

Unified English Braille

**Guidelines for
Technical Material**

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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.

Guidelines for Technical Material

1	General Principles.....	1
1.1	Spacing	1
1.2	Underlying rules for numbers and letters.....	2
1.3	Print Symbols	3
1.4	Format.....	3
1.5	Typeforms	4
1.6	Capitalisation.....	4
1.7	Use of Grade 1 indicators.....	5
2	Numbers and Abbreviations.....	8
2.1	Whole numbers	8
2.2	Decimals.....	9
2.3	Dates	9
2.4	Time	10
2.5	Ordinal numbers.....	10
2.6	Roman Numerals	11
2.7	Emphasis of Digits.....	11
2.8	Ancient Numeration systems.....	11
2.9	Hexadecimal numbers.....	12
2.10	Abbreviations.....	12
3	Signs of Operation, Comparison and Omission	15
3.1	Examples.....	16
3.2	Algebraic Examples.....	17
3.3	Use of the braille hyphen.....	17
3.4	Positive and negative numbers	18
3.5	Calculator keys.....	18
3.6	Omission marks in mathematical expressions.....	19
4	Spatial Layout and Diagrams	20
4.1	Spatial calculations.....	20
4.2	Tally marks	25
4.3	Tables	26
4.4	Diagrams.....	27
5	Grouping Devices (Brackets)	30
6	Fractions	31
6.1	Simple numeric fractions	31
6.2	Mixed numbers.....	31
6.3	Fractions written in linear form in print.....	32
6.4	General fraction indicators.....	32
6.5	Extra Examples	33
7	Superscripts and subscripts	34
7.1	Definition of an item.....	34
7.2	Superscripts and subscripts within literary text.....	35
7.3	Algebraic expressions involving superscripts	35
7.4	Multiple levels.....	37

7.5 Negative superscripts	37
7.6 Examples from Chemistry	38
7.7 Simultaneous superscripts and subscripts	38
7.8 Left-displaced superscripts or subscripts	38
7.9 Modifiers directly above or below	39
8 Square Roots and other radicals.....	40
8.1 Square roots.....	40
8.2 Cube roots etc.....	41
8.3 Square root sign on its own	41
9 Functions	42
9.1 Spelling and capitalisation	42
9.2 Italics	42
9.3 Spacing	43
9.4 Trigonometric functions	44
9.5 Logarithmic functions	45
9.6 The Limit function	46
9.7 Statistical functions.....	46
9.8 Complex numbers	47
10 Set Theory, Group Theory and Logic.....	48
11 Miscellaneous Symbols	50
11.1 Spacing	51
11.2 Unusual Print symbols.....	51
11.3 Grade 1 indicators	51
11.4 Symbols which have more than one meaning in print	51
11.5 Examples.....	52
11.6 Embellished capital letters.....	55
11.7 Greek letters.....	56
12 Bars and dots etc. over and under.....	57
12.1 The definition of an item	57
12.2 Two indicators applied to the same item	59
13 Arrows.....	60
13.1 Simple arrows.....	60
13.2 Arrows with unusual shafts and a standard barbed tip	61
13.3 Arrows with unusual tips.....	62
14 Shape Symbols and Composite Symbols	65
14.1 Use of the shape termination indicator	66
14.2 Transcriber defined shapes	66
14.3 Combined shapes	67
15 Matrices and vectors.....	69
15.1 Enlarged grouping symbols	69
15.2 Matrices.....	69
15.3 Determinants	70
15.4 Omission dots.....	70
15.5 Dealing with wide matrices	71
15.6 Vectors	72
15.7 Grouping of equations	73

16 Chemistry.....	74
16.1 Chemical names.....	75
16.2 Chemical formulae	75
16.3 Atomic mass numbers.....	76
16.4 Electronic configuration	76
16.5 Chemical Equations	77
16.6 Electrons	78
16.7 Structural Formulae.....	78
17 Computer Notation.....	83
17.1 Definition of computer notation.....	83
17.2 Line arrangement and spacing within computer notation	83
17.3 Grade of braille in computer notation	86

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.)

$$y = x + 4c$$

2 Numbers and Abbreviations

Refer to [Section 1.2](#) for a summary of the rules for Grade 1 mode and Numeric mode as they apply to the braille of numbers and letters in mathematics.

The braille representation of numbers such as dates and times should reflect the punctuation used in print.

2.1 Whole numbers

456

⠠⠠⠠⠠⠠⠠

3,000

⠠⠠⠠⠠⠠⠠⠠⠠

5 000 000

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

Calling seat numbers 30-59.

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

In the 60's

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

In the 60s

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

In the '60s

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

Phone 09-537 0891

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

For negative numbers [see 4.2.](#)

2.2 Decimals

8.93

⠠⠠⠠⠠⠠⠠⠠⠠

0.7

⠠⠠⠠⠠⠠

.7

⠠⠠⠠⠠

Is the number in the range 2-5.5?

⠠⠠⠠⠠ ⠠⠠ ⠠⠠⠠⠠⠠⠠⠠ ⠠⠠ ⠠⠠ ⠠⠠⠠⠠⠠⠠⠠ ⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

.8 is a decimal fraction.

⠠⠠⠠⠠ ⠠⠠⠠ ⠠⠠ ⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

For recurring decimals see [Section 12](#) (bars, dots etc. over and under)

2.3 Dates

28-5-2001

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

5-28-01

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

2001/5/28

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

2001.5.28

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

28/5-31/5

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

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

⠠⠠⠠⠠⠠⠠

2.6 Roman Numerals

Roman numerals should be brailled as if they were normal letters using the rules for grade 1 mode. Note that "v" and "x" will have grade 1 indicators but "i" will not.

Read parts I, II and V.

⠠⠠⠠⠠⠠⠠ ⠠⠠⠠⠠⠠⠠ ⠠⠠⠠⠠⠠⠠ ⠠⠠⠠⠠⠠⠠⠠⠠ ⠠⠠ ⠠⠠⠠⠠⠠⠠

Answer questions i, vi and x.

⠠⠠⠠⠠⠠⠠⠠⠠ ⠠⠠⠠⠠⠠⠠ ⠠⠠⠠ ⠠⠠⠠ ⠠⠠ ⠠⠠⠠⠠⠠

CD

⠠⠠⠠⠠⠠⠠⠠⠠

2.7 Emphasis of Digits

If a typeform indicator applies to a digit or digits within a number, the numeric indicator needs repeating after any typeform indicator. If the first digit is affected then the typeform indicator should be placed before the numeric indicator.

67845

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

67845

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

67845

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

67845

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

67845

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

For recurring decimals see [Section 12](#) (bars, dots etc. over and under)

2.8 Ancient Numeration systems

Braille symbols to represent numerals from other number systems may be devised for each situation using transcriber defined print symbols. These should be defined either on the special symbols page or in a transcriber's note. (See example in [Section 11.5.7](#))

2.9 Hexadecimal numbers

Hexadecimal numbers occur in a computer setting and are made up of the digits 0 to 9 and the letters A to F. They should be treated the same as any other string of letters and numbers.

Fatal exception 0E has occurred at 0028:C00082CD

2.10 Abbreviations

The following signs are used for special print symbols:

	¢	cent
	€	euro
	₣	franc
	£	pound (sterling)
	\$	dollar
	¥	yen (Japan)
	₦	naira (Nigeria)
	%	percent
	°	degree
	'	foot or minute (shown as a prime sign)
	"	inch or second (shown as a double prime sign)
	Å	angstrom (A with small circle above)

Note that the Rand (South Africa) is written in print as a normal capital R so would be brailled as such.

