

Unified English Braille

**Guidelines for
Technical Material**

2008 version updated August 2014

About this Document

This document has been produced by the Maths Focus Group, a subgroup of the UEB Rules Committee within the International Council on English Braille (ICEB). At the ICEB General Assembly in April 2008 it was agreed that the document should be released for use internationally, and that feedback should be gathered with a view to producing a new edition prior to the 2012 General Assembly.

The purpose of this document is to give transcribers enough information and examples to produce Maths, Science and Computer notation in Unified English Braille.

This document is available in the following file formats: pdf, doc, dxp or brf. These files can be sourced through the ICEB representatives on your local Braille Authorities.

Please send feedback on this document to ICEB, again through the Braille Authority in your own country.

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Guidelines for Technical Material

1 General Principles

1.1 Spacing

1.1.1 The layout of the print should be preserved as nearly as possible. However care should be taken in copying print spacing along a line as this is often simply a matter of printing style. Spacing should be used to reflect the structure of the mathematics. Spacing in print throughout a work is often inconsistent and it is not desirable in the braille transcription that this inconsistency should be preserved.

1.1.2 For each work, a decision must be made on the spacing of operation signs (such as plus and minus) and comparison signs (such as equals and less than). When presenting braille mathematics to younger children, include spaces before and after operation signs and before and after comparison signs. For older students who are tackling longer algebraic expressions there needs to be a balance between clarity and compactness. A good approach is to have the operation signs unspaced on both sides but still include a space before and after comparison signs. This is the approach used in most of the examples in this document.

1.1.3 There are also situations where it is preferable to unspace a comparison sign. One is when unspacing the sign would avoid dividing a complex expression between lines in a complicated mathematical argument. Another is when the comparison sign is not on the base line (for example sigma notation where i equals 1 is in a small font directly below).

1.1.4 When isolated calculations appear in a literary text, the print spacing can be followed.

1.2 Underlying rules for numbers and letters

Listed below is a summary of the rules for Grade 1 mode and Numeric mode as they apply to the brailleing of numbers and letters in mathematics. Refer to the complete versions of these rules for more detail.

1.2.1 Grade 1 mode

A braille symbol may have both a grade 1 meaning and a contraction (i.e. grade 2) meaning. Some symbols may also have a numeric meaning. A grade 1 indicator is used to set grade 1 mode when the grade 1 meaning of a symbol could be misread as a contraction meaning or a numeric meaning.

Note that if a single letter (excluding a, i and o) occurs in an algebraic expression, it can be misread as a contraction if it is "standing alone" so may need a grade 1 indicator. The same is true of a sequence of letters in braille that could represent a shortform, such as ab or ac, if it is "standing alone".

A letter, or unbroken sequence of letters is "standing alone" if the symbols before and after the letter or sequence are spaces, hyphens, dashes, or any combination, or if on both sides the only intervening symbols between the letter or sequence and the space, hyphen or dash are common literary punctuation or indicator symbols. See the General Rule for a full definition of "standing alone".

1.2.2 Numeric mode

Numeric mode is initiated by the "number sign" (dots 3456) followed by one of the ten digits, the comma or the decimal point.

The following symbols may occur in numeric mode: the ten digits; full stop; comma; the numeric space (dot 5 when immediately followed by a digit); simple numeric fraction line; and the line continuation indicator. A space or any symbol not listed here terminates numeric mode, for example the hyphen or the dash.

A numeric mode indicator also sets grade 1 mode. Grade 1 mode, when initiated by numeric mode, is terminated by a space, hyphen or dash. Therefore while grade 1 mode is in effect, a grade 1 indicator is not required except for any one of the lowercase letters a-j immediately following a digit, a full stop or a comma. (Note that Grade 1 mode, when initiated by numeric mode, is not terminated by the minus sign, ⠆⠈⠆.)

1.3 Print Symbols

One of the underlying design features of UEB is that each print symbol should have one and only one braille equivalent. For example the vertical bar is used in print to represent absolute value, conditional probability and the words "such that", to give just three examples. The same braille symbol should be used in all these cases, and any rules for the use of the symbol in braille are independent of the subject area. If a print symbol is not defined in UEB, it can be represented either using one of the seven transcriber defined print symbols in [Section 11](#), or by using the transcriber defined shape symbols in [Section 14](#).

1.4 Format

⠆⠆⠆ continuation indicator

1.4.1 In print, mathematical expressions are sometimes embedded in the text and sometimes set apart. When an expression is set apart, the braille format should indicate this by suitable indentation, for example cell 3 with overruns in 5 or cell 5 with overruns in 7. An embedded expression which does not fit on the current braille line should only be divided if there is an obvious dividing point. Often it is better to move the whole expression to the next braille line.

1.4.2 When dividing a mathematical expression, choice of a runover site should follow mathematical structure:

- before comparison signs
- before operation signs (unless they are within one of the mathematical units below)
- before a mathematical unit such as
 - fractions (and within the fraction consider the numerator and denominator as units)
 - functions
 - radicals
 - items with modifiers such as superscripts or bars
 - shapes or arrows
 - anything enclosed in print or braille grouping symbols
 - a number and its abbreviation or coordinates

Usually the best place to break is before a comparison sign or an operation sign. Breaking between braille pages should be avoided.

1.7 Use of Grade 1 indicators

	grade 1 symbol indicator
	grade 1 word indicator
	grade 1 passage indicator
	grade 1 passage terminator
	grade 1 passage indicator on a line of its own
	grade 1 passage terminator on a line of its own

1.7.1 Grade 1 indicators will not be needed for simple arithmetic problems involving numbers, operation signs, numerical fractions and mixed numbers.

Evaluate the following:

$$3 - 2\frac{1}{2} =$$

1.7.2 Simple algebraic equations which include letters but no fraction or superscript indicators may need grade 1 symbol indicators where letters stand alone or follow numbers. (See [Section 1.2](#) for the underlying rules and [Section 3.2](#) for more examples.)

$$y = x + 4c$$

1.7.3 More complex algebraic equations are best enclosed in grade 1 passage indicators. This will ensure that isolated letters and indicators such as superscript, subscript, fractions, radicals, arrows and shapes are well defined without the need for grade 1 symbol indicators.

Consider the following equation:

$$3x-4y+y^2 = x^2$$

Note that this particular equation could also be written

because the left hand side of the equation is in grade 1 mode following the numeric indicator (see [Section 1.2](#)).

Similarly

$$\frac{x^2 + 2x}{1 + x^2} = 1$$

(fraction: x squared plus 2x all over 1 + x squared close fraction)
can be safely written as

but could also be written

See [Section 11.5](#) for more examples of the use of grade 1 passage indicators.

1.7.4 If a complex algebraic expression does not include a comparison sign (such as an equals sign) then it is unlikely to include interior spaces in braille (see [Section 1.1.2](#)). In this case a grade 1 word indicator will be enough to ensure that superscript, subscript, fractions, radicals, arrows and shape indicators are well defined without the need for grade 1 symbol indicators.

Evaluate $\sqrt{(y-x^2)}$.

See [Section 7.3](#) for more examples of the use of grade 1 word indicators.

2.4 Time

5:30 pm

⠠⠼⠒⠠⠼⠒⠠⠏⠎⠎

5.30

⠠⠼⠒⠠⠼⠒

08.00

⠠⠠⠠⠠⠠⠠

1300

⠠⠼⠠⠠⠠⠠

6-7 a.m.

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

6:15-7:45

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

2.5 Ordinal numbers

1st

⠠⠠⠠⠠

2nd or 2d

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

3rd or 3d

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

4th

⠠⠠⠠⠠⠠

1er

⠠⠠⠠⠠⠠⠠

Follow print for order, spacing, capitalisation and punctuation of abbreviations. (If it is unclear in print whether there is a space between a number and its unit, or if print spacing is inconsistent, then it is recommended that a space is inserted in the braille.)

