

The system of mathematical writing in German Braille

**According to the decisions
dated November 30, 2013
in Basel**

**Black print version
(Separate versions are available for
reading on a Braille display)**

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The system of mathematical writing in German Braille

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Preface

The present set of rules is the result of a major revision of the German Braille mathematics writing since the creation of the "International Mathematics Writing for the Blind".

This was developed in the 1920s by representatives of several countries and ensured that the essential elements - symbols as well as representation techniques - had extensive international uniformity.

Traces of this uniformity can still be seen almost a century later. Even if the Chinese Braille is, as expected, very different from the German, those familiar with the German Braille will find something familiar when looking at the Chinese bump.

Development

Braille is continually being adapted to new needs and challenges. The fonts for individual languages are often developed independently of each other - and with them the respective mathematics fonts. In the course of these developments, international common ground was replaced by increasingly independent, independent mathematics writings.

In the German-speaking area, a revision was made from the 1950s onwards and recorded in a new set of rules (1955, 2nd edition 1986). Over time, however, regional variants emerged. This is how they developed

Notations in the Federal Republic of Germany and in Austria, in the GDR and in Switzerland differ. In order to standardize the mathematics writing for this language area again and thus not to further restrict the interchangeability of mathematical literature, a subcommittee was formed in 2006 by the Braille Committee of the German-speaking countries.

Compactness versus context independence

Traditionally, numerous Braille characters in mathematics writing have different values or meanings than in text writing.

A reinterpretation of the 64 possible Braille characters allows a very compact - and therefore clear - representation of the mathematical notation. This comes with the compromise that the Braille characters are only unique when they can be clearly assigned to mathematical or text writing.

In various languages, however, a paradigm shift took place. By representing mathematical symbols using longer combinations of Braille characters, they are unique in both general and mathematical contexts.

However, the compactness of the reproduction is lost.

This mathematics publication maintains the separation between text and mathematics writing in favor of the brevity and clarity of the presentation. However, approximations to the text font could be achieved, for example in the identification of upper and lower case letters.

Innovations

"The system of mathematical writing in German Braille" is divided into two parts.

This first part describes the rules for reproducing mathematical facts in Braille. There are significant innovations in the structure. Lists of characters introduce the respective chapters or sections. Numerous examples illustrate the implementation of the rules. A glossary clarifies specific Braille terms. Notes on written calculation procedures will make it easier for teachers to access practical work with Braille.

The additional representation of the examples in LaTeX might be interesting. An important concern is to be able to check the accuracy of your own interpretation of the Braille examples. For this purpose, the black text display is available to sighted people. The LaTeX representation also offers tactile readers a control option.

Preface

A fundamental innovation concerns the possibility of communication between the different reader groups. Care was taken to ensure that different media versions such as Braille and black print can be used in parallel. The examples are numbered and the text has been structured so that the layout in Braille and black text is essentially the same.

The second part is a relief volume in which both the tactile black-letter symbols and the Braille equivalents of all mathematical symbols from the rules are listed. This makes communication between blind, visually impaired and sighted people easier.

Further examples can be viewed on the website of the Braille Committee of the German-speaking Countries (BSKDL). be supplemented (www.bskdl.org).

The new content of the font is summarized in the appendix "A2 Changes in the mathematics font".

This set of rules is not designed as a textbook. For blind and sighted teachers, translators and readers of Braille, this handout is intended to supplement the principles of Braille (see "System of German Braille"), especially in the field of mathematics. It builds on the basic rules and requires knowledge of them.

**Basel, January 2015
On behalf of the Mathematics Writing Subcommittee
of the Braille Committee of the German-Speaking Countries
The editorial team**

To use this regulations

Construction

This set of rules is published in Braille and black print. A fine structure with decimal classification serves for orientation in the work and makes communication easier when working with the various media output forms.

The numbering of the examples reflects this structure.

Basic techniques and tips for reproducing mathematics in Braille are explained in Chapter 1. Chapters 2 to 11 introduce the individual elements of the notation and their use. Finally, chapters 12 to 15 focus on selected areas of mathematics.

In appendices, suggestions for working with written calculation methods are given, the changes and innovations of this revision of the mathematics writing are listed and Braille-specific technical terms are explained in a glossary.

For a quick search, a list of all Braille characters covered and a subject index are available.

The individual subject areas are structured as follows: •

List of

characters • Rules and explanations • Examples

Each example appears in two or three representations: •

Black font (black font output) • Braille • LaTeX notation

An exception are the examples in "Appendix A1 Written calculation methods over several lines", which only appear in Braille. In addition to implementation and design options, the focus here is on practical work with Braille.

For the use of this work

In a second part, relief representations are intended to enable blind readers to experience mathematical symbols in black letters and to make communication with others easier.

The Braille Committee of the German-speaking countries has a subpage on Braille mathematics on its website (www.bskdl.org) for downloading documents and collecting examples. Interested parties are invited to contribute to expanding the sample collection.

LaTeX

As a way of comparing Braille with a second representation, a LaTeX notation was chosen for tactile readers who cannot rely on the visual representation.

It cannot be assumed that all touch readers know LaTeX. And yet it has been shown that even with a little knowledge of LaTeX, it is possible to determine, for example, whether a character is still contained in an exponent or not. And it is precisely such uncertainties that need to be minimized as much as possible when studying the examples.

For the sake of clarity, the LaTeX representation consists of Original LaTeX and not one of the simplified variants that are increasingly used on computers as a type of mathematics for the blind. On the other hand, no great emphasis was placed on writing them in such a way that a LaTeX compiler could create aesthetically flawless black text from them.

To make reading the LaTeX expressions easier, 8-point Braille was chosen for this. For a quick lookup of used LaTeX keywords, a list is offered electronically on www.bskdl.org. This set of rules and the list are not suitable for learning LaTeX.

1 Basic techniques for transferring mathematics

1.1 Switching between text and math writing

$\%!$,	Announcement sign for one Passage in mathematics writing
$\%'$.	Discontinuation sign for one Passage in mathematics writing
$\%'$.	Announcement sign for one Passage in Textschrift
$\%'$.	Discontinuation sign for one Passage in Textschrift

Braille characters and their combinations sometimes represent different symbols in text and mathematical writing. Marking the transitions between the two scripts is therefore of great importance.

Three different techniques are available for this: • Layout technique •

Announcement and termination technique • Double space technique

The choice of technique depends on the context.

1.1.1 Layout

In documents with a large mathematical content, readers calculate with mathematical writing. To mark the change from text to mathematical writing, it is often enough to use the layout to distinguish lines with mathematical content from the rest of the text.

A very frequently used design option for identifying lines of mathematics writing is indentation and outdentation. This involves rows around a number of shapes

1 Basic Techniques

indented with respect to the preceding text environment. The change back to text writing is done by starting a new line in the text layout. If several lines are required for the mathematical passage, the following must be noted: • The mathematical passage must be different from the surrounding ones

Make text passages stand out clearly.

- The first and continuation lines are regarding her to design indentation differently.

Other design forms include edge markings (see example 1.1.1 B02) or table columns (see examples 1.1.1 B03 and 1.1.1 B04).

Example 1.1.1 B01 The

conversion factor from the unit electronvolt eV

in joules J is:

$$1\text{ eV} = 1.6 \cdot 10^{-19} \text{ J}$$

the conversion factor of the electronvolt in joule:

$$\begin{aligned} \#a_{\text{eV}} &= \#a_{\text{J}} \cdot e' \\ &= \#a_{\text{J}} \cdot 1.6 \cdot 10^{-19} \end{aligned}$$

The conversion factor from the unit electronvolt eV to joule J is:

$$1 \text{ eV} = 1.6 \cdot 10^{-19} \text{ J}$$

Example 1.1.1 B02

(Note: The beginning of the mathematics text is also marked with an m in the left margin column.)

The conversion factor from the unit electronvolt eV

in joules J is:

$$1\text{ eV} = 1.6 \cdot 10^{-19} \text{ J}$$

1 Basic Techniques

the conversion factor of the
 3nh3t electronvolt eV in joule J : $\#a_e v = \#a_v e'$
 $= \#a_v \cdot \#a, f \cdot \#a_j \cdot \#a_c'$
 $= \#a, f \cdot \#a_j \cdot \#a_c'$

The conversion factor from the unit electronvolt eV to joule J is:

$$1 \text{ eV} = 1 \text{ V} \cdot e = 1 \text{ V} \cdot 1,6 \cdot 10^{-19} \text{ C} = 1,6 \cdot 10^{-19} \text{ J}$$

Example 1.1.1 B03

(Note: In LaTeX only the tabular representation is used rudimentarily pointed out.)

Sentence	Formula
Multiplication is commutative.	$a \cdot b = b \cdot a$
Multiplication is associative.	$(a \cdot b) \cdot c = a \cdot (b \cdot c)$
The 1 behaves neutrally with regard to multiplication.	$a \cdot 1 = a$

sentence

.....

d0 multiplication $ab = ba$

i} commutative.

d0 multiplikation $2a \cdot b \cdot c = a \cdot 2b \cdot c$

i} associative.

d0 $\#a \text{ verh`lt si4 } a \cdot \#a = a$

bez8gli4 of multiplication

n2tral.

formula

1 Basic Techniques

`\[ \text{Theorem} & \text{Formula} ]`

`\text{Multiplication is commutative.} & a \cdot b = b \cdot a`

`\text{Multiplication is`

`associative.} & (a \cdot b) \cdot c = a \cdot (b \cdot c) \\ \text{The 1 behaves} \\ \text{neutrally with regard to multiplication.} & a \cdot 1 = a]`

Example 1.1.1 B04

(Note: In LaTeX only the tabular representation is used rudimentarily pointed out.)

Special squares:

Description	Perimeter	Area
square	$a + b + c + d$	$\frac{d}{2} (h_1 + h_2)$
trapeze	$a + b + c + d + m + h$	a
Dragon square 2 2	$a + b$	$\frac{1}{2} d_1 d_2$
Parallelogramm 2 2	$a + b$	ah
Rhombus	$4 a$	$\frac{1}{2} d_1 d_2$
square	$4 a$	a^2

1 Basic Techniques

special goals:

Description scope

fl`4eninhalt

v0reck

$$a + b + c + d ; d_1, 8 \# b < "$$

$$2h_1, +h_1;` a + b + c + d$$

trapeze

$$m.h_1a \# b'a + \# b'b \# a; .d_1, d_1;$$

dra4en- v0reck

paralle- $\# b'a + \# b'b$ a.h1a logram rhombus square $\backslash \text{\text{Special quadrilaterals}}$

$\backslash \# d'a \dots \# a; .d_1, d_1; \# d'a \dots a$;

$\text{\text{Description}}$

$\& \text{\text{Perimeter}} \& \text{\text{Area}} \backslash \backslash$

$\text{\text{Quadrilateral}} \& a + b + c + d \& \frac{d_{\{1\}}{2}(h_{\{1\}} + h_{\{2\}}) \backslash \backslash \text{\text{trapezoid}} \& a$

$+ b + c + d \& m \backslash \cdot h_{\{a\}} \backslash \backslash \text{\text{Dragon}}$

$\text{\text{Square}} \& 2a + 2b \& \frac{1}{2}d_{\{1\}}d_{\{2\}} \backslash$

$\backslash \text{\text{Parallelogram}} \& 2a + 2b \& a \cdot h_{\{a\}} \backslash \backslash \text{\text{Rhombus}} \&$

$4a \& \frac{1}{2}d_{\{1\}}d_{\{2\}} \backslash \backslash \text{\text{Square}} \& 4a \&$

$a^{\{2\}} \backslash$

1.1.2 Announcement and termination symbols for mathematics writing

%!,

Announcement sign for one

Passage in mathematics writing

%'.

Discontinuation sign for one

Passage in mathematics writing

The transitions from text to mathematical writing and back are marked most clearly with announcement and termination signs.

The announcement character occurs immediately before the first character of the mathematical font. Except at the beginning of the line

1 Basic Techniques

it is usually preceded by a space. However, it occurs immediately after an opening text bracket or other symbol that could also be followed by text without a space.

The discontinuation mark is placed immediately after the last character of the mathematics passage. This is followed by a space or punctuation mark.

Mathematics passages introduced with the announcement mark must be concluded with the termination mark. They may only be interrupted by short passages of text delimited using the double space technique.

Punctuation marks at the end of a mathematical passage are usually not part of the mathematical expression itself

For the sake of clarity, they are written after the discontinuation symbol, where they do not have the preceding point 6 need (see "3.7 Punctuation").

Example 1.1.2 B01 (Note:

Heading from a textbook.)

14 The decomposition of $ax^2 + bx + c$ into linear factors +

#ad d0 decomposition of $ax^2 + bx + c$. in
linear factors

=====

or in shorthand:

#ad 0 z7legu v $ax^2 + bx + c$. * l*e)fakt?c

=====

14 The decomposition of $ax^2 + bx + c$ into
Linear factors

1 Basic Techniques

Example 1.1.2 B02

Everyone knows the formula $E = mc^2$, but only a few understand it.

Everyone knows the formula $E = mc^2$, but only a few miss s^0 .

Everyone knows the formula $E = mc^2$, but only a few do you understand.

Example 1.1.2 B03

Newtonian mechanics is at speeds in

Range of the speed of light ($3 \cdot 10^8 \frac{\text{m}}{\text{s}}$) not more valid.

Newtonian mechanics is at speeds in the range of the speed of light ($c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$) no longer valid.

Newtonian mechanics is no longer valid at speeds in the range of the speed of light ($c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$).

1.1.3 Announcement and termination symbols for Text font

%'

Announcement sign for one Passage in Textschrift

%'

Discontinuation sign for one Passage in Textschrift

Text writing within a mathematics writing passage can also be marked with announcement and termination symbols. The announcement symbol appears immediately before the first text character after a space that occurs at the border point. The discontinuation character follows immediately after the last text character.

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In a mathematics passage, the text insert is usually in the same degree of abbreviation (short, full or basic script) as the rest of the transmitted text.

These announcement and termination symbols may also be used within a mathematics passage, which in turn is delimited with announcement and termination symbols.

On the other hand, a text insert marked with an announcement symbol may not contain any mathematical inserts.

Example 1.1.3 B01

$I_{10} = 1 \text{ B} \quad (\text{guide value}) \quad 120 \mu\text{A}$

$I_{10} = 1 \text{ B} \quad (\text{guide value}) \quad 120 \mu\text{A}$

$I_{10} = 1 \text{ B} \quad (\text{guide value}) \quad 120 \mu\text{A}$

$I_{10} = 1 \text{ B} \quad (\text{guide value}) \quad 120 \mu\text{A}$

1.1.4 Double space technique Wherever

a change between text and mathematical fonts can be expected, very short insertions of the other font may be marked using the double space technique.

There is a double space before the first character in the other writing system. The change back to the previous writing system is again indicated with a double space. The double space must be between characters and cannot be used at the beginning or end of a line.

The end of an insert that begins with a double space must also be marked by a double space. Only if there is an insert in mathematical font at the end of a paragraph can this terminating double space be dispensed with, since a new paragraph cancels the correspondence caused by the double space technique anyway.

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As a rule, punctuation marks at the end of a mathematical passage are not part of the mathematical expression. They may still be written before the double space at the border point - where necessary with a period - (see "3.7 Punctuation"). If a mathematical expression immediately follows a leading punctuation mark (quotation marks, opening bracket), the double space technique cannot be used.

Example 1.1.4 B01

the equation $x^2 = 16$ is to be resolved. x

d0 gl34young x|; =#of i} na4 'x 1fzul9sen.

The equation $x^2 = 16$ has to be solved for x .