Note that the foot or minute may be shown in print by an apostrophe (') and the inch or second by a nondirectional double quote ("). This usage can be followed in braille.

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?

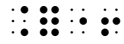
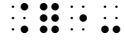



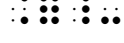
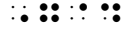
30 mph 50 km/h 30 mph 50 km/h 30 mph 50 km/h 30 mph 50 km/h

Water freezes at 0°C or 32°F.

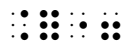
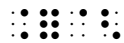
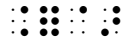
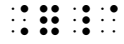
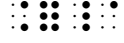

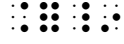

0°C 32°F 0°C 32°F 0°C 32°F 0°C 32°F 0°C 32°F

3 Signs of Operation, Comparison and Omission

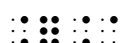
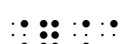



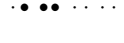

Operation signs:

	+	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)
---	---	---

(see also [Section 11](#) for signs of operation and comparison used in set theory, group theory and logic)

3.1 Examples

In most of the examples below, operation signs are unspaced from preceding and following terms but comparison signs are spaced. The first two examples show the use of extra space for the younger learner. Follow the guidelines in Spacing ([Section 1.1.2](#)).

$$3 + 5 = 8$$

⠠⠨⠶⠱⠣⠦⠶⠦⠠⠨

$$8 - 5 = 3$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$3 \times 5 = 5 \times 3 = 15$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$2 \text{ cm} + 4 \text{ cm} = 6 \text{ cm}$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$200\text{g} \times 5 = 1\text{kg}$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$5.72 \text{ m} \div 10 = 57.2 \text{ cm}$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$15 \pm 0.5$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$\text{Area} = bh = 5.3 = 15$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$3.9 \times 4.1 \approx 16$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

$$5 - 3 \neq 3 - 5$$

⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨⠶⠱⠣⠦⠶⠱⠣⠠⠨

3.6 Omission marks in mathematical expressions

	—	long dash
	—	underscore
		visible space
	□	square (see Section 14)

3 + 7 = — (omission shown as a centred horizontal line in print)

3 + 7 = ____ (omission shown as a low horizontal line in print)

3 + 7 = ? (omission shown as a question mark in print)

3 □ 7 = 10 (omission shown as an empty square in print)

3 7 = 10 (omission shown as an unmarked gap in print)

$\frac{9}{12} = \frac{3}{4}$ (omission shown within a fraction in print)

Note that the visible space is the same symbol as the closing root indicator (defined in [Section 12](#)). If the radicand is to be filled in then the symbol would be repeated to terminate the root.

5 = √

4 Spatial Layout and Diagrams

4.1 Spatial calculations

⠠⠨⠠⠥⠠⠆⠠⠤⠠	begin horizontal line mode
⠠⠨⠠⠥⠠⠆⠠⠤⠠	vertical line segment
⠠⠨⠠⠥⠠⠆⠠⠤⠠	spaced numeric indicator
⠠⠨⠠⠥⠠⠆⠠⠤⠠	numeric passage indicator
⠠⠨⠠⠥⠠⠆⠠⠤⠠	numeric passage terminator

Where horizontal lines are needed within children's sums, horizontal line mode should be used. The layout of the calculation can follow print, though feedback from teachers working with students should also be taken into account. These guidelines can also be applied for other spatial arrangements such as financial statements or accountancy texts.

Columns to be added should not contain numeric indicators or operation signs. This can be achieved by aligning numeric indicators vertically — a numeric indicator followed by a space still initiates numeric mode.

Alternatively use the numeric passage indicator and the numeric terminator which set numeric mode and grade 1 mode for the enclosed text. In a numeric passage numeric indicators are not used, and any lowercase letter a to j is preceded by a grade 1 indicator.

The line above and below spatial calculations should either be blank, or should only contain the numeric passage indicator or terminator.

4.1.1 Addition or subtraction

$$\begin{array}{r} 456 \\ + 34 \\ \hline 490 \end{array}$$

$$\begin{array}{r} \text{⠠⠨⠠⠥⠠⠆⠠⠤⠠} \\ \text{⠠⠨⠠⠥⠠⠆⠠⠤⠠} \\ \text{⠠⠨⠠⠥⠠⠆⠠⠤⠠} \\ \text{⠠⠨⠠⠥⠠⠆⠠⠤⠠} \end{array}$$

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.

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

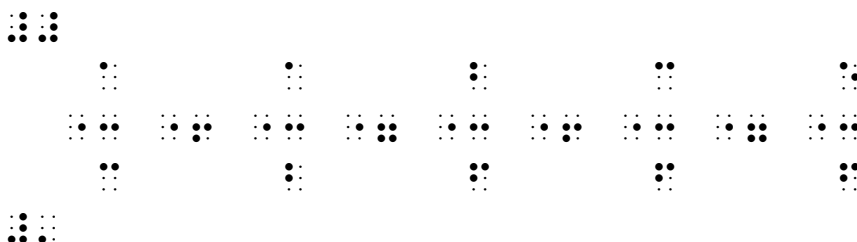
$$\begin{array}{r} 93 \\ \hline 5) 465 \\ \underline{45} \\ 15 \\ \underline{15} \end{array}$$

4.1.4 Spatial fractions for teaching purposes

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



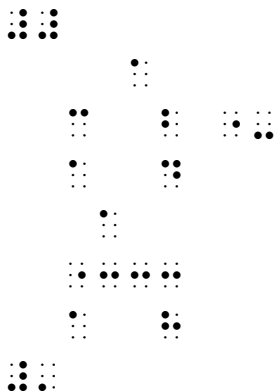
$$\frac{1}{3} + \frac{1}{2} = \frac{2}{6} + \frac{3}{6} = \frac{5}{6}$$



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 two Braille representations of the equation $\frac{1}{5} \times \frac{8}{9} = \frac{8}{15}$. The first representation shows the fraction $\frac{1}{5}$ followed by a multiplication sign, then $\frac{8}{9}$, followed by an equals sign and $\frac{8}{15}$. A cancellation line is drawn through the 5 and 9. The second representation shows the same equation but with a different spatial arrangement for the cancellation line, illustrating two possible ways to represent this operation in Braille.

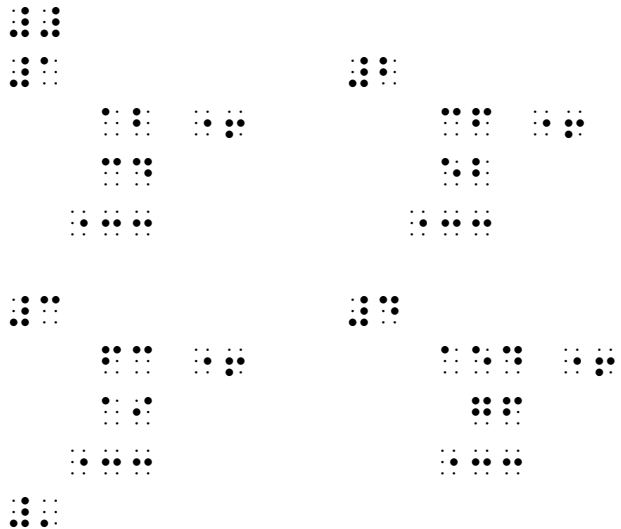
Using cancellation lines within general fraction indicators (See [Section 6](#))

The image shows a Braille representation of the equation $\frac{1}{5} \times \frac{8}{9} = \frac{8}{15}$ using cancellation lines within general fraction indicators. The cancellation line is drawn through the 5 and 9 within the fraction indicators.