Where should I write the dollar sign, US\$ or \$US?

US\$ \$US US\$ \$US US\$ \$US US\$ \$US US\$ \$US

30 cents can be written as \$0.30, 30c or 30¢.

\$0.30 30c 30¢ \$0.30 30c 30¢ \$0.30 30c 30¢

In South Africa, this would cost R13.51.

R13.51 R13.51 R13.51 R13.51 R13.51 R13.51 R13.51 R13.51

Before decimalisation, £1.75 was £1 15s so half of it was 17s 6d or 17/6.

£1.75 £1 15s 17s 6d 17/6 £1.75 £1 15s 17s 6d 17/6 £1.75 £1 15s 17s 6d 17/6

Half a yard is 1 ft 6 in or 1' 6" which is about 45 cm or 0.45 m.

1 ft 6 in 1' 6" 45 cm 0.45 m 1 ft 6 in 1' 6" 45 cm 0.45 m 1 ft 6 in 1' 6" 45 cm 0.45 m

1 L of water weighs 1000 g which is about 2 lbs 4 oz.

1000 g 2 lbs 4 oz 1000 g 2 lbs 4 oz 1000 g 2 lbs 4 oz 1000 g 2 lbs 4 oz

Is the speed limit 30 mph or 50 km/h?

30 mph 50 km/h 30 mph 50 km/h 30 mph 50 km/h 30 mph 50 km/h

Water freezes at 0°C or 32°F.

0°C 32°F 0°C 32°F 0°C 32°F 0°C 32°F 0°C 32°F

3 Signs of Operation, Comparison and Omission

Operation signs:

	+	plus
	-	minus (when distinguished from hyphen)
	x	times (multiplication cross)
	÷	divided by (horizontal line between dots)
	±	plus or minus (plus over minus)
	∓	minus or plus (minus over plus)
	·	multiplication dot

Comparison signs:

	=	equals
	<	less than, or opening angle bracket
	>	greater than, or closing angle bracket
	≤	less than or equal to
	≥	greater than or equal to
	≠	not equal to (line through an equals sign)
	≈	approximately equal to (tilde over horizontal line)
	≈	approximately equal to (tilde over tilde)

Less common signs of comparison:

	≪	is much less than
	≫	is much greater than
	≈	tilde over equals sign (approximately equal)
	≐	equals sign dotted above and below (approximately equal)
	≐	equals sign with bump in top bar (difference between or approximately equal)
	≐	equivalent to (three horizontal lines)
	∝	is proportional to

Ratio

	:	ratio sign (represented by a colon as in print)
---	---	---

4.1.3 Division

The spaced vertical line segment (dots 456) can be used to represent the curved or straight line used in print to denote "5 into 15". A single space may also be acceptable. The layout of division calculations can be adjusted to suit local teaching practices.

$$5\overline{)15} = 3$$

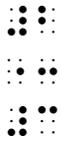
Below, the version on the left follows print layout, while the version on the right is an Australian example which has been adjusted to make it easier for the student to replicate.

$$\begin{array}{r} 93 \\ \hline 5) 465 \\ \underline{45} \\ 15 \\ \underline{15} \end{array}$$

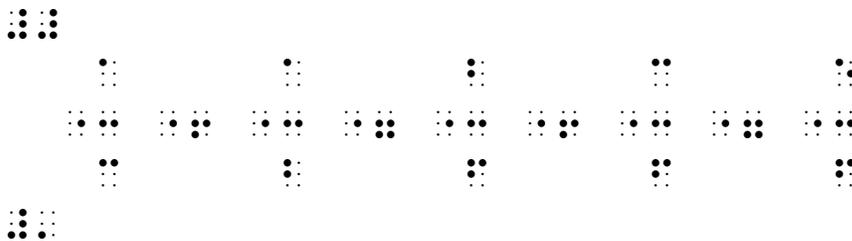
$$\begin{array}{r} 93 \\ \hline 5) 465 \\ \underline{45} \\ 15 \\ \underline{15} \end{array}$$

4.1.4 Spatial fractions for teaching purposes

$$\frac{2}{3}$$



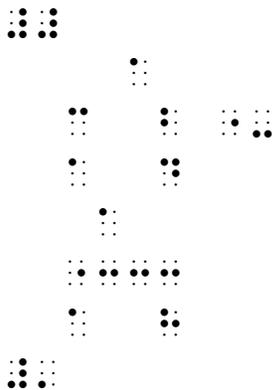
$$\frac{1}{3} + \frac{1}{2} = \frac{2}{6} + \frac{3}{6} = \frac{5}{6}$$



4.1.5 Carryovers

Insert spaces between the digits in braille so that the small numbers can be placed on their own row above or below the central calculation. The layout of this type of example can be adjusted to suit local teaching practices.

$$\begin{array}{r} 3 \text{ } ^1 2 \\ \underline{1 \text{ } 1 \text{ } 4} \\ 1 \text{ } 8 \end{array}$$



4.1.6 Cancellation

⠠⠠⠠⠠⠠⠠ line through previous item (defined in [Section 12](#))

When cancellation of numbers or expressions is shown in print, it is sometimes better to preserve the usual braille form and explain the process in a transcriber's note. Take the age of the student into account and check with local teaching practices.

For the fraction example below, two possible approaches are shown.

$$\frac{1}{5} \times \frac{8}{9} = \frac{8}{15}$$

Spatial arrangement

The image shows the Braille representation of the equation $\frac{1}{5} \times \frac{8}{9} = \frac{8}{15}$. It illustrates two different spatial arrangements for the cancellation of the number 8. In the first arrangement, the 8 in the numerator of the second fraction is cancelled with the 8 in the denominator of the result. In the second arrangement, the 8 in the numerator of the second fraction is cancelled with the 8 in the numerator of the result. The Braille uses various indicators for fractions, multiplication, and equality, along with numeric passage indicators.

Using cancellation lines within general fraction indicators (See [Section 6](#))

The image shows the Braille representation of the equation $\frac{1}{5} \times \frac{8}{9} = \frac{8}{15}$ using cancellation lines within general fraction indicators. This approach uses a single large fraction indicator that encompasses the entire equation, with cancellation lines indicating the removal of the 8s.

4.1.7 Numbered calculations

If a series of calculations are numbered, then numeric passage indicators can be used to enclose the whole series. However it is recommended that the numeric indicator is also used before each item number. Ex:

4.4 Diagrams

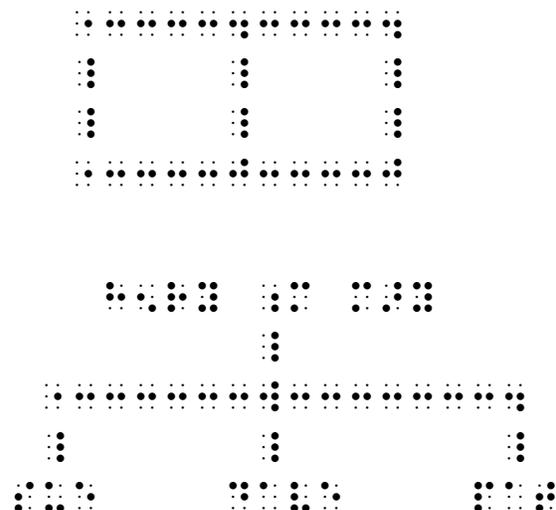
This section does not attempt to give advice on the design of tactile diagrams or on the range of production methods available.

4.4.1 Horizontal Line Mode

Most transcribers have experimented with the use of braille symbols for drawing simple box shapes or family trees. Although these are often not as readable as a raised line drawing, they still have their uses.