Example 1.1.4 B02 The

base and exponent of a power are for

a n

i. generally not

^{already}
a n y

(Example of one

interchangeable: 4^2
Exception: $2^4 = 4^2$).

base 'a and exponent 'n to the power of 3 are f8r a *=n i. generally
not justifiable: a|n *=n|a =b3sp0l for 3ne 1take: !, #b|/ =#d|, '.=.

Base a and exponent n of a power are for a

$\neq n$ i. generally not interchangeable: $a^n \neq n^a$ (example for an
exception: $2^4 = 4^2$).

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Example 1.1.4 B03

That's it a^n for all integer exponents ($n \in \mathbb{Z}$) defined, but for $n < 0$ with the restriction $a \neq 0$ (because for $a = 0$ would be the definitions for a^{-n} and a^0 - because of $a^0 = a^{n-n}$ - on divisions lead to zero).

so that a^n for all integer exponents $n \in \mathbb{Z}$, but for $n < 0$ with the restriction $a \neq 0$ (because for $a = 0$ would be the definitions for a^{-n} and a^0 - because of $a^0 = a^{n-n}$ - if divisions through lead to zero).

This means that a^n is defined for all integer exponents ($n \in \mathbb{Z}$), but for $n < 0$ with the restriction $a \neq 0$ (because for $a = 0$ they would be the definitions for a^{-n} and a^0 - because $a^0 = a^{n-n}$ - lead to divisions by zero).

Example 1.1.4 B04

Under $\sqrt[n]{a}$ ($a \geq 0$), we understand...

under $\sqrt[n]{a}$ ($a \geq 0$) we understand...

Under $\sqrt[n]{a}$; We understand ($a \geq 0$)

...

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Example 1.1.4 B05

Everyone knows the formula $E = mc^2$, but only a few understand it.

Everyone knows the formula $E = mc^2$, but only a few miss it.

Everyone knows the formula $E = mc^2$, but only a few understand it.

1.1.5 Notes on the use of correspondence techniques

It must always be clear to readers whether they are reading text or mathematics. The following considerations apply when choosing the appropriate technology

Principles:

- The announcement and termination symbols clearly mark the correspondence.
- A passage of mathematics that begins with the announcement mark must end with the termination mark.
- Layout techniques elegantly and clearly delimit the scope area of the respective font.
- The double space technique is expressly only suitable for very short inserts - if possible without line breaks.
- If a mathematical passage begins with a quotation mark or a text bracket, it must not be announced using the double space technique.
- As a rule, punctuation marks at the end of a mathematical passage do not belong to the passage itself. They are therefore immediately to the right of the termination mark '%'. to set. However, if the discontinuation is done by double spaces, they are written in front of them (if necessary with a period 6) so that they do not stand alone.
- A short mathematical expression at the end of a text

Paragraphs can be introduced using the double space technique. The end of the paragraph also marks the end of the insert. Final punctuation marks are not

1 Basic Techniques

written indirectly after the mathematical expression and, if necessary, preceded by a point 6.

- Usually text inserts are in mathematical

Passages written with the same degree of abbreviation as the surrounding

- text. • Single or few words in mathematical passages

(for example "and", "therefore", "It applies") can be written in basic font (with capitalization) without leaving the mathematical font (see "3.8 Text in the mathematical font"). A balance must be struck between the advantageous avoidance of correspondence and a potentially disruptive break in style, especially in shorthand texts.

Caution is advised with umlaut letters and ß, which can be read as other characters in mathematical writing, especially as a fraction dash and closing brackets.

Punctuation marks may need to be preceded by a period 6.

Example 1.1.5 B01

f) $f''(x) = f''(x)$ for every $x \in D$

$f''(x) = f''(x)$ für alle $x \in D$

or

$f''(x) = f''(x)$ für $x \in D$

or

$f''(x) = f''(x)$ 'für alle' $x \in D$ \[f(-x) = f(x) \]; \text{für alle} \]; $x \in D$

1.2 Separating and keeping mathematical expressions together

%'

Line separator in place of a space

%"

Line separator between two immediately adjacent characters

%"

point of cohesion

1 Basic Techniques

In black print, each mathematical "sentence" usually appears alone on one line. There is no hyphen to indicate a mathematical line break in black text.

In Braille, a mathematical "sentence" often takes up more than just one line. Therefore, a character is needed to draw attention to the continuation on the next line.

The placement of spaces in Braille mathematics is not arbitrary. If a line break is necessary, a distinction is made between two cases: • If a mathematical expression is used in place of a

space is wrapped as line separator %' (point 6).

- Is the expression between two immediately adjacent to each other

If the following characters are wrapped, %" (point 4) must be used as a "coherent" separator.

In two other cases, characters with %" (point 4) are kept together to a certain extent: • If two adjacent characters, each with their own meaning, could be read together as another character with a new meaning, %" (point 4) is placed between the two, as long as no better solution is available (see Examples 5 B10 and 14.2 B06).

- In situations where a space is mandatory but would tear the expression apart, %" (point 4) can be used instead of the space. This technique is used primarily in projectives and fractions, but also in matrices.

%" (point 4) in these functions should not be confused with the point 4, which is an integral part of some symbols - for example %_"e (Euro) or %_" (degree sign) - or before a letter as Accent mark stands.

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1.3 Notes on Braille transmission

%'<=

Opening and closing brackets for
comments on Braille transmission

If the character base has been expanded specifically for the work to be implemented in Braille or if typographical features need to be presented or explained, it is necessary to make comments on the Braille reproduction of the original. The dissolution of tables or the verbalization or omission of figures should also be pointed out.

Notes that concern the entire translation of the work are summarized in a separate section or chapter with an appropriate heading at the beginning of the work or each volume of the Braille book. Here the introduced characters are listed in a list.

If the comment only applies to individual passages in the work, it is inserted in the brackets for comments on Braille transcription at the relevant point. This means they are not read as text from the black text template.

The notes on the Braille transcription - both in a separate section and in brackets - are written in the same degree of abbreviation as the rest of the text.

See examples 6.3 B01 and 14.3 B07.

2 digits and numbers

2.1 Arabic numerals and numbers

The mathematical writing has two forms of representation for the Arabic numerals:

- standard notation
- lowered notation

In standard notation, numbers are formed using the same Braille characters as the Latin letters a to j. They differ from these by the number sign in front of them.

The digits in the lowered notation consist of Braille characters in which the dots are placed one row lower than in the standard notation. These Braille characters also have multiple meanings and only represent numbers in certain contexts.

2.1.1 Numbers in standard notation

%#		Number symbol
%a	1	Number one
%b	2	Number two
%c	3	Number three
%d	4	Number four
%lt is	5	Number five
%f	6	Number six
%g	7	Number seven
%h	8	Number eight
%i	9	Number nine
%j	0	Digit zero

In mathematical writing, an Arabic number basically consists of the number symbol - as in text writing

2 digits and numbers

and one or more digits. This is called standard notation.

After the number sign %#, the Braille characters of the letters a to j represent the numbers 1 to 9 and 0, basically up to the next space, end of line or dash or other punctuation mark (although of course the decimal point and the decimal point are not). are considered punctuation marks).

The effect of the number symbol extends to: • the digits (in standard or lowered notation) • the decimal separator %,

- the outline symbol %.
- the opening bracket %2 when playing back
 - periodic decimal fractions (see "2.1.4 Periodic decimal fractions") •
 - the announcement
- for a special typographical
 - Award %!
- the apostrophe %' or the dash %- immediately after the number symbol

The effect of the number character is canceled by any other character as well as • a space • the end of the line - except for line separation with a dot 4 %" "

Any type of dash (for example a hyphen or slash) cancels the effect of the number symbol, so that numbers after it always require a new number symbol. An exception are dashes following numbers that appear in price information instead of a zero before the decimal point.

A number should only be separated at the end of the line if this is unavoidable, for example if the length of the number exceeds the entire line width.

An apostrophe, which replaces the place of leading digits, follows the number sign before the first digit (see example 2.1.1 B04).

Note: The

numbers in standard notation are always preceded by a number sign. However, it may make sense, e.g. B. in written arithmetic procedures, the number symbol separates from the numbers

2 digits and numbers

to move something away or to do without it completely in order to maintain clarity (see "Appendix A1 Written calculation methods over several lines").

Example 2.1.1 B01

3
#C
\\[3\\]

Example 2.1.1 B02

245
#bde
\\[245\\]

Example 2.1.1 B03

1:27 2:13 p.m
#ac':#bg-#ad':#ac \$clock
\\[13:27-14:13 \; \text{Clock}\\]

Example 2.1.1 B04

'05
#is
\\['05\\]

2.1.2 Numbers in lowered notation

%,	1	Number one
%;	2	Number two
%:	3	Number three
%/	4	Number four
%?	5	Number five
%+	6	Number six
%=	7	Number seven
%(	8	Number eight

2 digits and numbers

%*	9	Number nine
%)	0	Digit zero

Following some characters in mathematical writing, whole numbers without numerals can be written in lowered notation. This makes the expression one character shorter. In addition, the function of the number can be more easily interpreted in a compact mathematical expression.

The lowered notation is used for denominators of simple number fractions - including mixed numbers - as well as for projectives such as exponents, upper and lower indices (see "9.1 Fractions and mixed numbers" and "10.3 Indices and exponents").

A number in lowered notation may be preceded by a minus sign in exponents, indices, etc., but not in fractions. In these cases too, the number symbol is not necessary. However, numbers with decimal separators or dividing symbols may not be written lowered.

In text writing, the lowered notation can be used as another option for short forms of number structures such as ordinal numbers, decimal classifiers and dates. These notations can also be used in mathematics writing.

Example 2.1.2 B01

$$\frac{1}{3} = \frac{4}{12}$$

#a: =#d,;

$$\frac{1}{3} = \frac{4}{12}$$

Example 2.1.2 B02

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

|x|; 8 x|: < = x|-,

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

2 digits and numbers

Example 2.1.2 B03

2.3025
 It is $\times 10$
 $e^{\#b,cjbe ??\#aj}$
 $\backslash[e^{\{2.3025\}} \approx 10\backslash]$

2.1.3 Decimal fractions

%, , Decimal separator (comma)

In exceptional cases (see explanations below) %.

Decimal separator (dot)

In decimal fractions, the decimal separator is represented by the decimal point % , regardless of whether the template contains a comma or a period.

The point 3 % is avoided as a decimal separator because it is used in Braille as an outline symbol for long numbers.

An exception are amounts of money in Swiss francs and centimes. Here, the usual Swiss notation with a decimal point in Braille can be retained (see also "2.1.5 Structure of long numbers").

If decimal points are used in the template in other contexts and this is significant, this can be pointed out in a Braille note.

Dashes that replace one or two zeros in monetary amounts are represented by the symbol dots 3.6 %- .

Example 2.1.3 B01 2.34

$\#b,cd$
 $\backslash[2,34\backslash]$

2 digits and numbers

Example 2.1.3 B02

45.98

#de,ih

\[45.98\]

Example 2.1.3 B03 ¢,50

#-,not

\[-,50\]

Example 2.1.3 B04 100, ¢

#ajj,-

\[100,-\]

Example 2.1.3 B05 100,

¢ ¢

#ajj,--

\[100,--\]

Example 2.1.3 B06 (Note:

Representation of Swiss francs in Switzerland.)

Fr. 3.50

_\$fr.#c.ej

\[\text{Fr.} \]; 3.50\]

2.1.4 Periodic Decimal Fractions

%#...2...`

periodic decimal fraction

In the case of periodic decimal fractions, the repeating sequence of digits is crossed out in black letters. In Braille, this sequence of numbers is placed in parentheses %2...` without numbers.

2 digits and numbers

Example 2.1.4 B01

0,3̄

#j,2c`

\[0,\overline{3}\]

Example 2.1.4 B02

1,285714̄

#a,2begad`

\[1,\overline{285714}\]

Example 2.1.4 B03

3,428̄

#c,db2h`

\[3,42\overline{8}\]

2.1.5 Structure of long numbers

‰.

Outline symbols

Long numbers are divided into groups of 3 digits using the dot 3 ‰ symbol, regardless of the character used in the template (period, space, apostrophe, comma).

For amounts of money in Swiss francs and centimes, the dot is usually in black and the dot is 3 ‰ in Braille. used both as a decimal separator and as an outline symbol (see also "2.1.3 Decimal fractions").

This very rarely leads to difficulties in interpretation, as the last point is followed by not three, but only two digits and can therefore be recognized as a centime.

The structure of long numbers using spaces, which is common in black letters, is not adopted because the space cancels out the effect of the number symbol and the new number symbol is used.

2 digits and numbers

group would in turn have to be marked with a number symbol.

Likewise, the structure with apostrophes (Switzerland and Liechtenstein) is unsuitable for Braille. The apostrophe is represented with the same Braille character as the lowercase announcement character, which cancels out the effect of the number character.

Example 2.1.5 B01

23.354

#bc.ced

\[23.354\]

Example 2.1.5 B02

1 324 342

#a.cbd.cdb

\[1\;324\;342\]

Example 2.1.5 B03

19'041'500

#ai.jda.ejj

\[19'041'500\]

Example 2.1.5 B04

26 094 318,751 628

#bf.jid.cah,gea.fbh \[26\;094\;318,751\;628\]

Example 2.1.5 B05

1.000

#a.jjj

\[1.000\]

2 digits and numbers

Example 2.1.5 B06

1000

#ajjj

\[1000\]

2.1.6 Ordinal numbers, decimal classifiers, dates and times

The combinations of numbers and punctuation marks are generally written as in the template. Please note: • A period following or between numbers is not a point

Decimal point and is therefore marked with point 3 %. shown.

The number symbol is omitted after the bullet point.

- In time information, colons are used as punctuation marks.
sign announced by point 6 %' .
- In dates, hyphens are not allowed with period 6 %'
to announce. However, the following number receives a new number symbol.

Example 2.1.6 B01

3.5.11

#ceaa

\[3.5.11\]

Example 2.1.6 B02

7.10.4.3

#g.aj.d.c

\[7.10.4.3\]

Example 2.1.6 B03

24.12.2010

#bd.ab.bjaj

\[24.12.2010\]

2 digits and numbers

Example 2.1.6 B04

2010 12 24

#bjaj-#ab-#bd

\[2010-12-24]

Example 2.1.6 B05

12.45 p.m

#ab.de \$uhr

\[12.45 \; \text{Clock}]

Example 2.1.6 B06

12:45 p.m

#ab':#de \$uhr

\[12:45 \; \text{Clock}]

Where the text font offers a shortened notation for such numerical structures, this may also be used in the mathematics font.

Example 2.1.6 B07

(Note: In elementary school mathematics tasks in which a result has to be entered, a number sign is often placed after the equal sign. This makes the equal sign easier to distinguish from a g, among other things.)

1. 2 3+ =

2. 1 4+ =

#, #b + #c = # #; #a + #d = #

\[1. \quad 2 + 3 = \quad 2. \quad 1 + 4 =]

Example 2.1.6 B08

3.5.11

#:It is,,

\[3.5.11]

Example 2.1.6 B09**24.12.2010**

#;/ab#bjaj

\[24.12.2010\]

2.2 Roman numerals

%i	I, i	Roman numeral one
%in	V, v	Roman numeral five
%x	X, x	Roman numeral ten
%l	L, l	Roman numeral fifty
%c	C, c	Roman numeral hundred
%d	D, d	Roman numeral five hundred
%m	M, m	Roman numeral thousand

Roman numerals are written as letters (sequences). As capital letters, they should therefore always be announced with %> . Written as lowercase letters, they often do not need to be announced in mathematical writing (see "3.2 Upper and lower case letters of Latin letters"). Overlined

Roman numerals, which are sometimes used for multiples of thousands, are given a dash as the top mark (see "8 Simple and Summary Marks").