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:

<p>1</p> $\begin{array}{r} 12 \\ +34 \\ \hline \end{array}$	<p>2</p> $\begin{array}{r} 36 \\ +52 \\ \hline \end{array}$
<p>3</p> $\begin{array}{r} 63 \\ +19 \\ \hline \end{array}$	<p>4</p> $\begin{array}{r} 154 \\ +76 \\ \hline \end{array}$

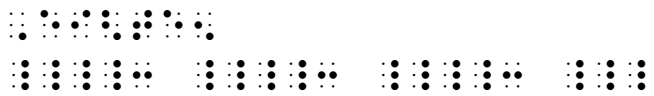


4.2 Tally marks

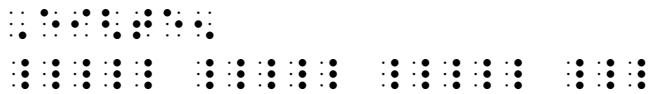
- ⠠⠠⠠⠠⠠ tally mark (vertical line segment)
- ⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠ 4 tally marks with strike through (representing 5 items)

The horizontal or diagonal strike-through represents the counting of a fifth item. This can either be shown as a fifth tally mark in braille or the "4 tally marks with strike-through" symbol can be used. Ex:

Eighteen
 ||| ||| ||| |||



or



4.3 Tables

Horizontal line mode is used to underline the column headings. Two spaces are left between columns. If numbers are to be added they should be right adjusted. Ex:

$$y = x^2 - 3$$

x	y
-1	-2
0	-3
1	-2
2	1
3	6

The Braille representation of the table above is as follows:

$$y = x^2 - 3$$

x	y
-1	-2
0	-3
1	-2
2	1
3	6

It is also acceptable to include a boxing line above and below the table.

4.4 Diagrams

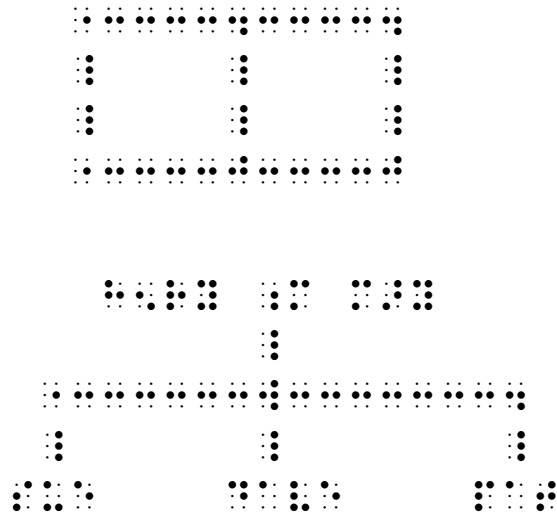
This section does not attempt to give advice on the design of tactile diagrams or on the range of production methods available.

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.

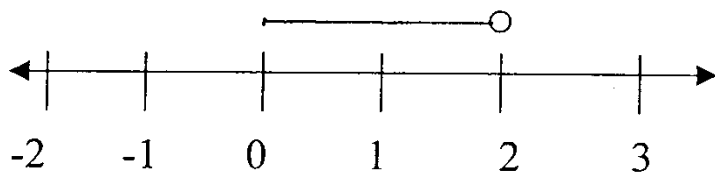
If an unbroken braille line begins with the horizontal line mode indicator ⠠⠠ then all the other cells in that line will be read as shapes rather than symbols.

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.

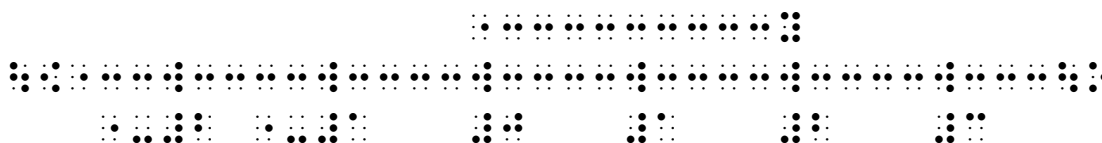


Refer to the *Rules of Unified English Braille, Section 16: Line Mode, Guide Dots* for symbols to use in line mode. Special mention is made of arrow symbols which can be used without terminating horizontal line mode. The following two examples illustrate the use of arrow symbols and also include unlisted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

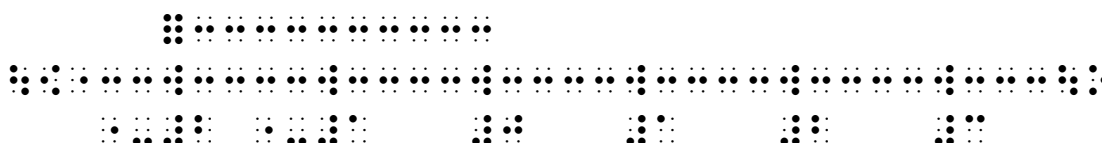
In the print example below a number line is graduated from -2 to 3 and an interval is marked above it starting at 0 and finishing with an open circle at 2. In the braille version, UEB arrow mode is used for the left and right pointing arrows



(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.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

(speed = distance over time, showing alternative usage of grade 1 indicators)

⠠⠎⠏⠑⠑⠎⠀⠠⠑⠗⠑⠎⠀⠠⠗⠁⠊⠎⠑⠀⠠⠗⠊⠎⠑

⠠⠎⠏⠑⠑⠎⠀⠠⠑⠗⠑⠎⠀⠠⠗⠁⠊⠎⠑⠀⠠⠗⠊⠎⠑

⠠⠎⠏⠑⠑⠎⠀⠠⠑⠗⠑⠎⠀⠠⠗⠁⠊⠎⠑⠀⠠⠗⠊⠎⠑

6.5 Extra Examples

These examples are included to further illustrate the difference in print between simple numeric fractions as defined in [6.1](#), and fractions which will need general fraction indicators in braille as defined in [6.4](#).

Simple numeric fractions:

$$\frac{3}{4}$$

$$\frac{73}{4}$$

$$\frac{3}{4.2}$$

$$\frac{5.3}{4,200}$$

$$5\frac{3}{4}$$

$$6\frac{3}{10\,000}$$

Fractions needing general fraction indicators because they contain letters:

$$\frac{x}{y}$$

$$\frac{x}{4}$$

$$\frac{3}{b}$$

$$\frac{a}{b+c}$$

$$\frac{3x}{4}$$

$$\frac{x}{4,000}$$

Fractions needing general fraction indicators because they contain something more than digits, commas or decimal points:

$$\frac{3^2}{6}$$

$$\frac{\$55}{5}$$

$$\frac{24m}{3cm}$$

$$\frac{?}{4}$$

$$\frac{\frac{2}{3}}{4}$$

$$\frac{2-5}{3}$$

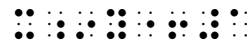
7 Superscripts and subscripts


⠠⠠⠠⠠	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:

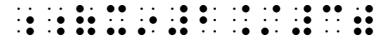
1. An entire number, i.e. the initiating numeric symbol and all succeeding symbols within the numeric mode thus established (which would include any interior decimal points, commas, separator spaces, or simple numeric fraction lines).
2. An entire general fraction, enclosed in fraction indicators (see [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)


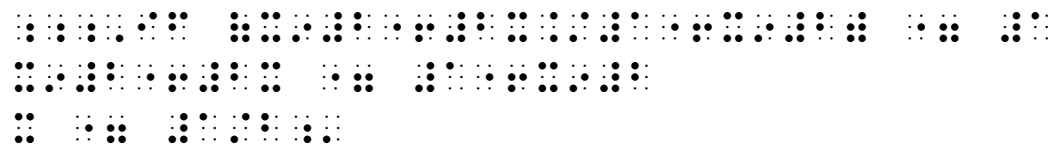
$x^{a/b}y = x$ (x superscript "a over b" end superscript y = x)


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

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

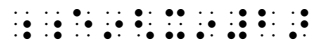
$x = 1/2$


(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.)

