quad \vdash \]

Pair, right or upper x, left or lower bold or hollow
\[ \cdot \quad \star \quad \vdash \]

Triplet (three pairs of regular electron dots)
\[ \vdash \text{ or } \vdash \]

Other triplets
Insert dots 46 before a pair shown horizontally in the list above to indicate that the arrangement is a triplet. For example:
\[ \vdash \]
3.2.2 Horizontal (including indicators)

<table>
<thead>
<tr>
<th>Bond Type</th>
<th>Braille Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>—</td>
</tr>
<tr>
<td>Double</td>
<td>=</td>
</tr>
<tr>
<td>Triple</td>
<td>==</td>
</tr>
<tr>
<td>Arrow, right-pointing</td>
<td>→</td>
</tr>
<tr>
<td>Arrow, left-pointing</td>
<td>←</td>
</tr>
<tr>
<td>Barred</td>
<td>........</td>
</tr>
<tr>
<td>Bold</td>
<td>——</td>
</tr>
<tr>
<td>Broken</td>
<td>—— ——</td>
</tr>
<tr>
<td>Dotted</td>
<td>————</td>
</tr>
<tr>
<td>Jagged, single</td>
<td>／ ／ ／ ／ ／</td>
</tr>
<tr>
<td>Jagged, double</td>
<td>／ ／ ／ ／ ／</td>
</tr>
<tr>
<td>Wavy, single</td>
<td>－ － －</td>
</tr>
<tr>
<td>Wavy, double</td>
<td>≃ ≃</td>
</tr>
</tbody>
</table>
Example 4.2.6-4: (oblique arrow bonds within spatial structure)
4.3 Electron Dot Bonds. Although all electron dots have the same chemical meaning, writers of textbooks use different types of dot notation to illustrate a point, trace transferred or shared electrons, denote free electrons, etc. In braille, these differences must be maintained. If what appears to be a bold dot is used and a smaller dot is not used elsewhere in the text, the bold dot must be transcribed as a regular electron dot (dots 16). Other types are transcribed according to the list in Section 3.2 of this Code.

When colored dots are used in print for distinction, choose one of the dot configurations not used elsewhere in the text to represent these colored dots. If this occurs in only one place, a transcriber’s note must be used to show the meaning of the configuration chosen. If the technique is used throughout the text, this use, including the color of the print dot, must be noted on the Special Symbols page.

4.3.1 Placement of Electron Dots. Electron dots must be placed above, below, to the right, to the left or on the diagonal as they appear in print. At times a single dot which appears above, below, to the right or left of the element may not be centered in print, but in braille this displacement is to be ignored unless it is on the diagonal. (See Examples 4.3.1-3, 4.3.1-4, and 4.3.1-5.)

When dots appear on the diagonal to the element in print, the symbol must be located to the right or left of the SYMBOL in braille on the line immediately above/below in the first cell preceding or following the SYMBOL to which it applies. When a pair of electron dots appears on the diagonal to the element, the left-most dot of the pair is considered the "left" dot in selecting the correct symbol to use (from the list in Section 3.2.1). If there are two sets of dots on the diagonal in print, they should be placed one directly under the other, on the diagonal to the SYMBOL. However, they may be placed diagonally to each other when it is necessary to avoid confusion with other notation in the structure. (See Example 4.3.1-11.)

Example 4.3.1-1: (all dots, single or double, identical in size and shape)
Example 4.3.1-2: (different types of dots)

\[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{O} \\
\text{C} \\
\text{H} \\
\text{H} \\
\end{array}
\]

Example 4.3.1-3: (single dots, centered in print)

\[
\begin{array}{c}
\text{O} \\
\end{array}
\]

Example 4.3.1-4: (single dots not centered on the SYMBOL in print)

\[
\begin{array}{c}
\text{O} \\
\end{array}
\]

Example 4.3.1-5: (single dot appears to be in subscript position in print)

\[
\begin{array}{c}
\text{O} \\
\text{H} \\
\end{array}
\]

Example 4.3.1-6: (triplets)

N::N or H:C::C:H
Example 4.3.1-7: (structure enclosed in grouping signs with superscript)

Example 4.3.1-8: (dots in ring structure)
Example 4.3.1-9: (dots combined with other notation [delta - partial charge])

\[ \delta^+ \text{H} \cdot \text{O} \cdot \delta^- \]