Example 2.2 B01**I, IV, MDCCCXXV**

>i', >iv', >mdcccxxv \[\text{I, IV, MDCCCXXV}

\]

Example 2.2 B02**i, xvi**

i', xvi \[\text{i,

xvi}\]

2 digits and numbers

Example 2.2 B03

$$\overline{X} = 10\,000$$

>x: =#aj.jjj

\[\text{\overline{X}} = 10\,000\]

Example 2.2 B04

$$\overline{IV} 4000 =$$

\$.>iv =#djij

\[\text{\overline{IV}} = 4000\]

3 letters and punctuation marks

3.1 Preliminary remarks on the labeling of Letters

Announcement symbol %'

	lowercase letters
%>	one or more capital letters
%\$	an uppercase letter followed by one or more lowercase letters
%<	Greek letters 1. special
%!	typographical distinction 2. special
%_	typographical distinction

Without marking, all letters in the mathematics font are lowercase Latin letters in their modern script forms. Latin capital letters and foreign or typographically special letters must be marked accordingly.

3.2 Latin capitalization Letters

Announcement symbol %'

	lowercase letters
%>	one or more capital letters
%\$	an uppercase letter followed by one or more lowercase letters

In mathematical writing, the capitalization of letters is very important for their meaning. It is therefore essential to ensure clarity.

3 letters and punctuation marks

In principle, no notice is required for lowercase Latin letters in mathematical writing. However, they must be marked with dot 6 %' where they can be interpreted as something else based on the preceding characters, for example: • Letters a to j immediately after in standard numbers

written numbers: They would be read as additional digits.

- immediately after the end-of-break character: The end-of-break character is identical to the announcement character for Greek letters. • immediately after announced with points 4.5 %>
- Capital letters: They could be interpreted as more capital letters.

All unannounced letters should be read as lowercase Latin letters.

In the interest of clarity, it is recommended that lowercase letters be announced once too often with a dot 6 %' rather than once too few.

An uppercase letter is only announced by the dots 4.6 %\$ if it is followed by at least one lowercase letter. Otherwise, individual capital letters must always be announced with the dots 4.5 %> .

The effect of the announcement characters for upper and lower case letters is canceled by: • the next space • the end of the line - except for the line separator dot 4 %"

- the next non-alphabetic Braille character of any Art

Example 3.2 B01

10 10 5 account B , 3

#aj'a', #ajk', #en', #c>b

\[10a, 10k, 5n, 3B\]

3 letters and punctuation marks

Example 3.2 B02

{ABCD, EFGH, IJKL }

!{>abcd', >efgh', >ijkl!}

\[{ABCD EFGH IJKL}\]

Example 3.2 B03

ABCd

>abc'd

\[ABCd\]

Example 3.2 B04

AbCd

\$ab\$cd

\[AbCd\]

Example 3.2 B05

solution set L

A

l9sungsmenge >l1>a

Solution set $\$L_{\{A\}}\$$

Example 3.2 B06

$$\frac{1 + n}{5} x$$

;#a +n 8 #e<'x

\[\frac{1 +n}{5}x\]

3.3 Greek letters

Announcement character

%<

Greek letters

The Greek letters in the mathematical font %a

	a	Alpha
%b	A,	Beta
%g	B, b C, c	Gamma
%d	D,	Delta
%lt is	d	Epsilon
%With	E,	Zeta
%j	e Z,	And
%h	z H , ÿ	Theta
%i	h	Iota
%k	ÿ,	Kappa
%l	ÿ, l,	Lambda
%m	i K,	My
%n	k	The
%x	L ,	Xi
%O	ÿ M,	Omikron
%p	µ N,	Pi
%r	n	Rho
%s	X ,	Sigma
%t	ÿ	Yes
%in	O,	Ypsilon
%f	o P_{phl}p	Phi
%c	P ,	Spend
%and	ÿ S,	Psi
%ln	ÿ T, ÿ ÿ, y ÿ, , ÿ X, x ÿ, ÿ ÿ, ÿ	Omega
%v		Digamma
%q	Q, q	Trug

3 letters and punctuation marks

The letters of the Greek alphabet are written using the same Braille characters as those of the Latin alphabet. Therefore, Greek letters must be expressly marked as such.

Lowercase Greek letters are announced by the %< character . For Greek capital letters, the announcement for capitalization %> or %\$ is also placed between this character and the first letter.

The announcement for Greek letters applies to an announcement of capitalization by dots 4.5 %> or

Points 4.6 %\$ and for all letters up to: • to the next space or end of line — except for the

Line separator %" or

• to the next non-alphabetic Braille character of any kind.

After a sequence of Greek letters, the announcements for uppercase or lowercase letters %> or %\$ or %' initiate a switch to Latin letters. If an announcement for uppercase or lowercase letters becomes necessary within a sequence of Greek letters, the announcement for Greek letters %< must be repeated.

Note: The

previous uppercase Greek announcement character %_ is no longer applied.

Example 3.3 B01

Store **a**, **BC**

\$shop <a', <b', <g \[\text{Shop} \]; \alpha, \;
 \beta, \; \gamma]

3 letters and punctuation marks

Example 3.3 B02

The sum of the angles α β γ results in 180° .

The sum of the angles α β γ gives 180° .

The sum of the angles α β γ gives 180° .

Example 3.3 B03

ρ With

ρ With ρ

Example 3.3 B04

$$v = \frac{2\pi r}{T}$$

$v = \frac{2\pi r}{T}$

Example 3.3 B05

$$A_O = \pi r^2 + 2\pi r h$$

$A_O = \pi r^2 + 2\pi r h$

Example 3.3 B06

$e^{(\alpha t + \beta)}$

$e^{(\alpha t + \beta)}$

3 letters and punctuation marks

Example 3.3 B07

(Note: For the spelling of the capital letter Delta as a difference symbol, see "3.5 Letter-Like Symbols".)

$$P = \frac{\ddot{y} \text{HAT ONE}}{\ddot{y}_t}$$

>p =;&d>e 8 &d't' =;&d>w 8 &d't<

$$[P = \frac{\Delta E}{\Delta t} = \frac{\Delta W}{\Delta t}]$$

Example 3.3 B08

$$\text{oh} = \frac{\ddot{y}}{\ddot{y}_t}$$

$$\omega = \frac{\Delta \varphi}{\Delta t}$$

Example 3.3 B09

$$F_{\text{c Off}}^{12} \text{ oh } r$$

>f1>w =#a;c1<w5<r\$of|;

$$[F_{\{W\}} = \frac{1}{2} c_{\omega} \rho A v^2]$$

Note: The

representation of Eta, Theta and Chi in the mathematical writing differs from the representation in (ancient) Greek. The usual symbols for these letters have other functions in mathematical writing and their use for Greek letters poses a great risk of confusion. In texts in which these letters appear in both mathematical and text fonts, the different representation must be explained in a Braille technical note.

The following symbols are used in the classical philological presentation:

3 letters and punctuation marks

%5	H, h	And
%4	Th,	Theta
%&	th X, x	Spend

The Braille alphabet used in modern Greece differs in several letters from those of the German Braille text and mathematics script.

3.4 Special typographic awards

Announcement sign %!

1. special typographic award 2.

special

%_

typographic award

If special print forms in mathematical templates indicate different mathematical meanings, the differences must also be made clear in Braille.

This is the case, for example, when certain letters appear in bold or even in Gothic print form, for example to mark them as vectors.

In traditional printing for mathematical works, units and short words are separated from variables using typographical means. In Braille mathematics, units and short words are marked specifically (see "4.1 Identification of unit symbols" and "3.6 Short word symbols"). It is therefore not necessary to reflect any italics for variables.

The two announcement symbols point 5% stand for the identification of special typographic awards of all types ! and points 4,5,6 %_ for free use. What type of award is involved in each individual case must be explained in a Braille technical note (see "1.3 Notes on Braille transmission"). Since the sign points 4,5,6 %_ also announces units, is for

3 letters and punctuation marks

letters the symbol point 5 %! recommended (see "4.1 Identification of unit symbols").

The announcement mark for the special typographic mark is placed immediately before the first letter in question or before any announcement for Greek letters and/or upper/lower case letters.

The announcement applies to any characters immediately following %< (Greek), %> or %\$ or %'

(uppercase and lowercase) — or combinations thereof — and for all letters up to: • the next space • the end of the line — except for the line separator %"

- to the next non-alphabetic Braille character of any kind

The announcement symbols may also appear in front of other Braille characters that have different meanings due to typographical differentiation. In this case, the announcement applies: • before a number symbol for the whole number •

immediately before a digit only for that one digit •
before all other symbols only for the following one

Symbol

The announcement by point 5 %! must not be used with projectives, as point 5 initiates the amplification of a projective (see "10.2 Amplified Projectives"). Furthermore, it is not permitted where it could be read as part of a symbol. For example, a preceding dot 5 in combination with square brackets %{} or %} does not form bold, but rather curly brackets %{} or %!} (see "6.2 Simple brackets").

However, the announcement by %_ may not be used where it could be confused with the first part of a lower summary marking (see "8.2 Summary markings").

Announcement by dots 4,5,6 %_ is not permitted directly before a single digit of a number to avoid confusion with the announcement of a unit.

3 letters and punctuation marks

If only part of an expression is highlighted so that it can be discussed in an explanation, the technique of horizontal summaries is recommended (see "15.2 Horizontal summaries and horizontal brackets"). For pairs of brackets that need to be highlighted, special Braille brackets can be used (see "6.3 Special Braille brackets").

Example 3.4 B01

ȳ

What are the vector and the distance $\overline{AB}$?

w0 l1ten the vector $\vec{v}$, and d0 }recke $\overline{ab}$?

What are the vector $\vec{\mathbf{v}}$ and the segment $\mathbf{AB}$?

Example 3.4 B02

4226

$\mathbf{4226}$

or

$\mathbf{4226}$

Example 3.4 B03

1234, 35 66

$\mathbf{1234, 35 66}$

Example 3.4 B04

ȳ

AB

$\vec{\mathbf{AB}}$

3 letters and punctuation marks

Example 3.4 B05

ÿ

$\mathbf{F}_G$

$\$$._{>f1}_{>g}\5

$\backslash\!\!\vec{\mathbf{F}}_{\mathbf{G}}\!\!\backslash$

Example 3.4 B06

AB 1 1

$_{>ab'}, \$_{>a1, >b1, \5

$\backslash\!\!\underline{\mathbf{AB}}, \backslash\!\!\underline{\mathbf{A}}_{\mathbf{B}_{\mathbf{1}}}$

3.5 Letter-like symbols

%&d	ÿ	large delta as a difference sign
%&s	ÿ	Sum symbol ÿ Product
%&p	symbol	
%< is	ÿ	is element of
%"d	ÿ	round d (for partial derivative) h-
%"h		cross, reduced Planckian
%"p	ÿ	weierstrass p
%%\$n		Set of natural numbers
%%\$Z %		Set of integers
%%\$q		Set of rational numbers
%%\$r		Set of real numbers
%%\$c		Set of complex numbers
%%\$h	H	Quantity of quaternions
%%\$p	P	Projective line

3 letters and punctuation marks

There are separate Braille symbols for many mathematical symbols whose shapes in black print are based on individual letters but are not identical to these letters.

The symbols for sum and product in black text have the shape of the Greek capital letters Sigma and Pi. However, due to their size, they are not treated like these letters in Braille, but rather with the symbol %&s for sum and %&p defined for them written for product (see "11.1 Functions").

The reduced Planck's constant (also known as "h-cross") is represented in black writing by a crossed-out small h, in Braille by the fixed character sequence %"h . Similarly, in partial derivatives, the curved small d in black writing is represented reproduced in Braille with %"d .

The capital letters for the standard quantities, which are drawn with double lines, are also represented in Braille by their own symbols, each consisting of three Braille characters: %\$\$\$n for natural numbers, %\$\$\$z for integers, %\$\$\$q for rational ones Numbers etc. and are considered extra-alphabetic symbols (see example 12 B09). If necessary, additional symbols can be created according to this pattern. The new creation must be explained in the preliminary remarks or the notes on Braille transmission (see "1.3 Notes on Braille transmission").

On the other hand, the Greek lowercase letter Pi cannot be distinguished from the other Greek lowercase letters and must be treated according to the rules for the representation of Greek letters (see "3.3 Greek letters").

Example 3.5 B01

$$= \frac{h}{2\pi i}$$

"h =h8#b<p \[hbar

=\frac{\text{h}}{2\pi i}]

3 letters and punctuation marks

Example 3.5 B02

$$= \{1, 2, 3, 4, 5, \dots\}; \quad {}_0 = \{0, 1, 2, 3, 4, 5, \dots\}$$

$$\\$n = \{ \#a', \#b', \#c', \#d', \#e', " \dots! \}; \\$n1) = \{ \#j', \#a', " \#b', \#c', \#d', \#e', \dots! \}$$

$$\backslash \mathbb{N} = \{1, 2, 3, 4, 5, \dots\}; \backslash \mathbb{N}_{\{0\}} = \{0, 1, 2, 3, 4, 5, \dots\}$$

Example 3.5 B03

$$m \ddot{y} z \quad \frac{\ddot{y}^2 \ddot{y} \ddot{y}}{2} \quad \ddot{y} \quad \tau \quad \frac{\ddot{y}^2 \ddot{y}}{2} \quad \ddot{y} \quad \text{with}$$

$$< m \& dz2; "d|; < y \ 8 \ "dt|; < ` \\ ? ? > t2; "d|; < y \ 8 \ "dz|; < ` \& dz$$

$$\backslash \mu \Delta z$$

$$\left(\frac{\partial^2 \psi}{\partial t^2} \right) \approx T$$

$$\left(\frac{\partial^2 \psi}{\partial z^2} \right) \Delta z$$

3.6 Kurzwortsymbols

%7

Key symbol for
Kurzwortsymbols

In black text, many defined functions etc. are often found in abbreviated form, for example "sin" for the sine function. The letters of these short word symbols are often typographically distinguished from variables etc. so as not to confuse them with each other.

In the Braille mathematical font there are separate symbols for a number of functions, which begin with the character %6. In this case, confusion with variables is also ruled out.
its.

If short word symbols occur that are not yet defined in Braille, they can be introduced with the key character for short word symbols %7 . Begins a short word

3 letters and punctuation marks

with a capital letter, the corresponding announcement character %\$ or %> must be placed immediately after the key character. The short word must be separated from subsequent arguments, etc. by a space or an announcement character (number symbol, lowercase character, etc.).

It is at the discretion of the transmitter or writer to write short words for which there are separate symbols beginning with the character %6 .

The key character %7 is also used to introduce various geometric symbols (see "14.1 Geometric symbols"). However, in these symbols the key character is never followed by a letter.

Example 3.6 B01

10 against 8 2 =

$$\#a_j \text{ mod } \#h = \#b$$

$$\backslash[10 \text{ \; } \backslash\text{mode} \text{ \; } \backslash; 8 = 2 \backslash]$$

Example 3.6 B02

1 OR 1 1 aber 1 XOR 1 0 =

$$\#a \text{ 7>or } \#a = \#a \text{ aber' } \#a \text{ 7>xor } \#a = \#j$$

$$\backslash[1 \text{ \; } \backslash\text{OR} \text{ \; } \backslash; 1 = 1 \text{ \; } \backslash\text{aber} \text{ \; } \backslash; 1 \text{ \; } \backslash\text{XOR} \text{ \; } \backslash; 1 = 0 \backslash]$$

Example 3.6 B03

(Note: For the usual representation see Example 14.2 B01)

sin30 0.5 °

$$7\sin\#c_j_") = \#j,e$$

$$\backslash[\sin 30^{\circ} = 0,5 \backslash]$$

Example 3.6 B04 **$\log_{10} x x =$** $6 \lg x = 6 \lg x$ **or** $7 \log_{10} x = 7 \lg x$ $\backslash [\log_{10} x = \lg x]$ **3.7 Punctuation****%'****Announcement sign for****Punctuation marks**

If punctuation marks appear in mathematical writing, they must be preceded by the period 6 %' to distinguish them from other symbols. The sentence point %. and the dash %- are excluded from this as there is no risk of confusion.