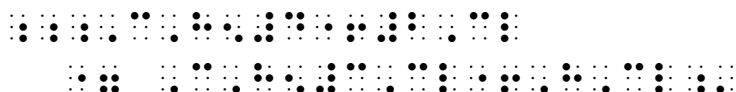
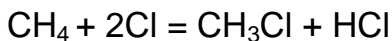
$$0.0045 = 4.5 \times 10^{-3} \quad (0.0045 = 4.5 \text{ times } 10 \text{ to the minus } 3)$$


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


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


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.

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

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

8 Square Roots and other radicals

-  open radical (root)
-  close radical (root)
-  square root sign without vinculum

8.1 Square roots

The expression inside the square root sign in print (the radicand) should be preceded by the open radical sign and followed by the close radical sign. The radicand itself may be any expression whatsoever, and may therefore contain radicals as well as other mathematical structures. Note that both the opening and closing radical signs have alternative grade 2 meanings so may need grade 1 indicators.

$\sqrt{9} = 3$ (the square root of 9 = 3)



(Note that the square root of a simple number still needs to be terminated by the close radical sign.)

$r = \sqrt{x^2 + y^2}$ (r = the square root of x squared + y squared end root)



$$\sqrt{\frac{783.2 \times 6.547}{0.4628}}$$

(the square root of fraction 783.2 times 6.547 over 0.4628 end fraction end root)



$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

(x = the fraction: minus b plus-or-minus the square root of b squared minus 4ac end root all over 2a)



8.2 Cube roots etc

In print the radical index, if present, is printed above and to the left of the radical sign. This index is placed in braille as a superscript expression immediately following the opening radical symbol.

$$\sqrt[3]{8} = 2 \quad (\text{the cube root of } 8 = 2)$$

⠠⠨⠠⠚⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠼⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

$$q = \sqrt[3]{x^3 + y^3 + z^3}$$

(q = the cube root of x cubed + y cubed + z cubed end root)

⠠⠚⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

$$\sqrt[mn]{xy}$$

(the mn-th root of xy)

⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

$$81^{\frac{3}{4}} = \left(\sqrt[4]{81}\right)^3 = \left(\sqrt{\sqrt{81}}\right)^3 = \left(\sqrt{9}\right)^3 = 3^3 = 27$$

(81 to the three-quarters = (the fourth root of 81) cubed = (the square root of the square root of 81) cubed = (the square root of 9) cubed = three cubed = 27)

⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

⠠⠚⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

⠠⠚⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

8.3 Square root sign on its own

Sometimes print omits the horizontal line (vinculum) above the radicand. In older books $\sqrt{4}$ could mean the square root of 4, but in some modern contexts could be just a sequence of symbols.

When introducing simple roots to younger children, it is better to introduce the concept of opening and closing indicators from the start. If it is clear from the context that this is a square root, then it is best to assume an intended vinculum and to use the standard form. If, however, the square root sign is being used as an isolated graphic symbol then the dot 5 form can be used. Ex.

$$\sqrt{4} = 2 \quad \text{⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨}$$

$$\sqrt{4} = 2 \quad \text{⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨}$$

The $\sqrt{}$ sign ⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨⠠⠼⠠⠲⠠⠨

9 Functions

If a function name is preceded or followed by a letter of the same font and alphabet, it may not be clear where the function name begins or ends. In print this is clarified using a variety of techniques. Take the example a times the cosine of t . In print this is often written $a \cos t$. Notice that here the a and t are written in italics to show they are variables, and a small space is included either side of the function name. This technique is also used in print to distinguish word fragments other than functions.

The examples in this section are taken from secondary school science and mathematics but the same rules should be followed when dealing with functions within any subject area.

9.1 Spelling and capitalisation

Follow print for the spelling and capitalisation of function names.

Find the value of Cosine B.

⠒⠒⠒⠒⠒ ⠒ ⠒⠒⠒⠒⠒⠒ ⠒ ⠒⠒⠒⠒⠒⠒⠒⠒ ⠒⠒⠒⠒

9.2 Italics

Where letters before or after the function name are written in italics to indicate they are variables, the italics should be omitted in accordance with rule [1.3](#).

9.3 Spacing

Where the function name is preceded or followed by a letter, a space may be needed, to remove ambiguity as to where the function name begins and ends. The space is not needed if the function name is already separated by a bracket or by a braille indicator such as a capitalisation indicator, a Greek letter indicator or a fraction indicator. Care should be taken when a capital letter precedes a function name. This is summarised below.

9.3.1 If a function name is directly preceded or followed by a number, then the number should be written unspaced from the function name.

Sin 30

⠠⠎⠊⠒ ⠠⠑⠠⠎

3 tan 45° (3 tan 45 degrees)

⠠⠒ ⠠⠠⠎⠒ ⠠⠑⠠⠎ ⠠⠑⠠⠎

4cos5x

⠠⠒⠠⠠⠎⠠⠑⠠⠎

9.3.2 Insert a space if a function name is followed directly by a lower case Latin letter with no intervening braille indicators or brackets.

log y

⠠⠠⠠⠠⠠⠠⠠⠠⠠

sin θ (sin theta)

⠠⠠⠠⠠⠠⠠

Sec A

⠠⠠⠠⠠⠠⠠⠠⠠

log(x + y)

⠠⠠⠠⠠⠠⠠⠠⠠⠠

Lim $\frac{x}{2}$ (Lim "x over 2")

⠠⠠⠠⠠⠠⠠⠠⠠⠠

9.3.3 Insert a space if a function name is preceded directly by a lower or upper case Latin letter with no intervening braille indicators or brackets. Note that letters isolated by these extra spaces may need grade 1 indicators.

$x \sin 60$



$x \text{Sin } 60$



$X \log y$



$x \text{Log } y$



$\sin(A+B) = \sin A \cos B + \cos A \sin B$



$\sin 2\beta = 2 \sin \beta \cos \beta$ (sin 2 beta = 2 sin beta cos beta)



9.4 Trigonometric functions

Common trigonometric functions are Sine, Cosine, Tangent, Secant, Cosecant and Cotangent, usually abbreviated in print to sin, cos, tan, sec, cosec and cot.

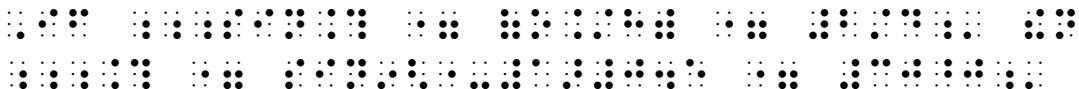
Their inverses may be written in print as

\sin^{-1} (sin superscript minus 1), \cos^{-1} , \tan^{-1} , \sec^{-1} , cosec^{-1} and cot^{-1} , or less commonly as arcsin, arccos, arctan, arcsec, arccosec and arccot.

You may also meet the associated hyperbolic functions sinh, cosh, tanh, sech, cosech and coth and their inverses.