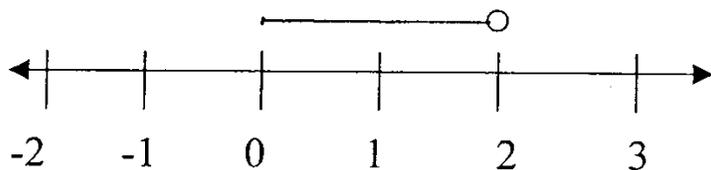
If an unbroken braille line begins with the horizontal line mode indicator ⠠⠨ then all the other cells in that line will be read as shapes rather than symbols.

If vertical lines are also shown using the vertical line segment ⠠⠨ then a back translation process or a tuned in reader can be clear that this is a diagram rather than a string of text.

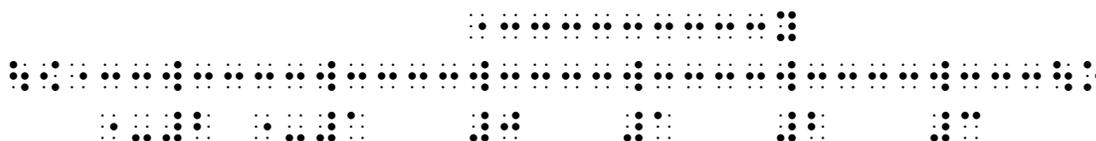


Refer to the *Rules of Unified English Braille, Section 16: Line Mode, Guide Dots* for symbols to use in line mode. Special mention is made of arrow symbols which can be used without terminating horizontal line mode. The following two examples illustrate the use of arrow symbols and also include unlisted dot patterns for the shapes of the hollow and solid circles used in print to represent the open or closed end of an interval.

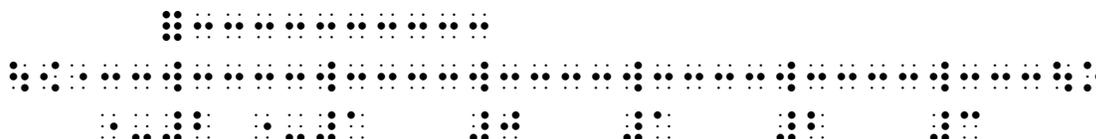
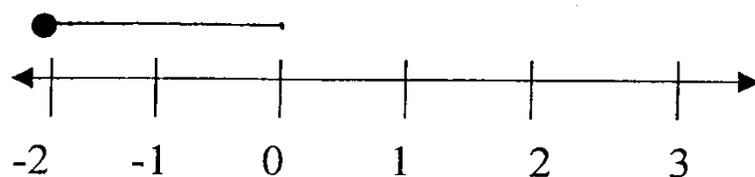
In the print example below a number line is graduated from -2 to 3 and an interval is marked above it starting at 0 and finishing with an open circle at 2. In the braille version, UEB arrow mode is used for the left and right pointing arrows



(See [Section 13](#)) and horizontal line mode is used between them. The interval itself is shown as a line finishing with the dot pattern ⠠⠨ for the empty circle.



In the second example below the interval starts with a solid circle at -2 and finishes at 0. In the braille version, the dot pattern ⠠⠨ has been used for the solid circle.



Note that in this second braille example, the horizontal line mode indicator ⠠⠨ could not precede the circle symbol without obscuring the position of that start point on the number line. In any diagram, tactual clarity may be deemed more important than technical ambiguity.

Always bear in mind that a well executed raised line drawing will generally be more readable than a diagram created using braille cell patterns.

See [Section 16](#) for examples of chemistry structures drawn using horizontal line mode and vertical and diagonal line segments.

4.4.2 Labelling diagrams

This section does not attempt to give advice on how to effectively label a diagram in braille so that it is clear to the reader which part of the diagram each label refers to. Rather, it lists code accommodations which can be made within the content of certain labels when space is at a premium.

- When labelling points, lines etc. with single letters, these can be consistently shown as two cells by omitting the grade 1 indicator for all capital letters and including it for all lowercase letters including a, i and o.
- When graduating an axis with negative numbers, the hyphen could be used instead of the minus sign (i.e. the dot 5 prefix could be omitted). Include a transcriber's note.
- When writing coordinates such as $(2, -3)$, any of the following could be considered: omitting the space; omitting the dot 5 prefix from the round brackets; omitting the dot 5 prefix from the minus sign. Include a transcriber's note.
- When labelling a line or curve with its equation, the space either side of the equals sign could be omitted.
- When labelling angles, the degree sign could be omitted. Include a transcriber's note.

7 Superscripts and subscripts

⠠⠠⠠⠠	level change down (subscript)
⠠⠠⠠⠠⠠	level change up (superscript or exponent)
⠠⠠⠠⠠⠠⠠	expression directly below
⠠⠠⠠⠠⠠⠠⠠	expression directly above
⠠⠠⠠⠠	braille grouping open
⠠⠠⠠⠠	braille grouping close

7.1 Definition of an item

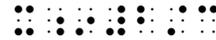
The scope of any of the four level change indicators, that is, the symbol(s) affected by it, is the next "item". An item is defined as any of the following groupings if immediately after the level change indicator:

1. An entire number, i.e. the initiating numeric symbol and all succeeding symbols within the numeric mode thus established (which would include any interior decimal points, commas, separator spaces, or simple numeric fraction lines).
2. An entire general fraction, enclosed in fraction indicators (see [Section 6](#)).
3. An entire radical expression, enclosed in radical indicators (see [Section 8](#)).
4. An arrow (see [Section 13](#)).
5. An arbitrary shape (see [Section 14](#)).
6. Any expression enclosed in matching pairs of round parentheses, square brackets or curly braces (see [Section 5](#)).
7. Any expression enclosed in the braille grouping indicators.
8. If none of the foregoing apply, the item is simply the next individual symbol.

x^y+1 ("x to the y" + 1)


x^{y+1} (x to the "y+1")


$x^{y+1}+3$ (x to the "y+1" + 3)


$x^{2/3}$ (x to the two thirds)


$\frac{x^2}{3}$ (x squared over 3)


$x^{1/2}y$ (x to the "half y")


$x^{1/2}y$ ("x to the half" y)

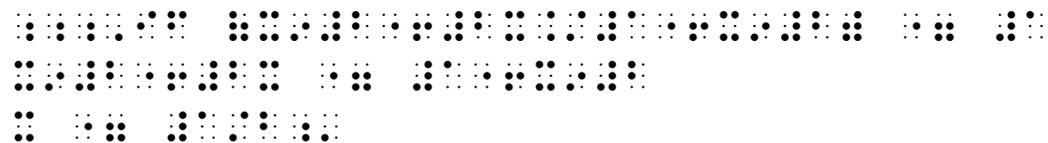

$x^{a/b}y = x$ (x superscript "a over b" end superscript y = x)


If $\frac{x^2+2x}{1+x^2} = 1$

$x^2+2x=1+x^2$

$x = 1/2$

(If fraction "x squared + 2x" all over "1 + x squared" end fraction = 1
 x squared + 2x = 1 + x squared
 x = 1 over 2)



7.4 Multiple levels

Note that a superscript which itself has a superscript does not fit the above definition of an item. In such cases braille grouping symbols are required.

$$e^{x^2} \quad (\text{e to the x squared})$$


$$e^{(x^2)} \quad (\text{e to the open parenthesis x squared close parenthesis})$$


$$P_{x_i} \quad (\text{P with an x sub i in the subscript position})$$


7.5 Negative superscripts

Negative superscripts must be enclosed in braille grouping symbols. (This is because a minus sign can be an item in its own right, as in [7.6](#) below.)