Brackets in the text are also preceded by point 6.

Round text brackets %= therefore each appear with a point 6.

Although a point 6 is already part of the symbol for square text brackets %' = , they must be announced with an additional point 6 (see "6.6 Text brackets in mathematics").

3.8 Text in the mathematics paper

For text insertions in mathematical passages, you usually switch to text font. However, individual words and short phrases can be written without leaving the mathematical writing. Then basic font must be used. In mathematics writing, capitalization is generally indicated, including words.

On the other hand, when changing to text font, capitalization is handled as in the rest of the text.

Usually the text is preceded by a space. This usually ensures that it cannot be confused with variables, for example. The German letters ä,

3 letters and punctuation marks

ö, ü and ß are written with Braille characters, which also depict mathematical symbols or parts of them. If they are lowercase letters, they must be marked with a dot 6 %' in critical situations.

As long as the mathematical font is not left, a line separator is required when breaking lines before or after a word (see "1.2 Separating and keeping mathematical expressions together").

The usual rules in mathematical writing apply to punctuation marks. In most cases they should therefore be marked with a preceding period of 6 %' (see "3.7 Punctuation").

Example 3.8 B01

a ≥ 0 , $n, z \in \mathbb{N}$ and $n \neq 1$

ao=#j', n',z &e\$\$n and' n *=#a

$\backslash[a \geq 0, \backslash; n, z \in \mathbb{N} \backslash; \text{and} \backslash; n \neq 1]$

Example 3.8 B02

$\sum F = 0$ constant $\dot{v} =$

&s>f =#j ==ov =constant

$\backslash[\sum F = 0 \rightarrow v = \text{constant}]$

Example 3.8 B03

$f(x) = \frac{\text{Kraft}}{\text{accelerated mass}} = \frac{F}{m}$

f2x` =;\$force 8 accelerated' \$mass< =;>f 8 m<

$\backslash[f(x) = \frac{\text{force}}{\text{accelerated Masse}} = \frac{F}{m}]$

4 units

4.1 Identification of unit symbols

%_

Unit symbol labels

Unit symbols are immediately preceded by the unit identifier %_. It is irrelevant whether they represent real units of measurement such as meters or auxiliary units such as percent.

If several units form a unit complex, only one identifier is required as long as the complex is not interrupted by spaces or values.

If a unit refers directly to a value, it is directly connected to it with the preceding identifier. Spaces in a black font template are ignored here.

The marking of units replaces the typographic means available to black writing to distinguish variables from unit and function symbols.

In order to prevent a possible risk of confusion between different types of symbols, the black font - which is often only perceived unconsciously by the reader - uses printing technology subtleties. Typical visual identifiers are straight letters for units and italics for variables - or a space (full or half) before unit symbols, but not before variables.

Example 4.1 B01

0,3 l 300 ml

#j,c_l = #cjj_ml

\[0,3 \text{\{}l\} = 300 \text{\{}ml\}\]

Example 4.1 B02

$$1 \text{ H } 1 \frac{\text{V s}}{\text{A}}$$

$$\#a_{>h} = \#a_{>v.s8>a}$$

$$\backslash[1 \text{ \text{H}} = 1 \frac{\text{V} \cdot \text{s}}{\text{A}}]$$

4.2 percent, per thousand

%_#j)	%	percent
%_#j))	‰	Blood alcohol level

Example 4.2 B01**20% of 51 km**

$$\#bj_{\#j}) \text{ von } \#ea_{\text{km}}$$

$$\backslash[20\% \text{ \text{von}} \text{ \text{km}}]$$

Example 4.2 B02

7 ‰

$$\#g_{\#j}))$$

$$\backslash[7 \text{ \text{permil}}]$$

4.3 Angle and temperature measurements

%_")	°	degree (squiggle)
%_""*	'	minute (dash)
%_""**	''	Second (double dash)
%_rad	rad	Radiant (rad)
%_rad ;	rad ²	Quadratradiant

4 units

Example 4.3 B01

120°

#abj_")

\[120^{\circ}]

Example 4.3 B02 /2

arc 90° = Pi

6a#ij_") =<p8#b

\[\arc 90^{\circ}=\frac{\pi}{2}]

Example 4.3 B03

20 5' 10"

#bj_")#e_""#aj_""

or

#bj_") #e_"" #aj_""

\[20^{\circ} \; ; \; 5' \; ; \; 10"]

4.4 Unit symbols made from letters

%"

Accent marks

Selected unit symbols from letters %_m

	m	Meter
%_cm	cm	centimeter
%_mm	mm	Millimeter
%_<m'm	μm	Micrometer
%_>v	IN	Volt
%_>mv	MV	I got it
%_m>a	mA	Milliamps
%_<m>w	μW	Microwatts
%_<>w	Oh	Ohm
%_k<>w	kΩ	Kiloohm
%_\$hz	Hz	Hertz

4 units

<code>%_k\$hz</code>	kHz	Kilohertz
<code>%_e>v</code>	eV	It was electronic
<code>%_\$me>v</code>	oder	
<code>%_>m'e>v</code>	MeV	Megaelectronvolt
	s	Seconds
<code>%_sec</code>	sec	Seconds
<code>%_min</code>	min	Minute
<code>%_>"a</code>	Oh	Angstrom

The letters that form the unit symbol are written following the unit identifier according to the usual rules (see "3 letters and punctuation marks").

If an accented letter is part of a unit symbol, it is represented by a dot 4 %" and the base letter.

Example 4.4 B01 1

atm 101.325 kPa

`#a_atm =#aja,cbe_k$pa`

`\[1 \text{atm} =101,325 \text{kPa}]\]`

Example 4.4 B02

1 Hz 1 s⁻¹ =

`#a_$hz =#a_s|-,`

`\[1 \text{Hz} =1 \text{s}^{-1}\]`

Example 4.4 B03

1 Å=100 pm 10⁻¹⁰ m

`#a_>"a =#ajj_pm =#aj|-,)_m`

`\[1 \AA =100 \text{pm} =10^{-10} \text{m}\]`

4 units

Example 4.4 B04

$$1 \pm 0 \quad \frac{9 \text{ cm } \ddot{y}}{s}$$

$$\#a_{<}w = \#aj^*_{<}cm8s<$$

or

$$\#a_{<}w = \#aj^*_{<}cm8s$$

$$\backslash[1 \ \Omega = 10^{\{9\}} \ \frac{\{\text{cm}\}}{\{\text{s}\}}]$$

Example 4.4 B05

$$1 \text{ A } 1 \text{ } \frac{\text{C}}{\text{s}} \quad 1 \text{ C s} \quad 1$$

$$\#a_{>a} = \#a_{>}c8s = \#a_{>}c.s|-,$$

or

$$\#a_{>a} = \#a_{>}c8s = \#a_{>}c.s|-,$$

$$\backslash[1 \ \text{A} = 1 \ \frac{\{\text{C}\}}{\{\text{s}\}} = 1 \ \text{C} \cdot \{\text{s}\}^{-1}]$$

Example 4.4 B06

$$\text{capacity} \quad \min = \frac{15 \text{ s}}{2 \text{ Oh}} = 7.5 \frac{\text{s}}{\text{Ohms}} = 7,5 \text{ F}$$

$$\begin{aligned} \text{\$kapazit`t1min} &= \#ae_s \ 8 \ \#b_{<}w<' \\ &= \#g,e_{<}s8<w< = \#g,e_{>}f \end{aligned}$$

or

$$\text{\$kapazit`t1min} = \#ae_s \ 8 \ \#b_{<}w<' = \#g,e_{<}s8<w = \#g,e_{>}f$$

$$\begin{aligned} \backslash[\text{Capacity}_{\{\text{min}\}}] &= \frac{15 \ \text{s}}{2 \ \Omega} \\ &= 7,5 \ \frac{\{\text{s}\}}{\{\Omega\}} = 7,5 \ \text{F} \end{aligned}$$

4.5 Magnification and contraction prefixes

Magnification and diminution prefixes are used to form a multiple and fraction of a basic unit, respectively. The best known are those of the International System of Units (SI), for example "k" ("kilo-", a thousand times the basic unit) and "m" ("milli-", a thousandth of the basic unit). They are treated as part of the unit. The unit identifier %_ therefore appears before the prefix and not before the basic unit.

Example 4.5 B01

10^{-3} m 1mm a thousandth of a meter

#aj|:-_m =#a_mm' =one \$thousandth
of a meter

$\backslash[10^{-3} \text{ m} = 1 \text{ mm} = \text{ein thousandths of a meter}]\backslash$

Example 4.5 B02

One millionth of a meter = 10^{-6} m 1 μm (1 micrometer)

\$ein \$millionstel \$meter' =#a.#aj|+_m =#a_<m'm' '=#a
\$mikrometer' =

or

'.\$3n million}el meter'.' =#a.#aj|+_m =#a_<m'm' '.=#a
mikrometer='.

$\backslash[\text{Ein Millionstel Meter} = 1 \cdot 10^{-6} \text{ m} = 1 \text{ } \mu\text{m} \backslash;$
 $\backslash\text{text}\{(1$
Mikrometer))\}

4 units

Example 4.5 B03

Storage capacity of x terabytes! But what, please, is a terabyte?

$$1 \text{ TByte} = 1,000 \text{ GByte} = 1,000,000 \text{ MByte} = 10^9 \text{ kByte} = 10^{12} \text{ Byte}$$

sp34 capacity of 'x terabytes+
 aber was, bitte sehr, i} 3n tera-byte? #a_>t\$byte =#a.jjj_>g\$byte'
 =#a.jjj.jjj_>m\$byte' =#aj]*_k\$byte =#aj|,;_ \$byte

Storage capacity of x terabytes! But what, please, is a terabyte? \[1
 \text{TByte} = 1\,000 \text{GByte}
 = 1\,000\,000 \text{MByte} = 10^9 \text{kByte} = 10^{12} \text{Byte}\]

4.6 Currency Symbols

Selected currency symbols %_"e

	€	Euro (Eurozone)
%_>eur	EUR	Euro (Eurozone)
%_ct	ct	Euro-Cent (Eurozone)
%_ \$fr.	Fr.	Franconia (Switzerland)
%_>chf %_"s	CHF	Franconia (Switzerland)
	\$	Dollar (especially USA)
%_>usd	USD	Dollar (USA)
%_"c	¢	cents (especially USA)
%_"l	£	Pounds (especially Great Britain)
%_>gbp	GBP	Pound (Great Britain)
%_>tl	TL	Pound/Lira (Türkiye)
%_>trl	TRL	Pound/Lira (Türkiye)

4 units

%_DKK	dkr	Crown (Denmark)
%_>dkk	DKK	Crown (Denmark)
%_\$kc	Kc	Crown (Czech Republic)
%_>czk	CZK	Crown (Czech Republic)
%_i>r	and R	Rupees (Indian)
%_>inr	INR	Rupees (Indian)
%_"s>a	\$A	Dollar (Australia)
%_>Aud	AUD	Dollar (Australia)
%_>nz"s NZ\$		Dollar (New Zealand)
%_>nzd	NZD	Dollar (New Zealand)
%_"and	¥	Yen (Japan)
%_>jpy	JPY	Yen (Japan)
%_"and	¥	Yuan (China)
%_>cny	CNY	Yuan (China)

Like other unit symbols, currency symbols are preceded by the unit identifier %_ .

If a currency unit terminated with a period precedes the value, no space is placed between the two.

Example 4.6 B01

7 €

#g_"e
 \[7 \euro]

Example 4.6 B02

5 € 27 ct

#e_"e #bg_ct
 \[5 \euro \; 27 \text{ct}]

4 units

Example 4.6 B03

€ 5.638,50

_"e#e.fch,ej \[\euro
5,638.50\]

Example 4.6 B04

EUR 83 million

_>eur#hc\$mio.
\[\text{EUR} \, ; 83 \text{Mio.}\]

Example 4.6 B05

(Note: See explanation of the point in Swiss monetary amounts in "2.1.3 Decimal fractions".)

Fr. 21.50

_ \$fr.#ba.ej
\[\text{Fr.} \, ; 21.50\]

Example 4.6 B06

Price = 30 €/ m²

\$price =#cj_"e8m|;
\[\text{Preis} =30 \euro \wedge \text{m}^{\{2\}}\]

5 operations and relations symbols

For symbols whose names are marked with an asterisk, special rules are described following the lists.

A Commonly used characters %+

plus %-	+	
	-	minus
%.	·	times (point)*
%;	:	divided by, is equal to (colon) equal to
%=	=	greater
%0,	>	than less
%9.	<	than

B Operation sign %+

	+	plus
%-	-	minus
%+-	±	plus/minus
%-+	∓	minus/plus
%.	·	times (dot)*
%	×	times (cross)
(%!(	⋆	times (star)
%)		linked with (Kuller, concatenation symbol, circle operator) divided by, is
%;	:	the same as (colon)
%8	$\frac{\quad}{\quad}$	Fraction line* (space rules see "9 fractions")
%6	!	Faculty*

5 operation and relation signs

C relation symbol

$\% =$	$=$	equal,
$\% \neq$	$\neq$	unequal,
$\% \equiv$	$\equiv$	identical, equal, congruent (number theory) not
$\% \equiv \neq$	$\neq$	identical same, incongruent (number theory)
$\% :=$	$:=$	equal by definition (colon equal sign) equal by definition
$\% =:$	$=:$	(equal sign colon) interchangeable (colon
$\% ::$	$::$	equal sign colon) similar, equivalent,
$\% ?$	$?$	proportional not similar, not equivalent,
$\% * ?$	$* ?$	not proportional approximately equal to greater than not
$\% ??$	$??$	greater than greater
$\% \geq$	$\geq$	than or equal
$\% \leq$	$\leq$	to less than
$\% \leq$	$\leq$	
$\% \geq$	$\geq$	not smaller than
$\% \leq$	$\leq$	less than or equal to
$\% \approx$	$\approx$	small versus
$\% \gg$	$\gg$	greater than
$\% \leq, \geq$	$\leq, \geq$	or less than less than or
$\% \geq, \leq$	$\geq, \leq$	greater than
$\% \leq \geq$	$\leq \geq$	larger, equal or smaller
$\% \geq \leq$	$\geq \leq$	smaller, equal or larger
$\% \sim$	$\sim$	corresponds
$\% \approx$	$\approx$	to approximately

5 operation and relation signs

D Divides (number theory)

%		Splits
%*	†	doesn't share

E Set theory (see "12 Set theory") %3. united with

cut with reduced by, without symmetrical difference

%0.	ÿ	vel (association
%1.	\	theory) et (association
% .	ÿ	theory) is element of
%3:		
%0:		
%&e	ÿ	
%*&It is	ÿ	is not an element of
%&*		has to the element
%2.	ÿ	is contained in, is a subset of is
%2=	ÿ	contained in or equals
%` ,	ÿ	contains, is a superset of
%`=	ÿ	contains or is equal to

F logic (see "13 logic") %0,

%0,	ÿ	and
%3,	ÿ	or
%.*	¬	not

G Geometry (see "14.1 Geometric Symbols") %?=

congruent (geometry) incongruent (geometry)

%*?=		projective to perspective
%:0		to
%=0		perpendicular
%#.	ÿ	to
%"%		parallel to (The second full character is part of the symbol.)