If $\sin \theta = \frac{o}{h} = \frac{2}{4}$ then $\theta = \sin^{-1} 0.5 = 30^\circ$

(If sin theta = o over h = 2 over 4 then theta = sin to the minus 1 of 0.5 = 30 degrees)



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 sub 1 z sub 2 = $\arg z$ sub 1 + $\arg z$ sub 2)



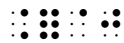
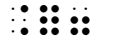
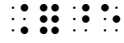
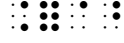


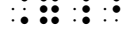
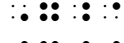

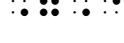


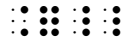










$$\arg(z_1 z_2) = \arg z_1 + \arg z_2$$

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

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

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

10 Set Theory, Group Theory and Logic

	\cup union (upright U shape)
	\cap intersection (inverted U shape)
	\emptyset null set (slashed zero)
	' complement (prime sign)
	\in is an element of (variant epsilon)
	\ni contains as an element (reverse variant epsilon)
	\subset contained in, is a subset of (U open to right)
	\supset contains, is a superset of (U open to left)
	\subseteq contained in or equal to
	\supseteq contains or equal to
	\subsetneq contained in, but not equal to (proper subset)
	\supsetneq contains, but is not equal to (proper superset)
	\triangleleft is a normal subgroup of (closed "less than")
	\triangleright inverse "is normal subgroup" (closed "greater than")
	\trianglelefteq is normal subgroup of or equal (closed "less than", line under)
	\trianglerighteq inverse "normal subgroup or equal" (closed "greater than", line under)
	$\triangleleft\cancel{\sim}$ normal subgroup but not equal (closed "less than", cancelled line under)
	$\triangleright\cancel{\sim}$ inverse "normal subgroup but not equal" (closed "greater than", cancelled line under)
	\vee or (upright v shape)
	\wedge and (inverted v shape)
	\neg "not" sign (line horizontal, then down at right)
	\vDash assertion ("is a theorem" sign; "T" lying on left side)
	\dashv reverse assertion ("T" lying on right side)
	$\vDash\!\!\vDash$ "is valid" sign (assertion with double stem on "T")
	$\dashv\!\!\dashv$ 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

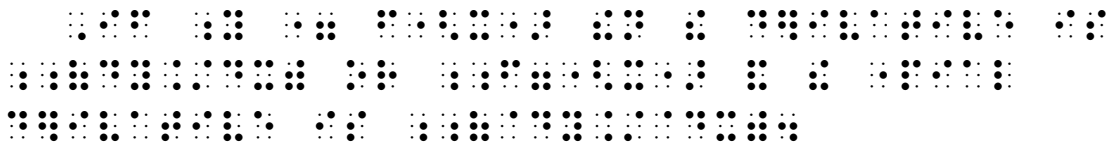
One of the underlying design features of UEB is that each print symbol should have one and only one braille equivalent. For example the vertical bar is used in print to represent absolute value, conditional probability and the words "such that", to give just three examples. The same braille symbol should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

11.5 Examples

11.5.1

If $y = f(x)$ then the derivative is $\frac{dy}{dx}$ or $f'(x)$ and the partial derivative is $\frac{\partial y}{\partial x}$.

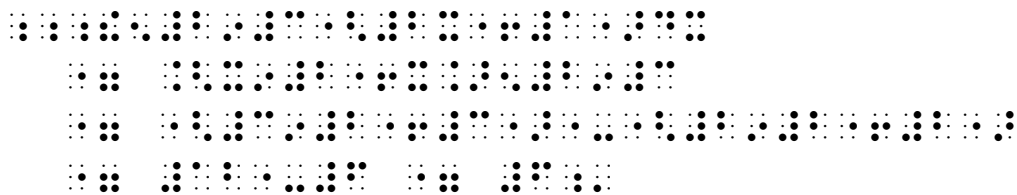
(If $y = f(x)$ then the derivative is dy over dx or f dash x and the partial derivative is curly d y over curly d x)



11.5.2

$$\begin{aligned} & \int_2^3 (2x+1)dx \\ &= [x^2 + x]_2^3 \\ &= (3^2 + 3) - (2^2 + 2) \\ &= 12 - 6 = 6 \end{aligned}$$

(the integral from 2 to 3 of $(2x+1) dx = [x \text{ squared} + x] \text{ sub } 2 \text{ super } 3 = (3 \text{ squared} + 3) \text{ minus } (2 \text{ squared} + 2) = 12 - 6 = 6$)

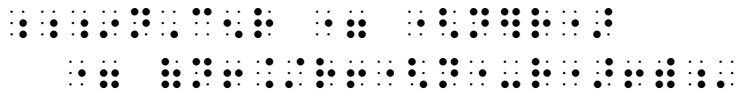


Note: the spacing of the integral sign in print can be unclear or inconsistent. In braille it is best to have the integral sign unspaced from the function and treat its limits as subscripts and superscripts. The dx at the end means "integrate with respect to x", and can also be written unspaced.

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)

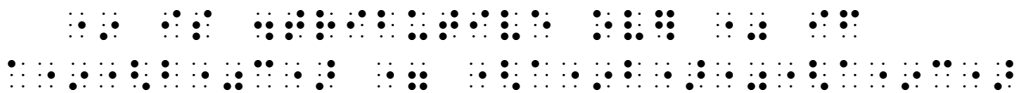


Note: the binomial coefficient works better as a shape than a vector (refer to 14.3.3).

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))

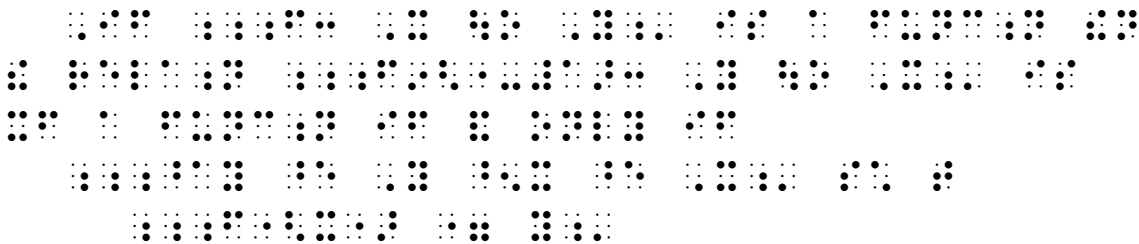


Note: the hollow dot should not be used to represent the abbreviation for degrees, which is covered in [Section 3](#).

11.5.5

If $f: X \rightarrow Y$ is a function then the relation $f^{-1}: Y \rightarrow X$ is itself a function if and only if $\forall y \in Y \exists x \in X$ such that $f(x) = y$

(If f from X to Y is a function then the relation f^{-1} from Y to X is itself a function if and only if for all y in Y there exists x in X such that $f(x) = y$)



Note: see [Section 13](#) for the representation of arrows.


11.5.6

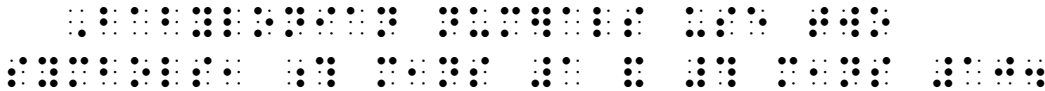
$$\{(x, y) \mid x + y = 6\}$$

(The set of (x, y) such that $x + y = 6$)



11.5.7

Babylonian numerals use two symbols,  means 1 and  means 10.

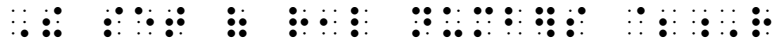


Note: the two transcriber defined symbols would be defined either on the special symbols page or in a transcriber's note.