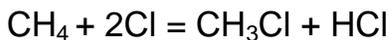
$$0.0045 = 4.5 \times 10^{-3} \quad (0.0045 = 4.5 \text{ times } 10 \text{ to the minus } 3)$$


$$v = 60 \text{ ms}^{-1} \quad (v = 60 \text{ ms to the minus } 1)$$


$$a^{-2b} \quad (\text{a to the minus } 2b \text{ power})$$


7.6 Examples from Chemistry

See [Section 16](#) for more examples.



Ions H^+ , Cl^- and Ca^{2+}

7.7 Simultaneous superscripts and subscripts

If more than one superscript or subscript apply, work from bottom to top, or left to right. If the print indicates by the placing of the subscript that it is being applied after the superscript then the order can be reversed.

$$x_1^2 = y_2^3 \quad (\text{x sub 1 squared equals y sub 2 cubed})$$

$$x^2_k \quad (\text{x squared sub k})$$

7.8 Left-displaced superscripts or subscripts

Sometimes in print a superscript or subscript is written to the left of the base symbol instead of to the right. These are handled simply by using the corresponding ordinary index expression prior to the base symbol.

$${}^{238}_{92}\text{U} \quad (\text{U with 92 written below left and 238 written above left})$$

$$^{-2+}^{-3} = ^{-}5 \quad (\text{minus 2 + minus 3 = minus 5 with minus signs in the superscript position})$$

9.8 Complex numbers

Functions used in complex number theory include \arg (argument), Re (real part), Im (imaginary part) and cis .

$$\arg(z_1 z_2) = \arg z_1 + \arg z_2$$

(arg of $z_1 z_2 = \arg z_1 + \arg z_2$)

$$\arg(z_1 z_2) = \arg z_1 + \arg z_2$$

$$z = r \operatorname{cis} \theta = r \cos \theta + ir \sin \theta$$

($z = r \operatorname{cis} \theta = r \cos \theta + ir \sin \theta$)

$$z = r \operatorname{cis} \theta = r \cos \theta + ir \sin \theta$$

10 Set Theory, Group Theory and Logic

⋃	U	union (upright U shape)
⋂	∩	intersection (inverted U shape)
∅	∅	null set (slashed zero)
'	'	complement (prime sign)
∈	∈	is an element of (variant epsilon)
∋	∃	contains as an element (reverse variant epsilon)
⊂	⊂	contained in, is a subset of (U open to right)
⊃	⊃	contains, is a superset of (U open to left)
⊆	⊆	contained in or equal to
⊇	⊇	contains or equal to
⊊	⊊	contained in, but not equal to (proper subset)
⊋	⊋	contains, but is not equal to (proper superset)
⊴	⊴	is a normal subgroup of (closed "less than")
⊵	⊵	inverse "is normal subgroup" (closed "greater than")
⊴	⊴	is normal subgroup of or equal (closed "less than", line under)
⊵	⊵	inverse "normal subgroup or equal" (closed "greater than", line under)
⊴	⊴	normal subgroup but not equal (closed "less than", cancelled line under)
⊵	⊵	inverse "normal subgroup but not equal" (closed "greater than", cancelled line under)
∨	∨	or (upright v shape)
∧	∧	and (inverted v shape)
¬	¬	"not" sign (line horizontal, then down at right)
⊢	⊢	assertion ("is a theorem" sign; "T" lying on left side)
⊣	⊣	reverse assertion ("T" lying on right side)
⊨	⊨	"is valid" sign (assertion with double stem on "T")
⊭	⊭	reverse "is valid" sign

11 Miscellaneous Symbols

⠠⠠⠠⠠	∫	integral sign
⠠⠠⠠⠠⠠	∮	closed line integral (small circle halfway up)
⠠⠠⠠⠠⠠	∂	partial derivative (curly d)
⠠⠠⠠⠠⠠	∇	del, nabla (inverted capital delta)
⠠⠠⠠⠠	'	prime (when distinguished from apostrophe in print)
⠠⠠⠠⠠⠠⠠	∝	is proportional to (varies as)
⠠⠠⠠⠠⠠	~	tilde (swung dash)
⠠⠠⠠⠠⠠	^	caret (hat)
⠠⠠⠠⠠⠠	*	asterisk
⠠⠠⠠⠠⠠	◦	hollow dot
⠠⠠⠠⠠⠠		vertical bar
⠠⠠⠠⠠⠠	∞	infinity
⠠⠠⠠⠠	!	factorial sign (exclamation mark in print)
⠠⠠⠠⠠⠠	∠	angle sign
⠠⠠⠠⠠⠠⠠	∟	measured angle sign
⠠⠠⠠⠠⠠⠠	⊥	measured right angle sign
⠠⠠⠠⠠⠠	∥	parallel to
⠠⠠⠠⠠⠠	⊥	perpendicular to
⠠⠠⠠⠠⠠	∴	"therefore" (three dots in upright pyramid)
⠠⠠⠠⠠⠠	∵	"since" (three dots in inverted pyramid)
⠠⠠⠠⠠⠠	∃	"there exists" (reverse E)
⠠⠠⠠⠠⠠	∀	"for all" (inverted A)
⠠⠠⠠⠠⠠	@	at sign
⠠⠠⠠⠠⠠	\	backslash
⠠⠠⠠⠠⠠	_	underscore
⠠⠠⠠⠠⠠	#	cross hatch
⠠⠠⠠⠠⠠	&	ampersand
⠠⠠⠠⠠⠠		broken vertical bar

⋮⋮⋮	first transcriber-defined print symbol
⋮⋮⋮⋮	second transcriber-defined print symbol
⋮⋮⋮⋮⋮	third transcriber-defined print symbol
⋮⋮⋮⋮⋮	fourth transcriber-defined print symbol
⋮⋮⋮⋮⋮	fifth transcriber-defined print symbol
⋮⋮⋮⋮⋮	sixth transcriber-defined print symbol
⋮⋮⋮⋮⋮	seventh transcriber-defined print symbol

11.1 Spacing

In general, the spacing of symbols can follow print. However if a symbol is clearly being used as a sign of operation or comparison, follow the guidelines in [Section 1.1](#).

11.2 Unusual Print symbols

If a print symbol is not defined in UEB, it can be represented either using one of the seven transcriber defined print symbols above, or by using the transcriber defined shape symbols in [Section 14](#). ([See example 11.5.7 below](#))

11.3 Grade 1 indicators

If the braille version of a print symbol also has a grade 2 meaning, and grade 1 mode is not already in force, then grade 1 indicators will be needed. Symbols in the list above for which this applies are the integral sign, the prime sign and the therefore sign.

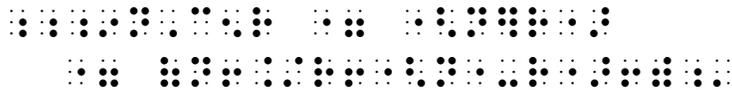
11.4 Symbols which have more than one meaning in print

One of the underlying design features of UEB is that each print symbol should have one and only one braille equivalent. For example the vertical bar is used in print to represent absolute value, conditional probability and the words "such that", to give just three examples. The same braille symbol should be used in all these cases.

11.5.3

$${}^n C_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$$

(super n capital C sub r = enlarged brackets enclosing n at the top and r at the bottom = fraction n factorial over r factorial times (n minus r) factorial end fraction)

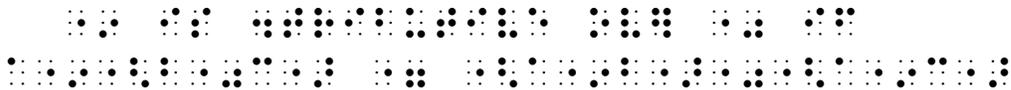


Note: the binomial coefficient works better as a shape than a vector (refer to 14.3.3).