5 operation and relation signs

%""%=	#	parallel and equal (The second full character is part of the symbol.)
-------	---	--

H arrows (see "7 arrows") %::0

ÿ arrow to the right

%:,	ÿ	Right arrow
%9::	ÿ	Left arrow
%!:	ÿ	Left arrow
%9::0	ÿ	Double arrow with single shaft
%!:,	ÿ	Double arrow with single shaft
%==0	ÿ	Implication arrow (arrow to the right with double shaft)

%4=,	ÿ	Implication Arrow (Right Arrow with Double Shaft)
%9==0	ÿ	Equivalence Arrow (Double Arrow with Double Shaft)
%4!=,	ÿ	Equivalence Arrow (Double Arrow with Double Shaft)

%>:,	ÿ	Assignment arrow
%4!;	ÿ	up arrow
%4;,	ÿ	Down arrow

A space must be placed before almost all operation and relation symbols, but not after them. Since many operation and relation signs do not contain a dot in the top row of dots (points 1 and 4), connecting to the sign immediately following makes it easier to see the vertical position of the dots with your finger.

The space before an operation or relation symbol is only omitted after Braille characters, which cannot be followed by a space anyway. These are primarily the operation and relation symbols, opening brackets, exponents and indices as well as the root symbol.

The space before the painting point is often omitted to make it clear that the two partial expressions belong together. So that the point is not read as a bullet point

5 operation and relation signs

a following number must be followed by numerals.

The general space rules for operation and relation symbols explained above do not apply to the fraction bar and the factorial symbol.

The reproduction of fractions is discussed in detail in the chapter "9 Fractions".

The factorial character %6 immediately follows the term. A space after the factorial character eliminates confusion with one of the many symbols that begin with the key character %6 . If there is no space at this point, clarity must be ensured. For example, a painting point (possibly with a Braille note) or the cohesion point %" can be inserted in front of an opening bracket to ensure clarity (see example 5 B10).

The vertical or slanted line through a black text symbol, which negates the meaning of the symbol, is represented in Braille by a preceding %* .

Individual relation symbols can have different shapes in black letters. The bottom line at the symbol for

For example, "greater than or equal to" can be displayed horizontally or diagonally. The Braille symbol represents all common variants of the black symbol.

Notes: For

markings on symbols that look like surgical or

Relation symbols look like, see "8 Simple and summary markings".

The previously common division symbol %/ was deleted from the character inventory.

Example 5 B01

8 7 7 8 + =

#h + #g = #g + #h

\[8 + 7 = 7 + 8 \]

5 operation and relation signs

Example 5 B02

$$x \cdot 5 = 2$$

$$x \cdot 5 = 2$$

$$[x \cdot 5 = 2]$$

Example 5 B03

$$63 \cdot 5 = 315$$

$$63 \cdot 5 = 315$$

or

$$63 \cdot 5 = 315$$

$$[63 \cdot 5 = 315]$$

Example 5 B04

$$a \cdot b = b \cdot a$$

$$ab = ba$$

$$[a \cdot b = b \cdot a]$$

Example 5 B05

$$34 \cdot 5 = 170 \text{ or } 34 \cdot 5 \times = \quad \quad \quad \cdot =$$

$$\cdot (\cdot = \cdot \text{agj oder' } \cdot (\cdot = \cdot \text{agj}$$

$$[34 \cdot 5 = 170 \text{ \texttt{\text{or}} }; 34 \cdot 5 = 170]$$

Example 5 B06

$$8 \cdot (-7) = -56$$

$$\cdot 2 \cdot (-7) = -56$$

or

$$2 \cdot (-7) = -56$$

$$[8 \cdot (-7) = -56]$$

```
#aj :#d =#b,e \[10 :4 =2,5\]
```

$$\backslash[a : b = c \backslash]$$

n6 =#a.#b.#c.#d....".2n -#a`.n

```
n6 =#a .#b .#c .#d ....'
      .2n -#a` .n
```

$$n! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot \dots \cdot (n-1) \cdot n$$
$$2a + \#a^6 = a6.2a + \#a^6$$
$$2a + \#a^6 = a6"2a + \#a^6$$
$$\backslash[(a + 1)! = a! (a + 1)\backslash]$$
 $g(x)\backslash]$

6 brackets and vertical Strokes

The following symbols are connected directly to the neighboring character on the "inside": %2 () [] { }

		round opening bracket
%`		round closing bracket
%{		square opening bracket square
%}		closing bracket curly opening
%{		bracket curly closing bracket acute
%!}		opening bracket acute closing bracket
%(	<	obtuse-angle opening bracket
%\$)	>	obtuse-angle closing
%{'		
%'}'	ŷ ŷ	bracket
%!>{		Gaussian opening bracket (upper limit)
%!>}		Gaussian closing bracket (upper limit)
%!<{		Gaussian opening bracket (lower limit) Gaussian closing bracket
%!<}		(lower limit) round special opening
%#2		
		Braille paper clip
%#`		round special closing ones
		Braille paper clip
%#{		square special opening ones
		Braille paper clip
%#}		square special closing ones
		Braille paper clip

6 brackets and vertical bars

%#⤵		curly special opening Braille paper clip
%#⤴		curly special closing Braille paper clip
%\$⤵	⠏	Line summary bracket: large left curly bracket vertical bar summarizing several lines
	⠏	
	⠏	
%"⤵	⠏	
%"⤴		Vertical double line (The second full character is part of the symbol.) Braille note
%'≤		brackets (opening and closing)
%<8		Start of a new line

For horizontal summary brackets, see "15.2 Horizontal summaries and horizontal brackets".

6.1 General information about brackets

In mathematics writing, it is essential to accurately reproduce the difference between opening and closing brackets. This is why the brackets in Braille text are unsuitable for mathematical expressions. Therefore, separate forms of brackets are required in mathematics writing.

6.2 Simple brackets

What all bracket symbols have in common is that they are connected directly to the content to be bracketed on the inner pages, i.e. without spaces. Whether there has to be a space on the outside of the bracket depends on the adjacent character.

In black letters, outer brackets are sometimes printed slightly larger than those inside. In most cases, Braille does not have to reflect this mathematically insignificant difference. However, it may make sense to

6 brackets and vertical bars

to adopt the difference in Braille, for example for reasons of clarity or because the transcription should enable conclusions to be drawn about the spelling in the original. In these cases, special Braille clips can be used (see "6.3 Special Braille clips").

Example 6.2 B01 fxx

$() (= + 2)(x - 2)$

$f(2x) = 2x + b(2x - b)$

$\backslash[f(x) = (x + 2)(x - 2)\backslash]$

Example 6.2 B02

$\{\text{Apple, Pear, Orange}\}$

$\{ \$apple', \$pear', \$orange! \}$

$\backslash[\backslash\text{Apple}, \backslash; \backslash\text{Pear}, \backslash; \backslash\text{Orange}\backslash\backslash]$

Example 6.2 B03

$\frac{10}{7} \cdot \frac{10}{3} = \frac{100}{21}$

$\frac{10}{7} \cdot \frac{10}{3} = \frac{100}{21}$

$\backslashleft[\frac{10}{7} \cdot \frac{10}{3} ; \infty \right]$

Example 6.2 B04

$\frac{2}{t} \cdot \frac{1}{t} = \frac{2}{t^2}$

$2a + b < -2; t \# b < -a \backslash - \backslash;$

$\backslash\left(1 + \frac{2}{t}\right)^2 \cdot \backslashleft[\frac{1}{t} - \backslash\left(\frac{t}{2} - 1\right)^{-1}\right]^2 \backslash]$

6 brackets and vertical bars

Example 6.2 B05

(Note: For the illustration with the larger outer brackets highlighted, see Example 6.3 B01.)

$$\left(\lg x + 7 \right)^2 = 0$$

$$6! 22x + \#g^{\backslash};^{\backslash} = \#j \backslash \lg \left((x + 7)^{2} \right) = 0 \backslash$$

6.3 Special Braille brackets

%#2	round special opening ones Braille paper clip
%#`	round special closing ones Braille paper clip
%#{	square special opening ones Braille paper clip
%#}	square special closing ones Braille paper clip
%#!{	curly special opening Braille paper clip
%#!}	curly special closing Braille paper clip

The special Braille clips can be different

Can be used, for example, • to reproduce

design techniques of black writing for the separation of mathematical expressions that can be found in the

Braille cannot be realized or is difficult to implement • to display particularly highlighted brackets • to particularly highlight individual parts of expression

• to better structure

individual parts of complicated expressions can.

In black writing, conditions for the validity of a preceding expression are often spatially separated and

6 brackets and vertical bars

written at the end of the same line. The short lines of Braille rarely allow for such a technique. Enclosing the conditions in special braille brackets provides the necessary separation while also indicating that the brackets themselves do not appear in the black script template.

If pairs of brackets are particularly highlighted in the black font - for example in color or bold type - then they offer special Braille brackets provide a more elegant representation than the use of an announcement sign for special typographic awards (see "3.4 Special typographic awards"). In this case, the shape of the brackets must be recorded in a note on Braille transmission (see "1.3 Notes on Braille transmission").

The special Braille brackets can also be used to mark particularly highlighted partial expressions. In this case too, the shape of the brackets must be recorded in a note on Braille transmission (see "1.3 Notes on Braille transmission").

In the mathematical notation of black writing, the spatial distribution of symbols offers subtle opportunities to clarify the relationship of individual symbols to one another. When transferring complex expressions into Braille, it can be advantageous to understand the relationships between these symbols to make it clear using an additional pair of brackets. The special Braille paper clips are suitable for this. They signal that there are no brackets in these places in the black text.

6 brackets and vertical bars

Example 6.3 B01

(Note: In this example, the outer brackets are red.)

$$\left(\lg x + 7 \right)^2 = 0$$

'<=d0 special braille5rift brackets %2...#` }ehen for red
brackets.'<= 6l #22x + #g`|;#` =#j

$\left[\lg \textcolor{red}{\left(x+7 \right)^2} \textcolor{red}{\right]} = 0$

See also Example 6.4 B06.

6.4 Multi-line parenthetical expressions

If several lines with mathematical expressions are grouped together by a large curly bracket in black writing, the symbol %\$l is written in front of the first expression in braille writing. The line changes in black text are marked with %<8 , regardless of whether a new line is started in Braille (see examples 6.4 B05 and 6.4 B06).

There are two display options in Braille for pairs of brackets that extend over several lines. Typically, the opening bracket is placed at the

beginning of the first line and the closing bracket is placed after the last line. The line changes in the black font are also marked here with %<8 .

A new physical line is not required. Before and after this symbol you can

Depending on the need for clarity, spaces can be used, but the first of the two Braille characters must not be misinterpreted as a symbol for the end of a break.

Sometimes it is useful to copy the black print representation of a mathematical expression over several lines into Braille, for example for illustrative purposes when introducing the matrix concept. In this form of representation, the bracket symbols appear one below the other

6 brackets and vertical bars

on every line. The individual terms within the brackets are aligned so that the columns are clearly visible.

Spaces within terms must be filled with a dot 4 %" to clarify the affiliation of the elements.

Large empty spaces should be avoided (see example 6.4 B04).

A notice:

This form of presentation does not provide the same clarity as in black text. It is also very time-consuming to write and is less suitable for routine work.

Example 6.4 B01

$\begin{array}{c} 5 \\ \text{ } \end{array}$

$\begin{array}{c} 3 \\ \text{ } \end{array}$

$2n < 8k \quad 2\#e < 8\#c$

$\left(\begin{array}{c} n \\ k \end{array} \right)$

$\end{array} \right)$

$\left(\begin{array}{c} 5 \\ 3 \end{array} \right)$

$\end{array} \right)$

or

$\left[\binom{n}{k} \binom{5}{3} \right]$

Example 6.4 B02

$\begin{array}{c} 1 \ 2 \ 3 \ 4 \\ \text{ } \end{array}$

$\begin{array}{c} 2 \ 3 \ 4 \ 1 \\ \text{ } \end{array}$

$\begin{array}{c} \text{ } \\ \text{ } \end{array}$

$2\#a \ \#b \ \#c \ \#d < 8 \ \#b \ \#c \ \#d \ \#a$

The shorter notation, which deviates from the standard, is also clear and clear:

$2\#a\#b\#c\#d < 8 \ \#b\#c\#d\#a$

$\left(\begin{array}{cccc} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{array} \right)$

$\right)$

6 brackets and vertical bars

Example 6.4 B03

$$\begin{array}{ccc} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & & a_{2n} \end{array}$$

$$\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & & a_{nn} \end{pmatrix}$$

$$2a_{11}, a_{11}, \dots, a_{1n} \leq 8'$$

$$a_{11}, a_{11}, \dots, a_{1n} \leq 8' \dots \leq 8' a_{1n} \# a_{1n} \# b \dots a_{1nn}$$

$\left(\begin{array}{cccc} a_{11} & a_{12} & & \\ & \vdots & & \\ & a_{21} & a_{22} & \vdots \\ & & \vdots & \\ & & & \vdots \\ & & & a_{n1} & a_{n2} & \vdots \\ & & & & \vdots & \\ & & & & & a_{nn} \end{array} \right)$

Example 6.4 B04

$$\begin{pmatrix} 0 & x+1 \\ x-1 & 0 \end{pmatrix}$$

$$\begin{pmatrix} x & 1 \\ 1 & 0 \end{pmatrix}$$

$$2 \# j \ x'' + \# a \ 2x'' - \# a \ #j$$

or

$$2 \# j \ x'' + \# a \leq 8 \ x'' - \# a \ #j$$

$\left(\begin{array}{cc} 0 & x+1 \\ x-1 & 0 \end{array} \right)$

Example 6.4 B05

$$\begin{pmatrix} 1 & \text{for rational } x \\ 0 & \text{for irrational } x \end{pmatrix}$$

$$f_2(x) = \begin{cases} 1 & \text{for rational } x \\ 0 & \text{for irrational } x \end{cases}$$

or

6 brackets and vertical bars

$f_2(x) = \begin{cases} a & \text{if } x \text{ is rational} \\ b & \text{if } x \text{ is irrational} \end{cases}$

One possibility in shorthand:

$f_2(x) = \begin{cases} a & \text{if } x \text{ is rational} \\ b & \text{if } x \text{ is irrational} \end{cases}$

$<8 \#j \text{ f irr!n:e } x$

$\left[f(x) = \begin{cases} 1 & \text{if } x \text{ is rational} \\ 0 & \text{if } x \text{ is irrational} \end{cases} \right]$

$\text{\text{for rational}} \setminus; x \setminus 0 \setminus; \text{\text{for irrational}} \setminus;$

$x \text{right.}]$

Example 6.4 B06

(Note: See also "6.3 Special Braille brackets".)

$$f(x) = \begin{cases} e^x & \text{if } x \geq 0 \\ e^{x^2} & \text{otherwise} \end{cases}$$

$<d1<e52x' = \$l; <e + x$

$8 <e|; <' \#2 - <e 9 = x 9 = \#j \# ' <8 ; <e - x 8 <e|; <'$

$\#2 \#j 9 = x 9 = <e \# ' <8 \#j \#2 \text{sonst} \#$

or

$<d1<e52x' = \$l; <e + x$

$8 <e|; <'$

$\#2 - <e 9 = x 9 = \#j \# ' <8' ; <e - x 8 <e|; <' \#2 \#j 9 = x$

$9 = <e \# ' <8' \#j \#2 \text{sonst} \#$

6 brackets and vertical bars

```
\[ \delta_{\varepsilon}(x) = \left[ \begin{array}{l} \frac{\varepsilon + x}{\varepsilon^2} & -\varepsilon \leq x \leq 0 \\ \frac{\varepsilon - x}{\varepsilon^2} & 0 \leq x \leq \varepsilon \\ 0 & \text{sonst} \end{array} \right]
```

6.5 Vertical lines

%	vertical line
%%	vertical double line (The second full character is part of the symbol.)
%<8	Start of a new line

Individual vertical lines are represented with the symbol %| , for example as a relation symbol for "divide" or when solving equations to separate the description of the current solution step from the equation (see "5 operation and relation symbols" and "A1.6 Solving equations").