Example 4.3.1-10: (dots combined with superscript)

\[ \text{Mg}^+ + 2 \cdot \text{Br}^- \rightarrow \text{Mg}^{2+} + 2 \cdot \text{Br}^- \]

Example 4.3.1-11: (diagonal dots)

Example 4.3.1-12: (dots and letters in colored print)

F H
F : B : N : H
F H

..... A STRUCTURE WITHOUT DOT NO SCHEMATIC DOT MON : RED : BLUE PRINT........
Example 4.3.1-13: (dots combined with bonds)

\[ \hat{\text{O}} - \hat{\text{O}} - \hat{\text{O}} : \text{ or } \hat{\text{O}} = \text{C} = \hat{\text{O}} : \text{ or } \hat{\text{O}} = \text{C} = \hat{\text{O}} : \]

Example 4.3.1-14: (ion transfer)

4.3.2 Proportion. Sometimes print dots appear to be pairs of electron dots but are denoting proportion. Context will determine the meaning of these dots.

Example 4.3.2-1: (dots mean ratio, not electron dots)

Relative number of atoms: \[ \text{C} : \text{H} = 6.25 : 24.8 \]

Smallest ratio of atoms: \[ \frac{6.25}{6.25} : \frac{24.8}{6.25} = 1 : 4 \]

Empirical formula = \( \text{CH}_4 \)

\[ \text{RELATIVE NUMBER } \times \text{ ATOMS:} \]

\[ \text{SMALLEST RATIO } \times \text{ ATOMS:} \]

Empirical formula = \( \text{CH}_4 \)
Example 4.3.2-2: (dots mean ratio, not electron dots)

\[
\begin{align*}
Hg &: Na &: Al \\
0.0300 &: 0.0600 &: 0.0200 \\
3 &: 6 &: 2
\end{align*}
\]

4.4 Other Bonds. All of the following bonds may be extended to accommodate surrounding material. (See Examples 4.4.3-1, 4.4.3-6, and 4.4.3-19.)

4.4.1 Horizontal Bonds. Horizontal bonds are employed in both spatial and non-spatial structures and they are subject to Nemeth Code Rule XIX (Operation Signs). See Section 1.1 of this Code for construction of horizontal bonds. If numbers or other notation appear above and/or below some of the SYMBOLS or symbols, the arrangement is spatial. See Section 5.3 for placement of numbers and other notation.

Example 4.4.1-1: (horizontal bonds; no comparison sign; runovers required; displayed but not spatial)

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

Example 4.4.1-2: (horizontal bond; displayed; spatial because of electron dots over/under SYMBOL)

\[
\begin{align*}
Br - Br &= 2: Br
\end{align*}
\]
Example 4.4.1-3: (horizontal bonds; displayed; spatial because carbon atoms are numbered)

\[ CH_2 = CH - CH_2 - CH_3 \]

4.4.2 Vertical Bonds. Structures containing vertical or oblique bonds are always considered to be spatial arrangements and, in braille, require a blank line preceding and following the structure, whether embedded or displayed. As with horizontal bonds, the print type of bond must be duplicated in braille.

4.4.3 Format. A single vertical bond must be aligned with the first letter of the SYMBOL to which it applies. When bonds consisting of two or more cells apply to a single-letter SYMBOL, the first cell of the bond should be aligned with the capitalization indicator. If the SYMBOL consists of two or more letters, the first cell of a two-cell bond must be aligned with the first letter of the SYMBOL.

Oblique bonds are brailled to the right or left of the SYMBOL to which they apply, on a separate line below/above the SYMBOL as indicated by the print. Oblique bonds can be transcribed as oblique, vertical or horizontal if the print uses oblique bonds simply to accommodate the other notation present. Exception: In ring structures, the oblique bonds must be transcribed as in print to preserve the shape of the structure.

In cyclical or ring structures, some leeway is allowed in order to duplicate the print shape. However, the bonds must be arranged in such a way that the reader has no doubt as to which SYMBOL the bond applies.

When vertical bonds appear above or below unlabeled vertices, the bond should normally be aligned with the "outer" cell of the two-cell symbol. However, it may be aligned with the "inner" cell of the two-cell symbol in order to avoid confusion with other notation. (See Example 4.2.1-5.)

Displayed expressions should be indented two cells to the right of the margin but may start at the margin if by so doing the structure or an integral portion of the structure can be kept intact. It is crucial to avoid runovers within a ring.