11.5.4

* is distributive over ◦ if
 $a*(b\circ c) = (a*b)\circ(a*c)$

(asterisk is distributive over hollow dot if
 a asterisk (b hollow dot c) = (a asterisk b) hollow dot (a asterisk c))



Note: the hollow dot should not be used to represent the abbreviation for degrees, which is covered in [Section 3](#).

11.7 Greek letters

Greek letters are used heavily in Mathematics. The alphabet is listed below. Refer also to the Rule on Letters and their modifiers.

⠠⠠⠠⠠⠠	α Greek alpha	⠠⠠⠠⠠⠠⠠	A capital Greek alpha
⠠⠠⠠⠠⠠	β Greek beta	⠠⠠⠠⠠⠠⠠	B capital Greek beta
⠠⠠⠠⠠⠠	γ Greek gamma	⠠⠠⠠⠠⠠⠠	Γ capital Greek gamma
⠠⠠⠠⠠⠠	δ Greek delta	⠠⠠⠠⠠⠠⠠	Δ capital Greek delta
⠠⠠⠠⠠⠠	ε Greek epsilon	⠠⠠⠠⠠⠠⠠	E capital Greek epsilon
⠠⠠⠠⠠⠠	ζ Greek zeta	⠠⠠⠠⠠⠠⠠	Z capital Greek zeta
⠠⠠⠠⠠⠠	η Greek eta	⠠⠠⠠⠠⠠⠠	H capital Greek eta
⠠⠠⠠⠠⠠	θ Greek theta	⠠⠠⠠⠠⠠⠠	Θ capital Greek theta
⠠⠠⠠⠠⠠	ι Greek iota	⠠⠠⠠⠠⠠⠠	I capital Greek iota
⠠⠠⠠⠠⠠	κ Greek kappa	⠠⠠⠠⠠⠠⠠	K capital Greek kappa
⠠⠠⠠⠠⠠	λ Greek lambda	⠠⠠⠠⠠⠠⠠	Λ capital Greek lambda
⠠⠠⠠⠠⠠	μ Greek mu	⠠⠠⠠⠠⠠⠠	M capital Greek mu
⠠⠠⠠⠠⠠	ν Greek nu	⠠⠠⠠⠠⠠⠠	N capital Greek nu
⠠⠠⠠⠠⠠	ξ Greek xi	⠠⠠⠠⠠⠠⠠	Ξ capital Greek xi
⠠⠠⠠⠠⠠	ο Greek omicron	⠠⠠⠠⠠⠠⠠	O capital Greek omicron
⠠⠠⠠⠠⠠	π Greek pi	⠠⠠⠠⠠⠠⠠	Π capital Greek pi
⠠⠠⠠⠠⠠	ρ Greek rho	⠠⠠⠠⠠⠠⠠	P capital Greek rho
⠠⠠⠠⠠⠠	ς or σ Greek sigma	⠠⠠⠠⠠⠠⠠	Σ capital Greek sigma
⠠⠠⠠⠠⠠	τ Greek tau	⠠⠠⠠⠠⠠⠠	T capital Greek tau
⠠⠠⠠⠠⠠	υ Greek upsilon	⠠⠠⠠⠠⠠⠠	Υ capital Greek upsilon
⠠⠠⠠⠠⠠	φ Greek phi	⠠⠠⠠⠠⠠⠠	Φ capital Greek phi
⠠⠠⠠⠠⠠	χ Greek chi	⠠⠠⠠⠠⠠⠠	X capital Greek chi
⠠⠠⠠⠠⠠	ψ Greek psi	⠠⠠⠠⠠⠠⠠	Ψ capital Greek psi
⠠⠠⠠⠠⠠	ω Greek omega	⠠⠠⠠⠠⠠⠠	Ω capital Greek omega

12 Bars and dots etc. over and under

⠠⠠⠠⠠	bar over previous item
⠠⠠⠠⠠⠠	bar under previous item
⠠⠠⠠⠠⠠⠠	line through previous item (cancellation, "not")
⠠⠠⠠⠠⠠⠠⠠	simple right-pointing arrow over previous item
⠠⠠⠠⠠⠠⠠⠠⠠	simple right-pointing arrow under previous item
⠠⠠⠠⠠⠠⠠	dot over previous item
⠠⠠⠠⠠⠠⠠⠠	dot under previous item
⠠⠠⠠⠠⠠⠠⠠	tilde over previous item
⠠⠠⠠⠠⠠⠠⠠⠠	tilde under previous item
⠠⠠⠠⠠⠠⠠⠠	hat over previous item
⠠⠠⠠⠠⠠⠠⠠⠠	hat under previous item
⠠⠠⠠⠠⠠⠠⠠⠠	arc over previous item

12.1 The definition of an item

The definition of an item below is the same as that given for superscripts and subscripts in [Section 7.1](#).

As in [Section 7](#), an item is defined as any of the following groupings:

1. An entire number, i.e. the initiating numeric symbol and all succeeding symbols within the numeric mode thus established (which would include any interior decimal points, commas, separator spaces, or simple numeric fraction lines).
2. An entire general fraction, enclosed in fraction indicators (see [Section 6](#)).
3. An entire radical expression, enclosed in radical indicators (see [Section 8](#)).
4. An arrow (see [Section 13](#)).
5. An arbitrary shape (see [Section 14](#)).
6. Any expression enclosed in matching pairs of round parentheses, square brackets or curly braces (see [Section 5](#)).
7. Any expression enclosed in the braille grouping indicators.
8. If none of the foregoing apply, the item is simply the previous individual symbol.

13 Arrows

13.1 Simple arrows

⋮⋮⋮	arrow indicator
⋮⋮⋮⋮	bold arrow indicator
⋮⋮⋮⋮ →	simple right pointing arrow (east)
⋮⋮⋮⋮ ←	simple left pointing arrow (west)
⋮⋮⋮⋮ ↑	simple up pointing arrow (north)
⋮⋮⋮⋮ ↓	simple down pointing arrow (south)
⋮⋮⋮⋮ ↗	simple up and right pointing arrow (northeast)
⋮⋮⋮⋮ ↘	simple down and right pointing arrow (southeast)
⋮⋮⋮⋮ ↖	simple up and left pointing arrow (northwest)
⋮⋮⋮⋮ ↙	simple down and left pointing arrow (southwest)

A simple arrow has a standard barbed tip at one end (like a v on its side, pointing away from the shaft). The shaft is straight and its length and thickness are not significant. These arrows are represented by an opening arrow indicator and the appropriate closing arrow indicator. Notice that all these terminating symbols have three dots, arranged in a consistent pattern that best describes the direction.

Note that unless you are already in grade 1 mode, the arrow indicator will need a grade 1 symbol indicator. The bold arrow indicator will not need one, as this two cell symbol does not have a grade 2 meaning. Both arrow indicators set arrow mode so no further grade 1 indicators will be needed.

Arrows are signs of comparison so should usually be spaced. An exception is when they are written below the limit function (see [Section 9.6](#)).

Do not use arrow indicators when a simple right pointing arrow is the only modifier above or below an item. See "arrow over previous item" and "arrow below previous item" in [Section 12](#).

$n \rightarrow 0$ (n right arrow 0 - n tends to zero)

⠠⠨ ⠠⠗ ⠠⠢ ⠠⠐

input \rightarrow process \rightarrow output

(input "right arrow" process "bold right arrow" output)

⠠⠨ ⠠⠗ ⠠⠢ ⠠⠐ ⠠⠗ ⠠⠢ ⠠⠐ ⠠⠗ ⠠⠢ ⠠⠐

13.2 Arrows with unusual shafts and a standard barbed tip

Shaft symbols:

- ⠠⠨ short single straight line
- ⠠⠢ medium single straight line
- ⠠⠐ long single straight line
- ⠠⠢ double, short
- ⠠⠐ dotted, long
- ⠠⠢ curved or bent to the left (anticlockwise in line of direction)
- ⠠⠐ curved or bent to the right (clockwise in line of direction)
- ⠠⠢ sharp turn to the right (in line of direction)
- ⠠⠐ sharp turn to the left (in line of direction)

All shaft symbols can be elongated by repetition. The shaft symbols are placed between the opening and closing arrow indicators. Arrow length only needs to be indicated in braille when in print arrows of different lengths have different meanings.