If the lines appear in pairs, for example as absolute lines or as determinant lines in matrices, they are treated like brackets.

Example 6.5 B01

P 2 | 5 ()

```
>p2#b"l#e`
\[P(2 | 5)\]
```

Example 6.5 B02

| $\ddot{y}$ = | 3 3

```
"l-#c"l =#c
\[|-3| =3\]
```

6 brackets and vertical bars

Example 6.5 B03

$$e = \dot{y} | a \quad a \quad \neg$$

$$\langle e = "la - a:" \rangle$$

$$\backslash \backslash \text{varepsilon} = | a - \overline{a} | \backslash$$

Example 6.5 B04

$$y \ x \ \# \ddot{y} \ 3 \ 3 \quad |$$

$$y = "l" \# c x "l \ - \# c "l$$

$$\backslash [y = | 3x | - 3 \backslash]$$

Example 6.5 B05

$$\cos \Phi i = \frac{x \quad \text{and}}{|x| \quad \text{and}}$$

$$6c < f = ; x . y \ 8 \ "l x "l . "l y "l < \backslash [\cos \ \phi i = \frac{x \ \cdot y}{|x| \cdot |y|}]$$

Example 6.5 B06

(Note: See also “A1.6 Solving Equations.”)

$$x \ x^{-y} \ 3 \ 4 \ | \quad \cdot \ x$$

$$x = \# c x \ - \# d \ "l - x$$

$$\backslash [x = 3x - 4 \quad \text{quad} \quad | - x \backslash]$$

Example 6.5 B07

$$\{k \ \ddot{y} \quad | \quad \ddot{y} \ p k q p q \ \ddot{y} . \ddot{y} \ \mathfrak{F} y \ddot{y}$$

$$\{ \{ k \ \& e \$ \$ z \ "l \ p \ 9 = k \ 9 = q ! \} ' = : \{ p \dots q \}$$

$$\backslash [\{ k \ \in \ \mathbb{Z} \ | \ p \ \leq k \ \leq q \} = : [p \ \dots \ q]]$$

6 brackets and vertical bars

Example 6.5 B08

$$\left| \begin{array}{cc} a_1 & b_1 \\ a_2 & b_2 \end{array} \right|$$

"la1, b1, <8 a1; b1;"

$\left| \begin{array}{cc} a_1 & b_1 \\ a_2 & b_2 \end{array} \right|$

Example 6.5 B09

$$\|ax\|$$

"%ax"% ="la". "%x"%

$\|a \cdot x\| = |a| \cdot |x|$

6.6 Text brackets in mathematics

Brackets also appear in mathematical passages and serve a textual rather than a mathematical function. For this purpose, the brackets from the text font can be “imported” into the math font. They are then distinguished from mathematical symbols (such as the equal sign) by a preceding dot 6 %' (see "3.7 Punctuation").

Not all parentheses in a mathematical environment have the actual function of mathematical parentheses. Examples include formula numbers, equation conditions, and units behind equations. Here it is up to the person writing or transmitting to choose text or mathematical brackets.

Example 6.6 B01

$$I_1 = I_2 \quad (\text{total current})$$

>i1, =>i1; =>and '=\$gesamtstrom' =

$I_1 = I_2 = I \quad \text{(Gesamtstrom)}$

6 brackets and vertical bars

Example 6.6 B02

(Note: The formula numbering, which is usually on the right side of the page in black writing, is preferably placed on the left in Braille. In the second of the following variants, it is in text writing; it is only then changed to mathematical writing using layout technology. See "1.1.1 Layout".)

$$s v t a t = \ddot{y} + \frac{1}{2} t^2 \quad (1.1)$$

'=#a.a'= s =v1).t + #a;at|;

or

=#a.a'= s =v1).t
+ #a;at|;

or

$2 \#a.a` s =v1).t + \#a;at|;$
 $\backslash[s =v_{0} \cdot t + \frac{1}{2} a t^2] \quad (1.1) \backslash$

Example 6.6 B03

$$x^2 p x^2 = 0 (p \ddot{y} - 0)$$

x|; +px +q =#j '=p *=#j'='

or

x|; +px +q =#j 2p *=#j`
 $\backslash[x^2 + p x + q = 0] \quad (p \neq 0) \backslash$

7 arrows

The Braille mathematics font has two types of representation for arrows. •
In modular

rendering, arrows are composed of elements for direction (horizontal, vertical or diagonal), shaft and tip shape.

- Some horizontal arrows have additional defined ones
Representations available.

7.1 Modular arrows

Arrow modules

%4	Key symbol for arrow representations
%;	simple
%:	vertical shaft
%?	simple horizontal shaft
%*	single diagonal shaft (top left/ bottom right) single diagonal
%=	shaft (bottom left/top right) double
%;;	horizontal shaft dashed single
%::	vertical
%??	shaft
%**	dashed simple horizontal
%==	shaft
%!	dashed simple diagonal
%,	Shaft (top left/bottom right) dashed
	simple diagonal
	Shaft (bottom left/top right) dashed
	double horizontal
	shaft
	simple tip to the left or down
	simple tip to the right or up

7 arrows

%!!	double tip to the left or down
%,,	double tip to the right or up
%-	Stroke through the shaft
%>	small cross-line of an assignment arrow

**Horizontal arrows, mostly pointing to the
Key characters are omitted**

%:,	• Right arrow with simple Shaft and simple tip • Left arrow
%!:	with simple Shaft and simple tip
%!.,	• Arrow left and right with simple shaft and simple sharpen
%>:,	Assignment arrow

**With the modular display, arrows with different shaft and tip shapes can be
displayed in eight different directions.**

**Depending on the presence of the elements - similar to a modular system - an
arrow symbol is put together as follows: • Key symbol for arrows • Line through
the shaft
or cross line when assigning**

arrow
 • Tip on the left, for vertical arrows at the bottom of the
 Shaft (if available) • Shaft • Tip
 at the
 right, for vertical arrows at the top of the
 shaft (if available)

Triple and multiple peaks are formed analogous to the double ones.

7 arrows

The horizontal arrows $\%:$, $\%!:$, $\%!:$, and $\%>:$, (assignment arrow) are usually written without key characters.

If other arrow shapes are to be represented - for example a curved tip - one of the following characters can be inserted between the key and the following character: $\%/$, $\%+$, $\%($, $\%)$, $\%<$ and $\%\%$ (which in the last case is character to be used is the second full character). Such a mark could also serve as another shaft or tip shape mark. The meaning of the symbol used must be explained in a Braille technical note (see "1.3 Notes on Braille transmission").

The modularly displayed arrows have different functions and their relationship to neighboring characters is therefore not uniform. Therefore they are partly between spaces and partly attached to other characters.

As a marker, for example, they immediately follow the symbols they modify (see "8 Simple and Summary Markers"). As relation or operation symbols, they are written after a space and followed by the following character (see "5 operation and relation symbols").

Notes: If a

modular arrow with a left-pointing tip $\%!:$ ends, it must be ensured that this symbol cannot be confused with the symbol for special typographic distinctions or with the reinforcement of a projective (see "3.4 Special typographic distinctions" and "10.2 Reinforced projectives").

For arrow labels see "7.3 Labeling of arrows".

Example 7.1 B01

x x arctan

x $\%>:$, 6, t'x

$\backslash[x \mapsto \arctan x]$

Example 7.1 B02

$$\bar{f}x : \sqrt{\quad}$$

$$f: x \mapsto \sqrt{3x} \quad \overline{f}: x$$

$$\mapsto \sqrt{x}]$$

Example 7.1 B03

$$\lim_{x \rightarrow p} (f(x) - f(p)) = 0$$

$$\lim_{x \rightarrow p} f(x) = f(p)$$

$$= \lim_{x \rightarrow p} f(x)$$

$$\lim_{x \rightarrow p} f(x) = \lim_{x \rightarrow p} f(x)$$

$$\lim_{x \rightarrow p} f(x) = \lim_{x \rightarrow p} f(x)$$

Example 7.1 B04

$$f_1 : D_1 \rightarrow \mathbb{R}$$

$$f_1 : D_1 \rightarrow \mathbb{R} \quad f_1(x) = \sqrt{x}$$

$$\{ D_1 \} \rightarrow \mathbb{R} \quad x$$

$$\mapsto f_1(x) \text{ right.}]$$

7.2 Defined arrows

$\%::\text{O}$	$\rightarrow$	Right arrow with simple Shaft and simple tip
$\%9::$	$\leftarrow$	Left arrow with simple Shaft and simple tip
$\%9::\text{O}$	$\rightarrow$	Left and right arrow with simple shaft and simple Tips
$\%==\text{O}$	$\Rightarrow$	Right arrow with double Shaft and simple tip (Implication arrow)
$\%9==$	$\Leftarrow$	Left arrow with double Shaft and single tip
$\%9==\text{O}$	$\Leftrightarrow$	Left and right arrow with double shaft and single Tips (equivalence arrow)
$\%,,\text{O}$	$\dashrightarrow$	Right arrow with dashed Shaft and simple tip
$\%9,,$	$\dashleftarrow$	Left arrow with dashed Shaft and simple tip
$\%9,,\text{O}$	$\longleftrightarrow$	Left and right arrow with dashed shaft and simple sharpen

Reproduction as a defined arrow is particularly suitable where the arrow divides a mathematical expression as an operation or relation symbol. Arrows as markings or additions to a symbol are generally better represented with modular arrows.

Defined arrows should generally be placed between spaces. Exceptions exist where adjacent symbols do not allow this (such as brackets). For arrow labels see "7.3 Labeling of arrows".

7 arrows

Example 7.2 B01

$$\frac{1}{x} = \frac{1}{x} \quad \frac{1}{x} = \frac{1}{x}$$

$$\frac{1}{x} = \frac{1}{x} \quad \frac{1}{x} = \frac{1}{x}$$

$$\frac{1}{x} = 0 \quad \frac{1}{x} = 1$$

$$\frac{1}{x} = 1$$

Example 7.2 B02

$$\frac{1}{x} = 0$$

$$\frac{1}{x} = 0$$

$$\frac{1}{x} = 0$$

7.3 Labeling of arrows

In Braille mathematics, arrow labels - regardless of their spatial relationship to the arrow in the template - are always written in brackets following the arrow.

The arrow is followed by a dot 4 %" and the caption is enclosed in special round Braille brackets %2...#` . A change to text font must be marked. The closing bracket is followed by a space or a punctuation mark.

Alternatively, depending on the content, round mathematical brackets %2 and %` or round text brackets %=...= can be used. The opening bracket is preceded by a dot 4 %" for mathematical brackets and a dot 6 %" for text brackets . The writing system within the brackets corresponds to the selected type of bracket.

If the labeling in the template itself is in brackets and these are of significance to the content, they are adopted and supplemented by the brackets described above.

7 arrows

Example 7.3 B01

3 5 $\overset{+2}{\text{yyy}} \text{yyy} \text{yyy} \dots \overset{4}{\text{yyy}} \dots$

#e ::o"#2+#b#` ... ::o"#2.#c#`

... ::o"#2-#d#` ...

or

#e ::o"2+#b` ... ::o"2.#c` ...'

::o"2-#d` ...

$\backslash[5 \stackrel{+2}{\longrightarrow} \dots \stackrel{\cdot}{3} \{\longrightarrow \dots \stackrel{-4}{\longrightarrow} \dots \backslash]$

Example 7.3 B02

3.86 4.7 4 4.5 $\overset{\text{rounded}}{\text{y}} \text{yyyyyy} \ddot{\text{y}}$

#c,hf .#d,g ::o"#2'.rounded'.#`' #d .#d,e

or

#c,hf .#d,g ::o'='rounded='

#d .#d, e

$\backslash[3.86 \cdot 4.7 \stackrel{\text{gerundet}}{\longrightarrow} 4 \cdot 4.5 \backslash]$

8 Simple and summary markings

Announcement and termination

characters %>

Simple top mark announcement sign

%<

Simple bottom marker announcement sign

%\$

Announcement signs for summary top marks

%_

Announcement sign for summary bottom markers

%\$

Reinforcement character for summary markings Second reinforcement

%!

character for summary markings for nesting

%5

Discontinuation symbol for summary markings

%%\$5

Discontinuation mark for reinforced summary marks second discontinuation mark for

%!5

reinforced summary

Markings

Markings in the black font at the top right or at the bottom right of the symbol

are %0*

.

Line (diagonal or straight)

%/

*

Stern

%{(

x

cross (diagonal)

%+

+

Plus sign

%-

-

Minus sign

%4

⌋

Hook (actuarial science)*

8 Simple and summary markers

Markings that appear in black above or below the symbol %:

	$\cdot$	horizontal line
%?	$\sim$	Serpentine (tilde)
%;	$\cdot$	Point
%)		Kreis, Courier
%0	$\wedge$	Roof*
%=	=	equal sign
%2		The book
%:,	$\rightarrow$	Right arrow
%!:	$\leftarrow$	Left arrow
%4!	$>$	Wedge with tip right*
%4,	$<$	Wedge with tip on the left*

* On the signs for the actuarial

Hooks, the roof and the wedges must each be followed by a space or punctuation mark, otherwise they can be confused with other characters.

Markers are additions written in black letters above, below, or to the right of a symbol to change its meaning.

Examples include: • Arrows

over letters identifying them as vectors. • Dashes over letters identifying them as stretches. • Lines after letters that identify them as geometric images. • Lines after function symbols, the differential derivatives

to mark.

Subscript or superscript letters and numbers on a symbol do not count as markings. They are treated as indices (see "10.3 Indices and Exponents").

There are also no symbols for units such as degrees or angle-minute markings.

The usual line in black writing over repeating numbers and sequences of numbers in periodic decimal fractions

8 Simple and summary markers

is not represented by a marking in Braille (see "2.1.4 Periodic Decimal Fractions").

In terms of Braille writing, a distinction is made between simple and summary markings. Simple markings refer to a single symbol. Summary markers span multiple symbols, "summarizing" them.

The announcement characters are written directly before and the discontinuation characters immediately after the character or character sequence.

Note: The

previous wedge right tip $\%''0$ and left tip $\%''9$ symbols have been replaced by the symbols shown in the list.

8.1 Simple Markings

Markings that refer to a single symbol appear to the right of the symbol in Braille, regardless of whether they appear above, below, or to the right of the symbol in black.

An announcement sign introduces the marking and indicates whether it is in black letters at the top or top right or at the bottom or bottom right. The announcement mark is usually omitted from top markings.

If a symbol has both markings and indices or exponents, the markings are usually written before the latter (see "10.3 Indices and Exponents").

If several markings of the same type on a main symbol are replaced by a number in brackets, this is written as an index.

8 Simple and summary markers

Example 8.1 B01

(4) ffff', ", '"',

f*', f**', f***', f|2#d`
 $\backslash[f', f'', f''', f^{\{4\}}]$

Example 8.1 B02

(y f x y , ,)

$y^{**} = f2x', y', y^{*} \backslash[y'' = f(x, y, y')]$

Example 8.1 B03

Ax b + = 0

$>a?x? +b? =\#j$
 $\backslash[\tilde{A}\tilde{x} +\tilde{b} =0]$

Example 8.1 B04

$\overline{f}xx :$ $\sqrt{\quad}$

$f:': x >:, 3x$
 $\backslash[\overline{f}: x \mapsto \sqrt{x}]$

Example 8.1 B05

$\overset{*}{c}_k$

$c/1k$
 $\backslash[\overset{*}{c}_{\{k\}}]$

Example 8.1 B06

a_n

a^{*1n}
 $\backslash[a'_{\{n\}}]$

8 Simple and summary markers

Example 8.1 B07

(Note: The line marking is placed after the main symbol with a lower index and therefore covers both.)