11.6 Embellished capital letters

Embellished capital letters are often used to name common sets such as the universal set E, the set of real numbers R or integers I. These vary in print from book to book but can be represented in braille by the script typeform indicators.

The set of real numbers \mathfrak{R}



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.

12.2 Two indicators applied to the same item

If two indicators apply to the same item, then braille grouping symbols must be used to show which applies first.

$x^{\bar{y}}$ (x to the "y bar")

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

$\overline{x^y}$ (x to the y with a bar over the whole expression)

⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠⠠

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)

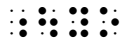
If an arrow has unusual tips, decide which is the head before you choose the direction of your closing indicator. The complete rules for deciding arrow direction are:

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 Combined shapes

If two print symbols have been combined to form a new previously undefined symbol, then it must be decided whether the second symbol is enclosed, superimposed, combined on the right or combined below. Each of the four composite symbol indicators signals a combining of the item just prior with the item immediately following it, where "item" is as defined in [Section 7](#).

Each composite symbol indicator will need a grade 1 symbol indicator unless the whole expression is already in grade 1 mode.

14.3.1 Physical Enclosure, ⦶⦶

⊕ (circle enclosing a plus sign)



In the example below, the circle enclosing a plus sign is being used as an operation sign. In the first version the operation sign is unspaced so a termination sign is needed but no grade indicators are needed because the number signs initiate numeric mode. In the second version the operation sign is spaced for clarity so no termination sign is needed but the shape symbols do need grade 1 indicators.

2⊕3 = 3⊕2 (2 "circled plus" 3 = 3 "circled plus" 2)



2⊕3 = 3⊕2 (2 "circled plus" 3 = 3 "circled plus" 2)



Note: See [Section 3.5](#) if numbers are enclosed in a square to represent a calculator key.

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 1. 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 $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ and the second is $\begin{bmatrix} 1 & 2 \\ -3 & 4 \\ 5 & -6 \end{bmatrix}$. The matrices are enclosed in large square brackets, and the minus signs are brailled to stand out.

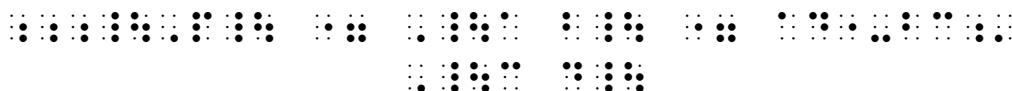
$$\begin{pmatrix} a & -b \\ -c & d \end{pmatrix}$$

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 represented by their respective Braille characters for variables and minus signs.

15.3 Determinants

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

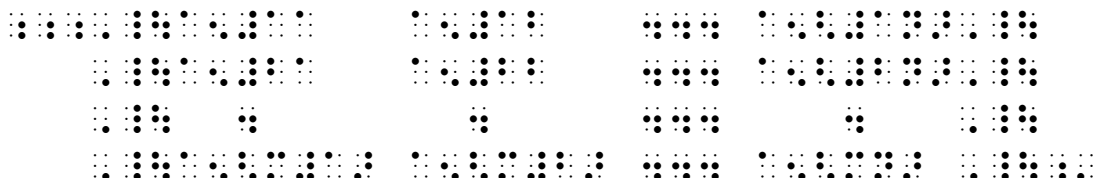
$$|P| = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$



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 above uses blocked entries and blank lines between rows to handle width. Each entry is represented by a 3x3 grid of Braille cells, with the first column of each row being blocked. There are blank lines between the rows of the matrix.

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 above uses a column-wise layout. The first column is completed without overruns, and the second column is placed below it, indented two cells. This approach makes the individual entries easier to read.

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.

A transcriber's note should be included in either case to explain the placement of each entry.

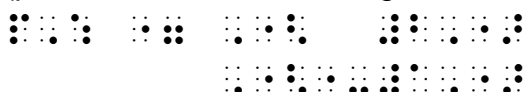
15.6 Vectors

Letters representing vectors are often printed in bold font and may have arrows or bars above or below. Boldface only needs to be shown in braille if it is the only method used. For arrows and bars above and below see [Section 12](#).

If the vector $\begin{pmatrix} 2 \\ -1 \end{pmatrix}$ was called p and went from point A to point B here are some of the most likely forms:

$$\underline{p} = \begin{pmatrix} 2 \\ -1 \end{pmatrix}$$

(p with a bar under = enlarged round brackets, 2 at the top and -1 at the bottom)



\overline{p} (p with a bar over)



p (bold p)



\overrightarrow{AB} (AB with an arrow over)



\underline{AB} (AB with a bar under)



15.7 Grouping of equations

Opening enlarged curly braces are often used to group equations. Print spacing should be followed where possible.

Solve:

$$\begin{cases} x+2y=7 \\ 2x-y=-4 \end{cases}$$

$$\begin{cases} x+2y=7 \\ 2x-y=-4 \end{cases}$$

$$f(x) = \begin{cases} 0 & \text{if } x < 0 \\ x^2 & \text{if } x > 0 \end{cases}$$

$$f(x) = \begin{cases} 0 & \text{if } x < 0 \\ x^2 & \text{if } x > 0 \end{cases}$$

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

16.1 Chemical names

cyclohexane

⠠⠨⠠⠭⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨

2,2-Dimethylpropane

⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨

1-Hydroxyl,2-nitrobenzene

⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨

Copper(II) Sulphate

⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨

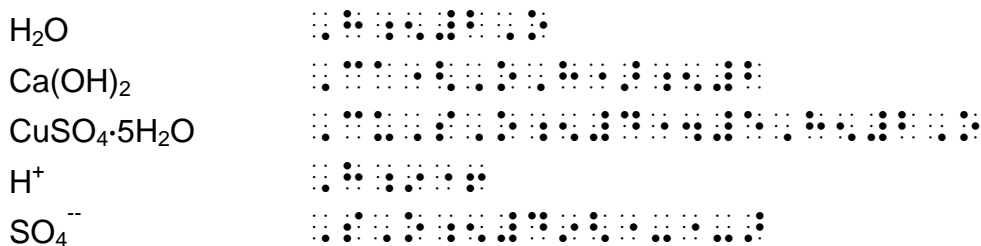
Copper^{II} Sulphate

⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨

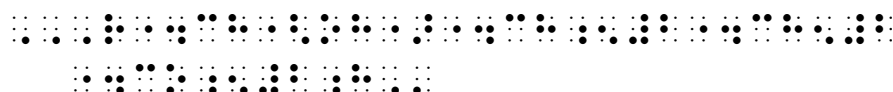
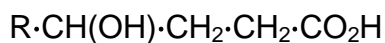
16.2 Chemical formulae

Use of capital indicators and terminators: The general UEB principles on the choice of single letter, word or passage mode apply; in particular, a capital terminator should not be used within a two-letter chemical element symbol. Using single capital indicators for chemical formulae provides a uniform appearance to the braille; nevertheless, there may be a clear advantage in using capital passage mode in some cases. Letters representing chemical elements should never be contracted.