These examples still have standard barbed tips.

\Rightarrow (double shafted medium length right pointing arrow)

⠠⠢ ⠠⠢

\curvearrowright (medium arrow pointing up with a sharp turn to the right)

⠠⠢

\curvearrowleft (medium length right pointing arrow bending clockwise)

⠠⠢

← - - - - (long, broken left pointing arrow)
 ⠠⠠⠠⠠⠠⠠⠠⠠

↓ ↓ ↓ (short, medium and long down pointing simple arrows)
 ⠠⠠⠠ ⠠⠠⠠ ⠠⠠⠠⠠⠠⠠⠠⠠

13.3 Arrows with unusual tips

Barb symbols:

⠠⠠⠠	regular barb, full, in line of direction
⠠⠠⠠	regular barb, full, counter to line of direction
⠠⠠⠠⠠	regular barb, upper half, counter
⠠⠠⠠⠠	regular barb, lower half, counter
⠠⠠⠠⠠	regular barb, upper half, in line
⠠⠠⠠⠠	regular barb, lower half, in line
⠠⠠⠠	curved, full, counter
⠠⠠⠠	curved, full, in line
⠠⠠⠠⠠	curved, upper half, counter
⠠⠠⠠⠠	curved, lower half, counter
⠠⠠⠠⠠	curved, upper half, in line
⠠⠠⠠⠠	curved, lower half, in line
⠠⠠⠠	straight, full, (directionless)
⠠⠠⠠⠠	straight, upper half, (directionless)
⠠⠠⠠⠠	straight, lower half, (directionless)

If an arrow has unusual tips, decide which is the head before you choose the direction of your closing indicator. The complete rules for deciding arrow direction are:

1. If there are directional tips, and all lead in the same direction, the head is the end that lies in that direction.
2. If there are no directional tips, but one end has a tip and the other does not, the end with the tip is the head.
3. In all other cases, the head of the arrow is deemed to be the end at the right, or in the case of strictly vertical arrows, at the top.

The tip(s) and shaft segment(s) are transcribed between the opening and closing indicators. These items are expressed in logical order, that is starting with the arrow tail and progressing towards the head, even if that runs counter to the physical order (as in the case of a left pointing arrow). Certain elements are omitted, corresponding to these reader rules:

1. If no tip is transcribed, it is understood that an ordinary full barbed tip occurs at the arrow head, and there is no other tip.
2. If no shaft is transcribed, it is understood that the shaft is a straight line of medium length. In this case, if no tip is transcribed, rule (1) also applies; if one tip is transcribed, it is at the head; if two tips are transcribed, the first is at the tail and the second at the head.

→ (otherwise ordinary right arrow, with curved head)



↔ (common horizontal bidirectional arrow)



↗ (horizontal bidirectional arrow, tilted from lower left to upper right)



➔ (otherwise ordinary right arrow, with tail and head tips)



➡ (otherwise ordinary right arrow, with two head tips)



← (otherwise ordinary left arrow, with tail and head tips)



↩ (otherwise ordinary left arrow, with two head tips)



\rightarrow (right arrow with a straight tail tip and a normal head tip)



\updownarrow (bold arrow up, followed by ordinary arrow down)



\rightleftharpoons (common right arrow over common left arrow – see [Section 14.3.3](#) regarding vertical juxtaposition)



\rightleftharpoons (half-barbed left arrow over half-barbed right arrow – reversible chemical reaction)



See [Section 16](#) for equilibrium arrows that occur in Chemistry.

14 Shape Symbols and Composite Symbols

Listing of shape indicators:

⠠⠠⠠⠠	shape indicator
⠠⠠⠠⠠⠠	filled (solid) shape indicator
⠠⠠⠠⠠⠠	shaded shape indicator
⠠⠠⠠⠠⠠	transcriber-assigned shape indicator
⠠⠠⠠⠠⠠⠠	transcriber-assigned filled (solid) shape indicator
⠠⠠⠠⠠⠠⠠	transcriber-assigned shaded shape indicator
⠠⠠⠠⠠	shape terminator

Listing of specific shapes:

⠠⠠⠠⠠⠠⠠	regular (equilateral) triangle
⠠⠠⠠⠠⠠⠠	square
⠠⠠⠠⠠⠠⠠	regular pentagon
⠠⠠⠠⠠⠠⠠	regular hexagon
⠠⠠⠠⠠⠠⠠	regular heptagon
⠠⠠⠠⠠⠠⠠	regular octagon (etc. for all regular polygons)
⠠⠠⠠⠠⠠	circle
⠠⠠⠠⠠⠠⠠⠠⠠	parallelogram

Composite Symbols:

⠠⠠⠠⠠	superposition indicator
⠠⠠⠠⠠	horizontal juxtaposition indicator
⠠⠠⠠⠠	vertical juxtaposition indicator
⠠⠠⠠⠠	physical enclosure indicator

14.3.2 Superposition, ⠠⠠⠠

Note that this structure should not be used for negation. See "line through previous item" in [Section 12](#).

\Re (R with superimposed x - prescription symbol)

⠠⠠⠠⠠⠠⠠

\oint

(Integral sign with a small circle superimposed half way up – closed integral defined in [Section 11.1](#))

⠠⠠⠠

\oint

(integral sign with a small square superimposed half way up - the termination could be omitted if there was a following space)

⠠⠠⠠⠠⠠⠠⠠⠠

14.3.3 Vertical Juxtaposition, ⠠⠠⠠

The upper symbol should be given first, followed by the vertical juxtaposition indicator, then the lower symbol.

This structure should not be used for bars, arrows, dots, tildes or hats over or under other symbols (see [Section 12](#)). Neither should it be used for superscripts or subscripts written directly over or under (see [Section 7](#)).

$\overset{\circ}{=}$ (a hollow dot with an equal sign underneath)

⠠⠠⠠⠠⠠⠠⠠

$\binom{n}{r}$

binomial coefficient (refer [Section 11.5.3](#))

⠠⠠⠠⠠⠠⠠⠠⠠

14.3.4 Horizontal Juxtaposition, ⠠⠠⠠

"Horizontal juxtaposition" is to be invoked only when two symbols are written in close proximity and it is clear from the usage that a new single symbol, distinct from the elementary symbols considered in sequence, is intended. Otherwise, symbols written one after the other should simply be brailled accordingly.

15 Matrices and vectors

15.1 Enlarged grouping symbols

When enlarged brackets are used in print for vectors, matrices, systems of equations, function definitions etc., the appropriate enlarged grouping symbols should be used in braille. These are the usual grouping symbols preceded by a dot 6. See the full list in [Section 5](#). These should be placed directly under each other. Blank lines before and after such arrangements may be needed for clarity.

15.2 Matrices

The columns should be left adjusted except for minus signs which should be brailled to stand out. One column of blank cells should be left between columns. Material outside the matrix, such as signs of operation and comparison, should be placed on the top line, even if they are centered in print.

$$I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

The Braille representation of the identity matrix $I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ uses enlarged grouping symbols (dot 6) around the matrix. The first row contains the number 1 followed by a blank cell, and the second row contains 0 followed by a blank cell. The matrix is enclosed in large parentheses.