1 and

$y_1, >^* \setminus$
 $[\{y_{1}\}^*]$

Example 8.1 B08

n 1 y+

$y; 1n^{\#} a \setminus \dot{y}$
 $_{\{n+1\}}]$

Example 8.1 B09

Sometimes with $+$ the amount of positive ones
 rational numbers and with $+$ the same amount
 denoted by the number 0.

man4 times with $q < +$ d0 set of positive rational numbers and
 with $q > +1$ d0- same set with the number #j.

or

man4 times with $q < +$. d0
 set of positive rational numbers and with $q > +1$. d0- same quantity
 with the number #j bez34net.

Sometimes $\mathbb{Q}_{+}$ denotes the set of positive rational numbers
 and $\mathbb{Q}^{+}_{+0}$ denotes the same set with
 the number 0.

8 Simple and summary markers

8.2 Summary Marks

Summary markings refer to several symbols and are placed in front of them in Braille.

From a Braille perspective, they are projectives (see “10 projective technology”).

The marking is always initiated by one of the two announcement characters for summary upper %\$ or lower %_ markings. If there are further summary markings within the marked area or

Projectives occur, the announcement character must be preceded by the character %\$ or %! expanded at the beginning and the corresponding closing character must be added at the end. (See the explanation of the amplification of projectives, "10.2 Amplified Projectives.")

The marking is valid until the effect is canceled by: • a final character • a space •

the end of the line

- except for the line separator %" or • another marking or a different projective

Example 8.2 B01

U AB AB =

>u =\$2>ab +\$:>ab

$\backslash[U = \frown\{AB\} + \overline{\{AB\}}]$

Example 8.2 B02

AB CD =

_:>ab = _:>cd

$\backslash[\underline{\{AB\}} = \underline{\{CD\}}]$

8 Simple and summary markers

Example 8.2 B03

$$\overline{ABAB} \ddot{y} = \ddot{y}$$

\$\$:>a 3.>b\$5 =>a: 0.>b:

or

\$\$:>a"3.>b =>a: 0.>b:

$$\overline{A \cup B} = \overline{A} \cap \overline{B}$$

Example 8.2 B04

$$\overline{v^2} = \text{mean square. speed}$$

\$\$:v|;\$5 =' .mean square.'

ge5windigk3t'.

$$\overline{v^2} = \text{mean square. Speed}$$

Example 8.2 B05

$$\ddot{P}_0 P$$

\$\$:,>p1)>p\$5

$$\vec{P_0 P}$$

Example 8.2 B06

$$\overline{AB} \overline{AB}$$

\$\$:>a*>b* "%\$:>ab \overline{A'B'}

$$\parallel \overline{AB}$$

Example 8.2 B07

$$\overline{T_{12} T_{18} \ddot{y}}$$

\$\$:>t1,; 0.>t1, (\$5

$$\overline{T_{12} \cap T_{18}}$$

8 Simple and summary markers

Example 8.2 B08

($A \cap B \cap C$)

$\$2 > a \ 0. > b \ 3.2 > a \ 0. > c \ ``$

$3.2 > b \ 0. > c \ ``\$5$

$\overline{(A \cap B) \cup (A \cap C) \cup (B \cap C)}$

9 fractions

%8	$\frac{1}{2}$	Fraction bar
%;		Bruchanfang
%<		Bruching
%%<		End of all fractions (The second full sign is part of the symbol.)

9.1 Fractions and mixed numbers

Fractions in which both the numerator and denominator consist of positive integers are represented as follows: The numerator is written in the standard notation and the denominator is added in the lowered notation without its own number sign and without spaces.

Note: If mathematical expressions combine number fractions with fractions in simple or detailed notation, the appropriate notation can also be chosen for number fractions in order to make all fractions uniform.

Both parts of a mixed number, the whole number and the fraction, are given a number sign and written next to each other without spaces.

Example 9.1 B01

$$\frac{1}{2}$$

#a;

$\frac{1}{2}$

9 fractions

Example 9.1 B02

$$\frac{27}{36}$$

#bg:+

$$\left[\frac{27}{36}\right]$$

Example 9.1 B03

$$\frac{3}{4} \frac{1}{3} \frac{9}{12} \frac{4}{12} \frac{5}{12} = \frac{\quad}{\quad}$$

#c/ -#a: =#i,; -#d,; =#e,;

$$\left[\frac{3}{4} - \frac{1}{3} = \frac{9}{12} - \frac{4}{12} = \frac{5}{12}\right]$$

Example 9.1 B04

$$\frac{10}{2} = \frac{5}{1}$$

;\#aj8-\#b< =-\#e

$$\left[\frac{10}{-2} = -5\right]$$

Example 9.1 B05

$$\frac{10}{2} + \frac{10}{2} = \frac{0}{2}$$

#also; +\#aj8-\#b =\#j

or

;\#aj8\#b< +;\#aj8-\#b< =\#j

$$\left[\frac{10}{2} + \frac{10}{-2} = 0\right]$$

Example 9.1 B06

$$4 \frac{1}{4}$$

#d#a/

$$\left[4\frac{1}{4}\right]$$

9 fractions

Example 9.1 B07

$$\frac{1}{4} + \frac{21}{3} = \frac{28}{12} + \frac{49}{12} = \frac{77}{12}$$

#a#c/ + #b#a: = #ba,; + #bh,;'
= #of,; = #d#a,;

or

#a#c/ + #b#a:'
= #ba,; + #bh,;' = #of,;' = #d#a,;

$$\frac{1}{4} + \frac{21}{3} = \frac{28}{12} + \frac{49}{12} = \frac{77}{12}$$

9.2 Simple fraction notation

If there is no space in either the numerator or the denominator of a fraction, the announcement and termination of the detailed fraction notation may be omitted (see "9.3 Detailed fraction notation"). The symbol for the fraction bar %8 immediately follows the numerator. The denominator follows directly without spaces.

This simplified notation is also permitted where spaces in the numerator or denominator are replaced by the coherence point %". It is not suitable for complex expressions that become confusing due to the suppression of spaces.

Example 9.2 B01

$$\frac{a}{b}$$

a8b

$$\frac{a}{b}$$

9 fractions

Example 9.2 B02

$$\frac{a}{2}$$

a8#b
`\[\frac{a}{2}\]`

Example 9.2 B03

$$\frac{1}{x^3}$$

#a8x|: \[
`\[\frac{1}{x^3}\]`

Example 9.2 B04

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

#ex8#cx"-#b
`\[\frac{5x}{3x-2}\]`

For examples of simple fraction notation for units, see examples 4.1 B02 and 4.4 B05 under "4 units".

9.3 Detailed notation of fractions

With the exception of numbers and other simple fractions, detailed fraction notation is mandatory (see "9.1 Fractions and mixed numbers" and "9.2 Simple fraction notation"), especially if:

- the numerator or denominator contains a space
- the Numerator begins with an operation sign
- a fraction contains another fraction
- there is no space before or after the fraction

The fraction begins with the break character %; initiated, which is immediately in front of the meter. The end of fraction character %< immediately after the denominator closes it.

9 fractions

With regard to spaces, the break start and end characters are treated like parentheses.

The symbol for the fraction line %8 stands between the numerator and denominator. Generally it is surrounded by spaces on both sides. The two spaces can only be omitted if there is no space in either the numerator or denominator. One space cannot be retained and the other omitted.

The break start character may not be used without the break end sign and vice versa, but see "9.4 Multiple Fractions" for the termination of multiple fractions.

For example, if the break start character is immediately after a symbol and there is confusion with the mark for the period %; or the figure 2 %; is possible in lowered notation, the cohesion point %" is inserted between these characters (see "8 Simple and summary markings").

If a letter follows the end of the break, it must not be confused with the announcement for Greek letters. Therefore, a Latin lowercase letter is announced with a dot 6 %' after the break end character and the cohesion point %" is inserted between the break end character and the announcement for capital letters (see "1.2 Separating and keeping mathematical expressions together" and examples 3.2 B06 and 11.3 B04).

Note:

Contrary to previous practice, all numbers immediately after the fraction bar must be written in standard notation (see "2.1.1 Numbers in Standard Notation").

9 fractions

Example 9.3 B01

$$\frac{a}{b}$$

$$;-a \geq b <$$

or

$$;-a \geq b <$$

$$\left[\frac{-a}{b}\right]$$

Example 9.3 B02

$$A = \frac{hb^2}{2} m$$

$$;a =;hb \geq b <_m|;$$

$$\left[A = \frac{hb^2}{2} \text{m}^2\right]$$

Example 9.3 B03

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

$$;#ex \geq #cx - #b <$$

$$\left[\frac{5x}{3x-2}\right]$$

Example 9.3 B04

$$\frac{4x^2 + 3x - 1}{(x+2)(x-1)^2} = \frac{a}{x+2} + \frac{b}{x-1} + \frac{c}{(x-1)^2}$$

$$;#dx|; + #cx - #a \geq 2x + #b <$$

$$2x - #a < ;< = a8x" + #b + b8x" - #a' + c82x" - #a <|;$$

or

$$;#dx|; + #cx - #a \geq 2x + #b < 2x - #a <|; < =; a \geq x + #b < ' +; b \geq x$$

$$- #a < +; c \geq 2x - #a <|; <$$

$$\left[\frac{4x^2 + 3x - 1}{(x+2)(x-1)^2} = \frac{a}{x+2} + \frac{b}{x-1} + \frac{c}{(x-1)^2}\right]$$

9 fractions

Example 9.3 B05

$$\frac{x}{x^2 + y^2} \cdot \frac{2xy}{x^2 + y^2} \cdot \frac{y}{y}$$

$$;x \geq x|; +y|; <'$$

$$.2; \#bx \geq x + y < -; x - y \geq x <'$$

$$\left[\frac{x}{x^2 + y^2} \cdot \left(\frac{2x}{x + y} - \frac{x - y}{x} \right) \right]$$

Example 9.3 B06

$$x \cdot \frac{x + 1}{x^2 - 1}$$

$$x"; x + \#a \geq x|; -\#a <$$

$$\left[x \frac{x + 1}{x^2 - 1} \right]$$

Example 9.3 B07

$$\frac{a^2 + b^2}{3(a - b)} x$$

$$;a|; +b|; \geq \#c2a - b <'x$$

$$\left[\frac{a^2 + b^2}{3(a - b)} x \right]$$

See also examples 14.2 B05 and 11.3 B04.

9.4 Multiple Fractions

When nesting fractions, each fraction must be introduced individually with a break start character and end with a break end sign, analogous to the mathematical parentheses rules.

If all introduced fractions end at the same place, the series of break end characters can **be replaced by the character for the end of all fractions** %< . (Note: The second full character is part of the symbol.)

Fractions from positive whole numbers may also be written within other fractions in the usual notation (see "9.1 Fractions and mixed numbers"). Fractions using simple fraction notation are also possible, but only use them with great caution.

Example 9.4 B01

$$\frac{a}{b} x^3 \quad \text{or} \quad \frac{\frac{a}{x}}{\frac{b}{x^3}}$$

;;a8x< 8 ;b8x|:<<

$\backslash\frac{a}{x}\{b/x^3\}$

or

$\backslash\frac{\frac{a}{x}}{\frac{b}{x^3}}$

Example 9.4 B02

$$\frac{\frac{3}{4}}{\frac{1}{3}} + \frac{\frac{1}{2}}{\frac{1}{3}} - \frac{1}{4}$$

;;#c/ -#a: 8 #a; +#a: -#a/<

$\backslash\frac{\frac{3}{4} - \frac{1}{3}}{\frac{1}{2} + \frac{1}{3} - \frac{1}{4}}$

9 fractions

Example 9.4 B03

$$\text{in} \cdot \frac{1}{\text{in}}$$

$$\text{in} \cdot \frac{\text{in}}{\text{in} + \frac{1}{\text{in}}}$$

$$;u -; \#a8u < 8 u -; u 8 u +; \#a8u \% <$$

$$\backslash [\frac{u - \frac{1}{u}}{u - \frac{u}{u + \frac{1}{u}}}]$$

10 Projective technique

%3	$\sqrt{\quad}$	root
%		upper index (back) or Exponent
%1		lower index (rear) front
% or %#		upper index
%1 or %#1 %\$		front lower index
		Announcement signs for summary top marks
%_		Announcement sign for summary bottom markers
%5		Final sign for simple projects
%\$		Projective gain sign second
%!		projective gain sign
'%\$5 or %!5		Final character for reinforced
%%5		projectives Final character for all projectives (The second full character is part of the character.)

In black letters, the meaning of a symbol is changed by superscript or subscript. An example of this are indices and exponents. Some symbols can be elongated to show how far their impact extends.

This is the case with the root symbol and various markings.

In Braille it is not possible to physically superscript or subscript a symbol. Likewise, no symbol can be dragged over others. Braille therefore uses its own technique to reproduce the same meaning in one dimension: the projective technique.

A projective is introduced by Braille characters, which indicate the superscript or subscript or the mathematical

10 Projective technique

Represent symbol. This is followed by the actual expression. The effect of the projective is valid until the corresponding discontinuation sign or until it is canceled by another sign or another announcement.

In terms of Braille writing, a distinction is made between simple and amplified projectives. Amplified projectives may contain certain elements that are not permitted in simple projectives.

10.1 Simple Projectives

A simple projective is introduced by the symbol for the projective in question. It cannot contain a space or any other projective. The effect is canceled by one of the following elements: • a space • the end of the line - except for the line separator %"

- a fraction bar %8
- a final character for an intensified projective • another projective • the end of a number in the lowered notation • a closing bracket when the opening bracket is is not also in the projective

In all other cases, the end of scope must end with the %5 character. If the end of the projective is clear even without a final character, omitting it results in shorter - and therefore mostly clearer - expressions. However, in cases of doubt, it is always better to put the final sign.

In order to avoid the amplification of a projective, spaces must be replaced by the cohesion point %" . This technique is particularly useful for short expressions with operation signs, such as a plus sign in an exponent.

10 Projective technique

Example 10.1 B01

$$x^{2n} + x^n$$

$$x^n; +x^n$$

$$\sqrt{x^2 + x^n}$$

Example 10.1 B02

$$a^2 b^3 c^4$$

$$a|b|c|$$

$$\sqrt{a^2 b^3 c^4}$$

Example 10.1 B03

$$b^x y^z a$$

$$a|x^5 b|y^5 c|z$$

$$\sqrt{a^x b^y c^z}$$

Example 10.1 B04

$$a^{-3} \cdot a^{+5} = a^{-3+5} = a^2$$

$$a| - \#c . a| + \#e = a| - \#c'' + \#e = a| \#b$$

or

$$a| - : . a| + \#e = a| - \#c'' + \#e = a|;$$

$$\sqrt{a^{-3} \cdot a^{+5}} = a^{-3+5} = a^2$$

Example 10.1 B05

$$\frac{x^n}{n!}$$

$$; x|n \ 8 \ n6 <$$

$$\sqrt{\frac{x^n}{n!}}$$

10 Projective technique

Example 10.1 B06

$$\frac{x^{2n+1}}{(2n+1)!}$$

;x|bn"+#a 8 2#bn +#a`6<

$$\left[\frac{x^{2n+1}}{(2n+1)!}\right]$$

10.2 Amplified Projectives

If a projective contains additional projectives, spaces or fraction bars, it must be "reinforced". This is done by placing the projective reinforcement character %\$ in front of the character for the projective in question. The scope of the projective is necessarily terminated by a reinforced final character %\$5 .

Amplified projectives can also occur nested. The outer projective is marked with %\$ as an intensifier, the first inner projective with the alternative intensifier %! initiated. At each additional nesting level, the two reinforcement characters alternate. The corresponding final character cancels the effect of the reinforced projective sign. If all projectives are to end at the same point, the collective terminator %%%5 can replace the sequence of terminators (the second

Full character is part of the character).