O	⠠⠨
Fe	⠠⠨⠠⠺
NO	⠠⠨⠠⠺
NaCl	⠠⠺⠠⠨⠠⠨
Al(O)Cl	⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨⠠⠨
O ₂	⠠⠨⠠⠨



An example of using capital passage mode:

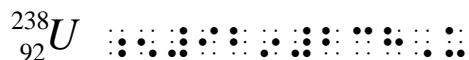


Note that Roman numerals are capitalised as a single group:



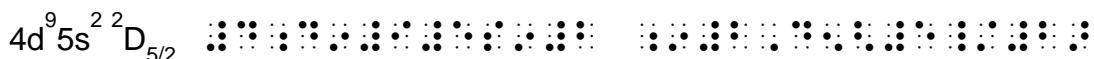
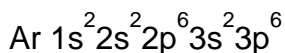
16.3 Atomic mass numbers

These are often shown with left-hand superscript and subscript numbers:

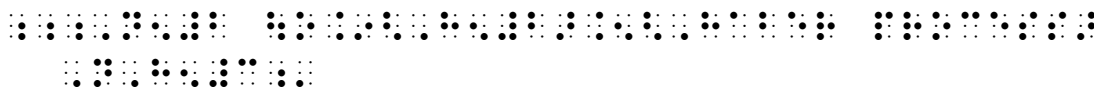
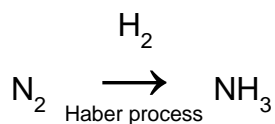
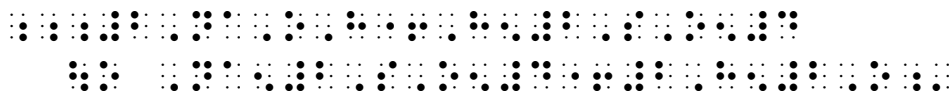
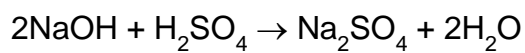


16.4 Electronic configuration

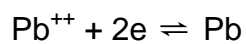
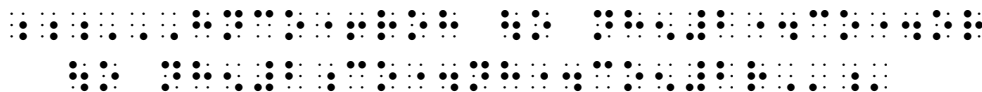
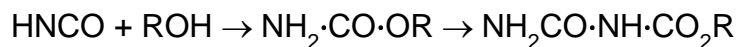
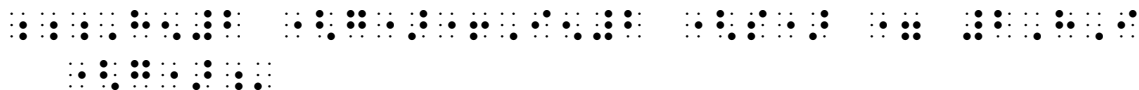
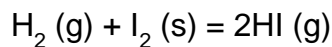
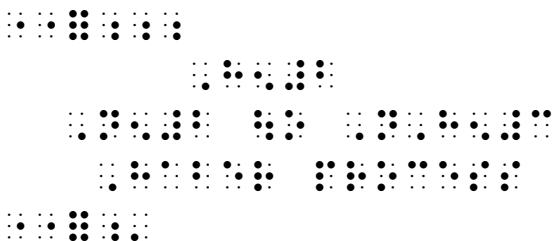
Such notation can involve left-hand superscripts, and a space or half-space in print needs to be retained in the braille to make the attachment clear.



16.5 Chemical Equations



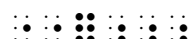
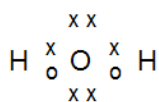
or



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.

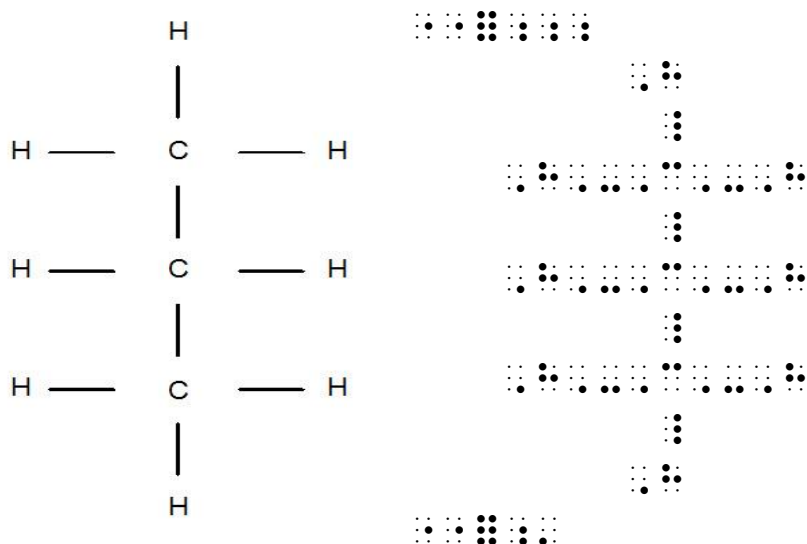
Cl·

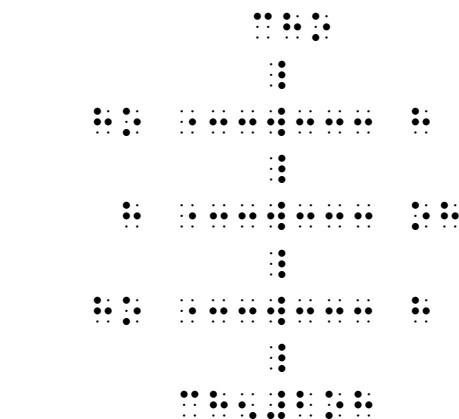
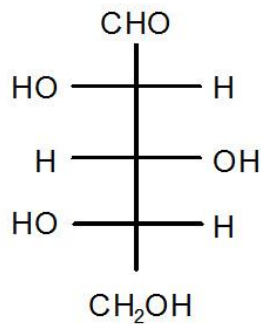
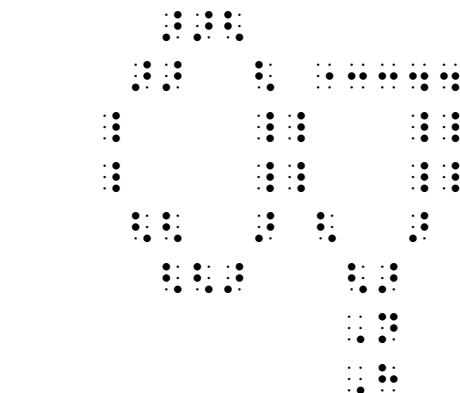
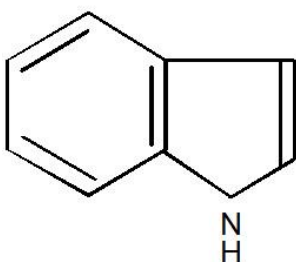
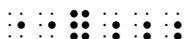
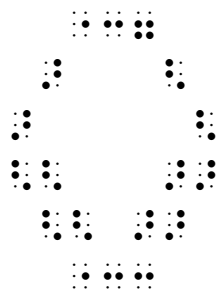


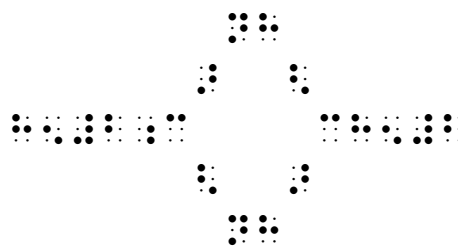
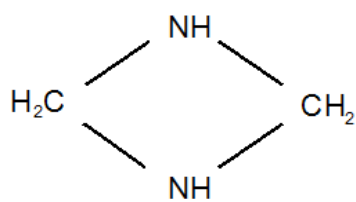
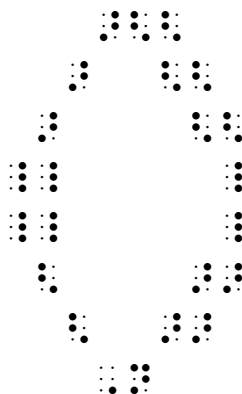
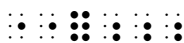
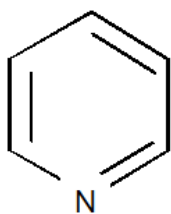
16.7 Structural Formulae