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ -3 & 4 \\ 5 & -6 \end{bmatrix}$$

The Braille representation shows two matrices multiplied together. The first matrix is a 2x3 matrix with elements 1, 2, 3 in the first row and 4, 5, 6 in the second row. The second matrix is a 3x2 matrix with elements 1, 2 in the first row, -3, 4 in the second row, and 5, -6 in the third row. Both matrices are enclosed in large square brackets, and a multiplication sign is placed between them.

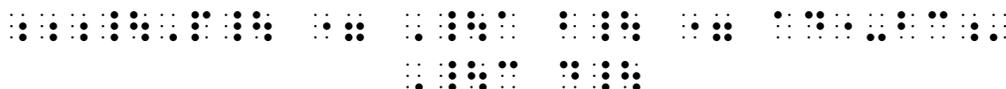
$$\begin{pmatrix} a & -b \\ -c & d \end{pmatrix}$$

The Braille representation of the matrix $\begin{pmatrix} a & -b \\ -c & d \end{pmatrix}$ uses enlarged grouping symbols (dot 6) around the matrix. The elements are arranged in two rows: the first row contains 'a' followed by '-b', and the second row contains '-c' followed by 'd'. The matrix is enclosed in large parentheses.

15.3 Determinants

These have the same structure as matrices but are normally enclosed in print with enlarged vertical bars.

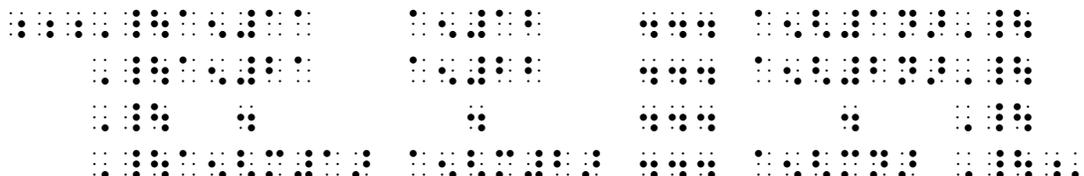
$$|P| = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$



15.4 Omission dots

The placement of dots used to indicate the omission of one or more rows or columns can follow the print.

$$\begin{vmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \cdot & \cdot & \dots & \cdot \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{vmatrix}$$



15.5 Dealing with wide matrices

If a matrix or determinant is too wide for the braille page, runovers within entries may be necessary. If there is not room to indent these runovers, they can be blocked and a blank line left between rows.

$$\begin{pmatrix} a_1x_1 + b_1x_2 + c_1x_3 & a_1y_1 + b_1y_2 + c_1y_3 & a_1z_1 + b_1z_2 + c_1z_3 \\ a_2x_1 + b_2x_2 + c_2x_3 & a_2y_1 + b_2y_2 + c_2y_3 & a_2z_1 + b_2z_2 + c_2z_3 \\ a_3x_1 + b_3x_2 + c_3x_3 & a_3y_1 + b_3y_2 + c_3y_3 & a_3z_1 + b_3z_2 + c_3z_3 \end{pmatrix}$$

The Braille representation of the matrix uses a combination of blocked entries and blank lines between rows to manage the width. Each entry is represented by a 3x3 grid of Braille cells. The first row of the matrix is followed by a blank line, then the second row, another blank line, and then the third row. This layout ensures that the structure of the matrix is clear, with each row's entries aligned vertically.

Another approach is to complete the first column without overruns and then to place the next column below this, indented two cells.

The Braille representation of the matrix uses a column-wise layout. The first column is completed first, and then the second column is placed below it, indented two cells. This approach makes the individual entries easier to read, as they are not broken across lines. The matrix is represented by a 3x3 grid of Braille cells, with the second column indented two cells relative to the first.

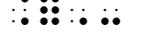
Notice that in the first example the structure of the matrix is clearer but in the second example the individual entries are easier to read. Notice also the different placement of the enlarged grouping signs in the two examples.

16 Chemistry

  equilibrium arrow, trend to the left

  equilibrium arrow, trend to the right

  equilibrium arrow (harpoons)

 dash or single line bond

 double line bond

 triple line bond

 quadruple line bond

 single dashed line

 double dashed line

 triple dashed line

 quadruple dashed line

 single dot

 double dot

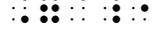
 triple dot

 quadruple dot

 single cross

 double cross

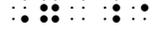
 triple cross

 quadruple cross

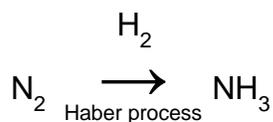
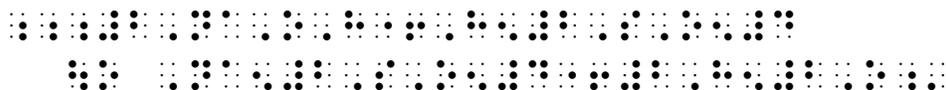
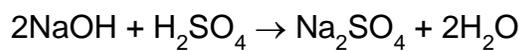
 single small circle

 double small circle

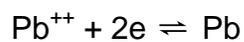
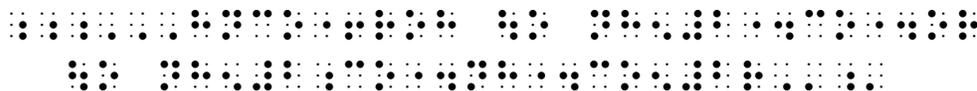
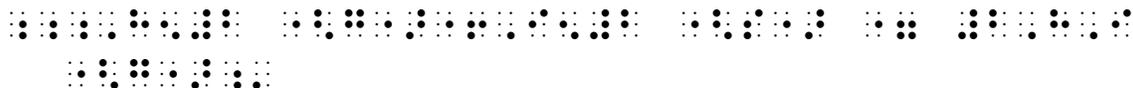
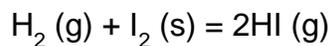
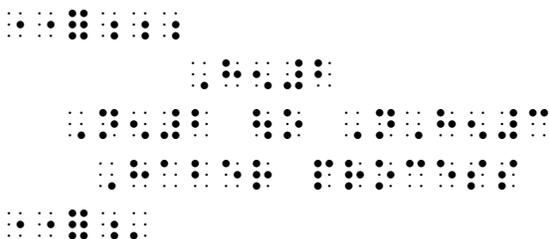
 triple small circle

 quadruple small circle

16.5 Chemical Equations



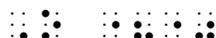
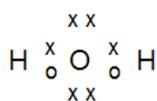
or



16.6 Electrons

Electrons shown as dots, crosses or circles attached to element symbols may be represented using the corresponding UEB signs for single, double, triple dots, etc. However, more complex cases (e.g. including graphic lines) are better dealt with using ordinary diagram methods, rather than trying to code them purely in braille.

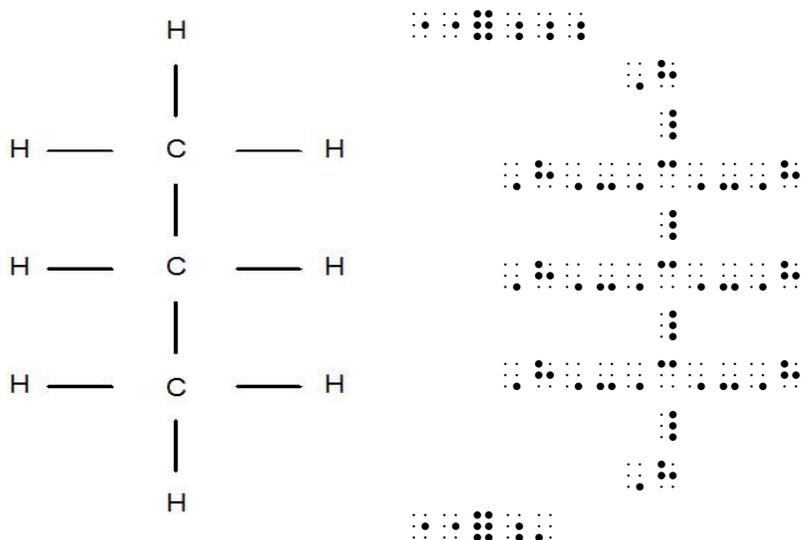
Cl·

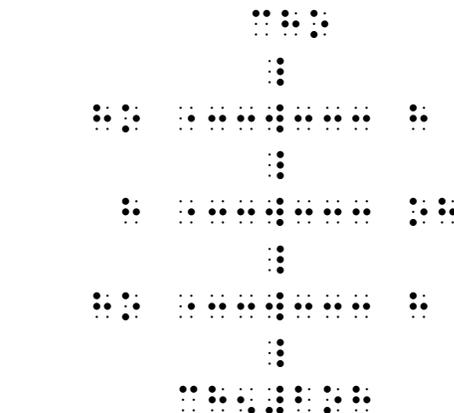
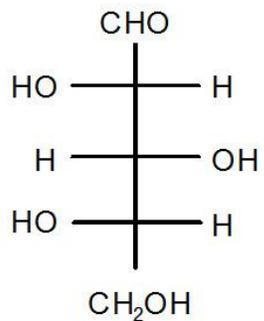
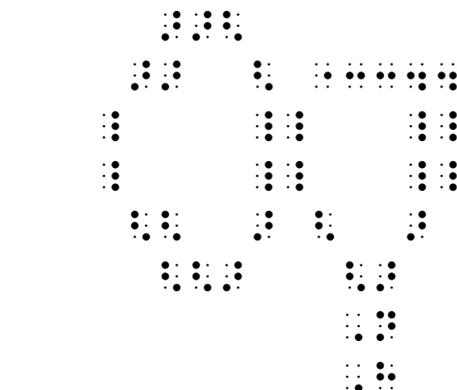
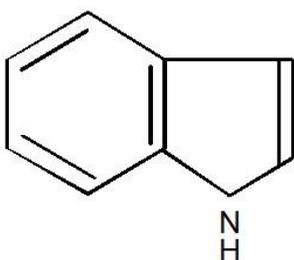
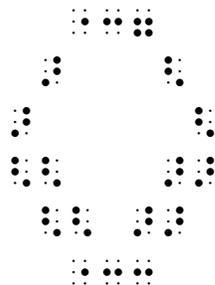


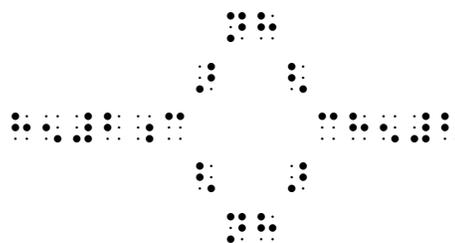
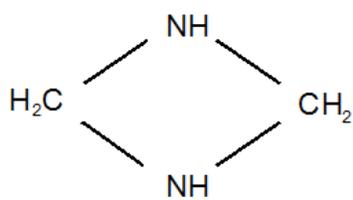
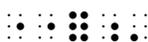
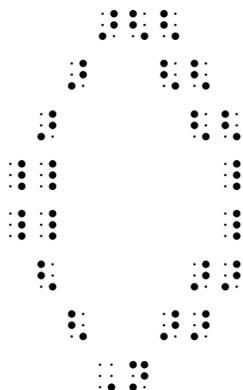
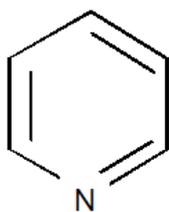
16.7 Structural Formulae

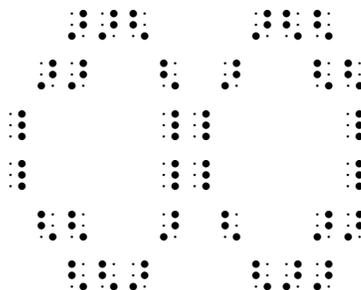
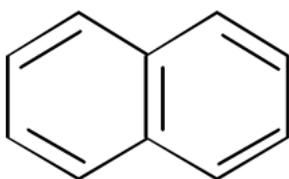
The general UEB method for line drawing may be used for representing structural formulae. Refer to the *Rules of Unified English Braille, Section 16: Line Mode, Guide Dots* for symbols used to draw lines using braille cells. In-line bond signs can be used in conjunction with the line drawing symbols.

Some examples are shown below. For more complex cases it is recommended that the structure be drawn out graphically rather than using transcriber defined symbols.









Linear Method

A method is available in which structural formulae are represented in a compact linear form in braille. However, as yet this has not been documented as a UEB technique.

17 Computer Notation

- ⠠⠠⠠ (on a line by itself) cursor indicator
- ⠠⠠⠠ visible space
- ⠠⠠⠠ (at end of line) continuation indicator
- ⠠⠠⠠⠠ (at end of line) continuation indicator with space
- ⠠⠠⠠⠠ nondirectional double quote (ASCII double quote)

17.1 Definition of computer notation

Computer notation is any text written in a formal syntax that is designed to allow computers to utilize the text directly for technical purposes related to the computer itself. Examples include computer programs written in procedural languages such as Java, C++, COBOL, and various "assembly" languages, nonprocedural scripting and markup languages such as XHTML, and data files prepared to meet the input requirements of specific programs. Even some short items such as email addresses, Web site URLs, and file names qualify as computer notation because of their technical purpose. Other examples might occur within an instruction manual for technical equipment, or within a statistics textbook that gives an example of a spreadsheet formula.

"Displayed" computer notation is presented in one or more lines separate from the surrounding literary text; "inline" computer notation is presented within ordinary literary text — for example, an email address mentioned within a sentence.

Historically, separate codes have been used for such computer notation. In UEB this is no longer the case, as each print symbol is represented by the same braille symbol, regardless of whether it appears in a literary, mathematical or computer context. Refer to the list of miscellaneous symbols at the start of [Section 11](#) for symbols on the computer keyboard such as the \ (backslash), ~ (tilde), @ (at sign), # (cross hatch), & (ampersand), * (asterisk), _ (underscore) and | (vertical bar).

17.2 Line arrangement and spacing within computer notation

The significance of line breaks within displayed computer notation depends upon the specific formal syntax involved. Unless the transcriber is certain that such line breaks are not significant, it should be assumed that they are, and the line-by-line arrangement preserved in braille. When the limited length of the braille

17.3 Grade of braille in computer notation

A displayed computer program or program fragment should normally be transcribed in grade 1 braille; nearby excerpts from a program that is displayed in grade 1 should preferably also be in grade 1, for consistency. Other expressions, such as email addresses, web sites, URLs, filenames, and computer expressions not displayed on separate lines, should normally be transcribed in grade 2 braille.

Example:

Now that you've seen the "Hello World!" application, you might be wondering how it works. Here again is its code:

```
/**
 * The HelloWorldApp class implements an application that
 * simply prints "Hello World!" to standard output.
 */
class HelloWorldApp {
    public static void main(String[] args) {
        System.out.println("Hello World!");    // Display
the string.
    }
}
```

The call to function `system.out.println`, passing it the constant string "Hello World!", does the essential work—but the other statements and comments also play a role...

Notes:

The indentation pattern on the left of the page has been followed in braille. The "continuation with space" indicators have been used whenever a print line needed to be broken at a space in braille. Overruns following a continuation indicator are indented in the braille version below, but it is also acceptable to start each overrun in cell 1. Notice that the non-directional double quotation marks around "Hello World" are treated as standard quotes in the introductory paragraph but have been brailled exactly as written when they appear in the program itself and in the extract. In the final paragraph, grade 1 indicators were used for the two extracts so it was not felt necessary to also show the change of font.