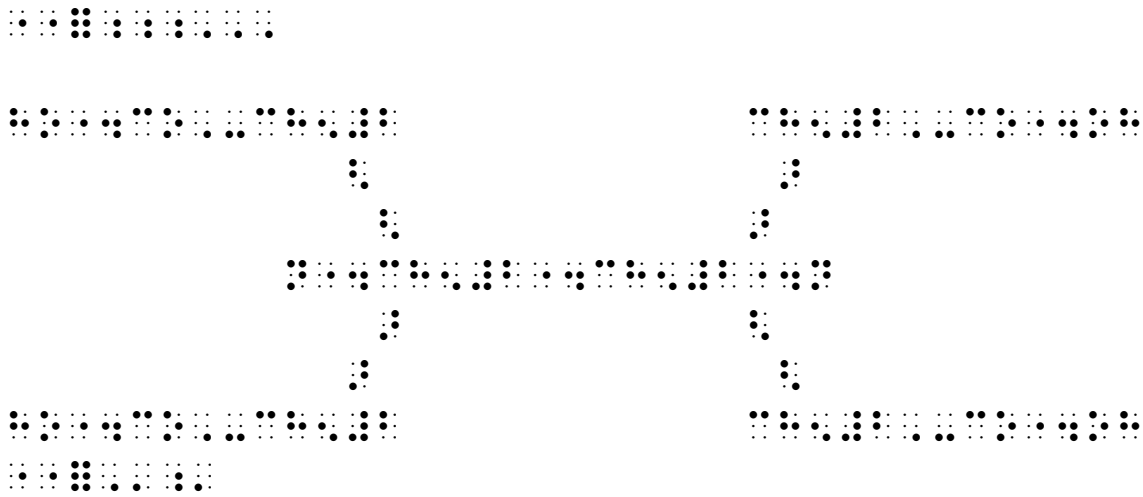
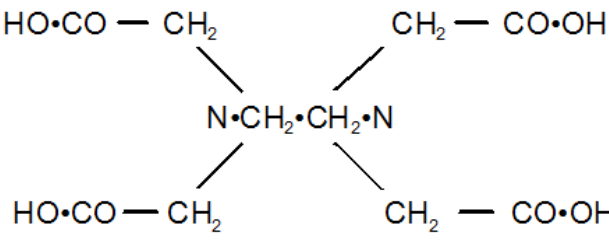
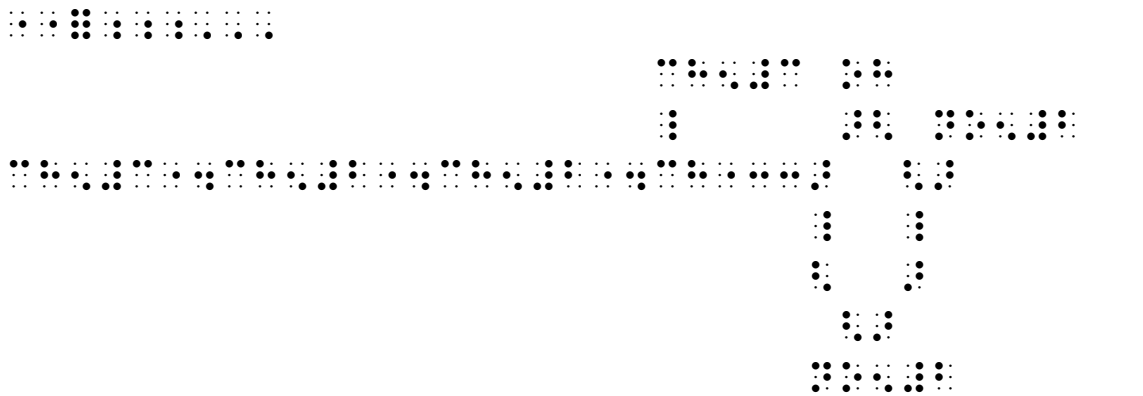
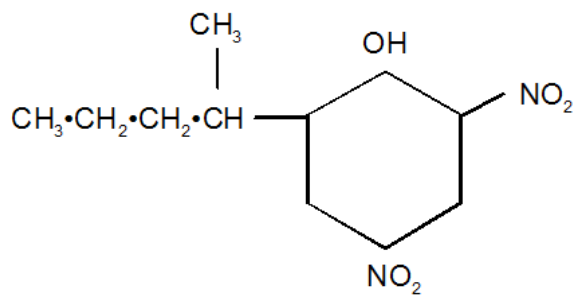
The general UEB method for line drawing may be used for representing structural formulae. Refer to the *Rules of Unified English Braille, Section 16: Line Mode, Guide Dots* for symbols used to draw lines using braille cells. In-line bond signs can be used in conjunction with the line drawing symbols.

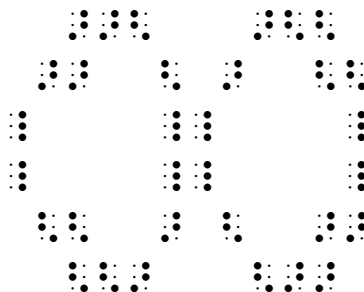
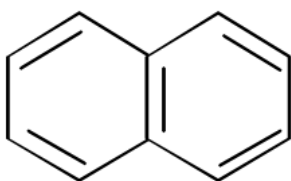
Some examples are shown below. For more complex cases it is recommended that the structure be drawn out graphically rather than using transcriber defined symbols.











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

line makes a break necessary in braille that does not correspond to a break in print, a continuation indicator should be inserted and the line continued on the next line. The specific continuation indicator used depends on whether the break in effect replaces a space in the original line (which is preferred, if practical, and in which case use dots 5, 5), or is simply introduced at an arbitrary point (in which case use dot 5). In the latter case, when practical, it is preferable not to introduce a break between letters.

The significance of spaces within computer notation also depends upon the specific formal syntax involved. Exact spacing, that is a certain number of spaces, may sometimes be significant, as in "strings" — although usually, only the presence or absence of space is significant. If the print presentation makes the number of spaces practical to count, as for example by using "visible spaces" (see below) or a monospaced font, and the transcriber is not certain that exact spacing is not significant, then it should be assumed that exact spacing is significant. Otherwise, spaces should be used where they are in print, but not necessarily the exact same number. As a particular application of the latter case, when the left margin shows a pattern of indentation, such indentation should be replicated in braille, but generally using multiples of two cells instead of the five or ten positions often used in print.

In print computer notation, a "visible space" can be represented by any of several ad-hoc characters, such as:

- ḃ U+0180 Latin small letter b with stroke (or "b" plus combining stroke or solidus)
- └ U+23B5 bottom square bracket
- Δ U+0394 Greek capital letter delta
- Δ U+2206 Increment
- △ U+25B3 White up-pointing triangle

When such "visible spaces" are used in print, dots 346 should be used in braille for each such "visible space" (preceded by grade 1 indicators if necessary). Likewise, if per the guidelines above it is determined that a sequence of three or more ordinary spaces in print is to be treated as significant, then each significant space in the sequence, other than the first and the last, should be indicated by dots 346 (with grade 1 indicators if necessary).

Examples:

1. A "command prompt" showing the cursor immediately following (in grade 1 context):

C:\>

```

      □
      ⠠⠠⠠⠠⠠⠠⠠⠠
          ⠠⠠
  
```


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.