Example 10.2 B01

$$\sqrt{x^2} =$$

$$3x|;5 = x \sqrt{x^2}$$

$$=x|]$$

Example 10.2 B02

$$n^{2^3} = n^8$$

$$n$|;5 = n[($$

$$\left[n^{2^3} = n^8\right]$$

10 Projective technique

Example 10.2 B03

(Note: The first root includes the exponent n , but the second does not.)

$$x^{\frac{n}{2}} = \sqrt[n]{x^n} = \sqrt{x^n}$$

$$x^{\frac{n}{2}} = \sqrt[n]{x^n} = \sqrt{x^n}$$

$$\sqrt[n]{x^{\frac{n}{2}}} = \sqrt[n]{x^n} = \sqrt{x^n}$$

Example 10.2 B04

$$\sqrt[4]{3^2} = \sqrt[4]{9}$$

$$\sqrt[4]{3^2} = \sqrt[4]{9}$$

$$\sqrt[4]{b \cdot \sqrt[3]{b^2} \cdot \sqrt{b}}$$

Example 10.2 B05

$$\text{Decay Law: } N = N_0 e^{-\lambda t} \quad \frac{1}{T_{1/2}}$$

$$\text{Decay law: } N = N_0 e^{-\lambda t} \quad \frac{1}{T_{1/2}}$$

$$\text{Disintegration law: } N = N_0 \cdot \left(\frac{1}{2} \right)^{\frac{t}{T_{1/2}}}$$

10.3 Indices and Exponents

If the superscript or subscript of one or more symbols is of mathematical significance in black writing, this is marked as "upper" or "lower index" in Braille mathematical writing.

Exponents cannot be distinguished typographically from other upper indices and are therefore introduced with the same Braille symbol in Braille (in contrast to previous practice).

10 Projective technique

10.3.1 Rear indices and exponents

Indices to the right of the main symbol are also written in Braille immediately to the right of that symbol. They are marked with the upper character %| or lower %1 index initiated. If necessary, this character is combined with a projective amplifying character.

If a symbol has several additional additions, these are transferred one after the other. Each addition must be introduced individually. Any existing exponent moves to the last position.

Simple markings are an integral part of the main symbol and are usually placed before indices (see "8.1 Simple markings").

Example 10.3.1 B01

$$\frac{x^n}{n!}$$

;x|n 8 n6<

or ;x|
n8n6<

or x|
n8n6

$$\frac{x^n}{n!}$$

Example 10.3.1 B02 ()

$$f_n(x), f_{n+1}(x)$$

f1n52x`, f1n"+#a52x`

$$[f_n(x), f_{n+1}(x)]$$

Example 10.3.1 B03

$$(P_{2n})^r$$

2>p1#bn"-#a`r \left(P_{2n}

$$-1\right)^r]$$

Example 10.3.1 B04

$$+(-a \text{ and } b)$$

$$e|''+2<a't''+<b`$$

$$\backslash[e^{\wedge}+\backslash\text{left}(\backslash\alpha\ t\ +\backslash\beta\right)\backslash]$$

Example 10.3.1 B05

$$\text{Time}_{\text{Bob}} = \frac{\text{distance}}{\text{speed}}$$

$$\text{time}_{\text{bob}} = \text{time}_{\text{alice}} = \frac{\text{distance}}{\text{speed}}$$

$$\backslash[\text{Time}_{\text{Bob}} = \text{Time}_{\text{Alice}} = \frac{\text{Distance}}{\text{Speed}}]$$

Example 10.3.1 B06

$$a_n^k = a_n^k$$

$$a_n^k = 2a_n^k$$

$$\backslash[a_n^k = (a_n)^k]$$

Example 10.3.1 B07

$$\tilde{y}^x \tilde{y}^i \tilde{y}^r$$

$$2x1n|i`|r$$

$$\backslash[(x_n^i)^r]$$

Example 10.3.1 B08

$$F_n(x)$$

$$>f_{1n1k}52x`$$

$$\backslash[F_{n\{k\}}(x)]$$

10 Projective technique

Example 10.3.1 B09

$$\begin{aligned} & \mathbf{X} \\ & \mathbf{n} \end{aligned}$$

$$2x\$1n|i\$5`|r$$

$$\backslash[(x_{\{n^{\{i\}}\}})^{\{r\}}]$$

Example 10.3.1 B10

$$\ddot{\mathbf{y}} \quad \mathbf{P}(\mathbf{i}, \mathbf{j})$$

o $\ddot{\mathbf{y}}$ in the

$$0 < \mathbf{j} \leq \mathbf{n}$$

$$\&s\$1\#j"9=i"9=m < 8 \#j"9.j"9.n\$5'$$

$$> p2i', j`$$

or

$$\&s1\#j"9=i"9=m51\#j"9.j"9.n' > p2i', j`$$

$$\backslash[\sum_{\substack{0 \leq i \leq m \\ 0 < j < n}} P(\mathbf{i}, \mathbf{j})]$$

Example 10.3.1 B11

$$\frac{x^2}{2}$$

It is

$$\sqrt{2} \mathbf{P} \mathbf{i}$$

$$;e\$|";x|;8\#b<\$5 \ 8 \ 3\#b<p<$$

$$\backslash[\frac{e^{\{\frac{x^{\{2\}}\{2\}}\}}}{\sqrt{2\pi}}]$$

Example 10.3.1 B12 kj

$$\mathbf{t} \quad \mathbf{j} \quad \mathbf{i} = \mathbf{g} \quad \mathbf{t}$$

$$< t1i|.j = g1ik5 < t|kj$$

$$\backslash[\tau_{\{i\}^{\{.j\}}} = g_{\{ik\}} \tau^{\{kj\}}]$$

10 Projective technique

Example 10.3.1 B13

$$K_{i,j}^{at.} = g g K_{risj}^{kr}$$

$$>k1.i.j|k.l. = g|kr5g|s5>k1risj$$

$$\backslash [K_{\{.ij\}}^{\{kl\}} = g^{\{kr\}} g^{\{ls\}} K_{\{risj\}}]$$

Example 10.3.1 B14

$$(P_{r_i}^{r_k})^n$$

$$2>p\$1<r1i\$5\$|<r1k\$5`|n$$

$$\backslash [({P_{\rho_i}})^{\rho_k})^n]$$

Example 10.3.1 B15

$$\frac{1}{2} \text{ and } r^2 \left| \begin{array}{c} R \\ 0 \end{array} \right. = \frac{1}{2} (1 \text{ It is } R^2)$$

$$- \#a;e\$|-r|;\$5"l1)|>r'$$

$$= \#a;2\#a -e\$|>r|;\$5`$$

$$\backslash \left[\left. \frac{1}{2} e^{-r^2} \right|_0^R = \frac{1}{2} (1 - e^{-R^2}) \right]$$

Example 10.3.1 B16

$$K \frac{a b}{2} + m \frac{2}{a b} + c$$

It is

$$e\$|<k";a +b 8 \#b<'$$

$$+<m";\#b 8 a +b< +c\$5$$

or

$$e\$|<k";a"+b8\#b<'+<m";\#b8a"+b<$$

$$+c\$5$$

$$\backslash [e^{\kappa \frac{a+b}{2}} + \mu \frac{2}{a+b} + c]$$

10 Projective technique

Example 10.3.1 B17

$$\lim_{t \rightarrow 1} \frac{t^a - t^b}{t^b - t^a}$$

$$\lim_{t \rightarrow 1} \frac{t^a - t^b}{t^b - t^a}$$

$$\lim_{t \rightarrow 1} \frac{t^a - t^b}{t^b - t^a}$$

$$\lim_{t \rightarrow 1} \frac{t^{\frac{1}{\alpha}} - t^{\frac{1}{\beta}}}{t^{\frac{1}{\beta}} - t^{\frac{1}{\alpha}}}$$

10.3.2 Front Indices

Two forms of announcement characters are available to introduce upper and lower indices to the left of the main symbol. The short forms %| and %1 are the standard forms. The long forms %#| and %#1 should only be used where there is a risk of confusion with indices on the preceding symbol, for example immediately after a variable. After a space, equal or operation sign or an opening bracket, confusion is excluded and the short forms must be used.

Example 10.3.2 B01

$$\sqrt[3]{8} = 2$$

$$\sqrt[3]{8} = 2$$

$$\sqrt[3]{8} = 2$$

Example 10.3.2 B02

$$10^{\log 3}$$

$$10^{\log 3}$$

$$10^{\log 3}$$

10 Projective technique

Example 10.3.2 B03

$$j_i m$$

$$1 \ln |5m$$

$$\sqrt[\{i\}^{\{j\}}]{m}$$

Example 10.3.2 B04

$$+ xy^{n-1} \sqrt{\quad}$$

$$x \cdot |n| + \#a^3 y$$

$$\sqrt[n+1]{x \cdot y}$$

Example 10.3.2 B05

$$x y^{n-1} \sqrt{\quad}$$

$$x \cdot |n| + \#a^3 y \sqrt[n+1]{x}$$

$$\sqrt[n+1]{y}$$

Example 10.3.2 B06

$$A^{x n-1} \sqrt{y}$$

$$> a \cdot |x| \cdot |n| + \#a^3 y^5$$

$$\sqrt[n+1]{A^{x \cdot y}}$$

Example 10.3.2 B07

$$^a \log x = ^a \log b \cdot ^b \log x$$

$$|a| x = |a| b \cdot |b| x \cdot \log x = \log a \cdot \log b \cdot \log x$$

$$\log x$$

Example 10.3.2 B08

$$a \cdot \sqrt[n]{m \cdot x}$$

$$a \cdot |n| \cdot m^5 \cdot y^8 \cdot x^5$$

$$\sqrt[n]{a \cdot \sqrt[m]{\frac{y}{x}}}$$

10 Projective technique

10.3.3 Indices from integers

If an index only consists of an integer, this can be written to the index character in the lowered notation without a number sign attached. For negative numbers, the minus sign is inserted between the index character and the number without a tie point %". If the positive property of the number is to be emphasized by a plus sign, the standard notation must be used and the plus sign must be replaced by the tie point %. " must be separated from the index character.

There is no need for a projective final sign after the number in lowered notation, since the end of a simple projective goes hand in hand with the end of a number in lowered notation.

Example 10.3.3 B01

$$a^2 b^3 c$$

$$a|;b|:c$$

$$\backslash[a^{\wedge}\{2\}b^{\wedge}\{3\}c\backslash]$$

Example 10.3.3 B02

$$a \ a \ a \ 11 \ 22 \ 12 \ 21$$

$$a_1, a_1;; -a_1,; a_1,;$$

$$\backslash[a_{\{11\}}a_{\{22\}}-a_{\{12\}}a_{\{21\}}\backslash]$$

Example 10.3.3 B03

$$f_{11} u_1 u_2$$

$$f_{1,2} u_1, ', u_1;`$$

$$\backslash[f_{\{1\}}(u_{\{1\}}, u_{\{2\}})\backslash]$$

10 Projective technique

Example 10.3.3 B04

$$\frac{x^3}{x^3} = 1$$

$$x^3 = x^3$$

$$x^3 = x^3$$

Example 10.3.3 B05

$$\frac{x^3}{3!}$$

$$x^3 = 8$$

or

$$x^3 = 8$$

$$\frac{x^3}{3!}$$

10.4 Roots and Additives

Square roots (without the qualifying number 2) are introduced with the symbol for roots (if necessary combined with a projective reinforcement symbol). The projective includes all symbols that are located under the root in the black font representation.

Numbers indicating that it is a third, fourth, or other root are represented as front upper indices on the root sign.

Example 10.4 B01

$$\sqrt{\frac{2}{2}} = \sqrt{1}$$

$$3\sqrt{b} = 3\sqrt{a}$$

$$\sqrt[3]{\frac{2}{2}} = \sqrt[3]{1}$$

10 Projective technique

Example 10.4 B02

$$\sqrt{a+b}$$

$$3a''+b \setminus$$

$$\sqrt{a+b}$$

Example 10.4 B03

$$\sqrt{a x (3) \ddot{y}^2}$$

$$3a^2x - \#c \setminus ; \$5$$

$$\sqrt{a(x-3)^2}$$

Example 10.4 B04

$$\sqrt{2\sqrt{2}} = \sqrt{4\sqrt{2}}$$

$$3\sqrt[3]{b} = 3\sqrt[3]{b} \cdot \sqrt[3]{b}$$

$$\sqrt{2\sqrt{2}} = \sqrt{2} \cdot \sqrt{4\sqrt{2}}$$

Example 10.4 B05

$$= \sqrt[3]{\ddot{y}^2 \pm \frac{u^q}{2}} \sqrt[3]{\frac{3\ddot{y}}{\ddot{y}^3} + \frac{\ddot{y}\ddot{q}^2}{\ddot{y}^3}}$$

$$u = \sqrt[3]{-q + \sqrt[3]{2p^8c} + 2q^8b} \setminus ; \%5 \setminus [u = \sqrt[3]{-\frac{q}{2}}$$

$$\sqrt[3]{2} \pm \sqrt[3]{\left(\frac{p}{2}\right)}$$

$$\sqrt[3]{3} \right)^3 + \left(\frac{q}{2}\right)^2 \right)^3 \setminus$$

11 Analysis

%#%	∞	infinity (The second full sign is part of the symbol.)
%&s	$\sum$	Sum symbol
%&p	$\prod$	Product symbol
%1	$\liminf$	lower limit (rear lower Index)
%	$\limsup$	upper limit (posterior upper Index)
%)	$\odot$	linked to (Kreis, Kuller)
%6l	$\log, \lg$	Logarithm
%6(l	$\ln$	natural logarithm
%6/l	$\lg$	Dual logarithm
%6,l	antilog	Antilogarithmus
%6:l	cpllog	Supplementary or complementary logarithm
%6e	$\exp$	Exponential function
%6n	on one	The number
%6{	$\arg$	Argument
%~	$\int$	Integral
%0~~	$\iint$	Doppelintegral
%0~)	$\oint$	circulation integral
%0~~)	$\oiint$	Envelope integral
%0~<:	$\int_{-}$	lower integral
%0~:	$\int_{+}$	oberes Integral
%0>~	$\int^{\cdot}$	Integral of a special kind
%"l	$\int^{\cdot}$	integral line
%0*	$\dot{}$	Derivative dash

11 Analysis

%;	'	Derivation point
%"d	ÿ	round d (for partial derivative) large
%&d	ÿ	delta as difference sign
%#l	lim	Limes
%#l<:	<u>lim</u>	Limes inferior
%#l:	<u>lim</u>	Limes superior

11.1 Features

%#%	ÿ infinity (The second full sign is part of the symbol.)
%&s	ÿ Sum symbol ÿ Product
%&p	symbol lower limit (lower
%1	index) upper limit (upper index)
%	linked to (circle, Kuller)
%)	

For the sum and product symbol, lower and upper limits are represented as lower and upper indices according to the template. Following the way of speaking, the lower limit is first indicated in Braille. There is usually a space before the expression following the limit information.

Example 11.1 B01

a ÿ n

&s a1<n

$\sum a_{n_u}$

11 Analysis

Example 11.1 B02

$$\sum_{n=1}^{\infty} a_n$$

Example 11.1 B03

$$\sum_{k=1}^n a_k$$

11.2 Logarithm and exponential functions

%l	log, lg	Logarithm
%l	ln	natural logarithm
%l	ld	Dual logarithm
%l	antilog	Antilogarithmus
%l	cplog	Supplementary or complementary logarithm
%e	exp	Exponential function
%n	on one	The number
%{	arg	Argument

The symbols listed above are used equally for all variants of the relevant short word symbols in the black font. The symbols in Braille also represent both uppercase and lowercase short word symbols.

If the argument begins with an announcement character (e.g. for numbers or upper or lower case letters), it is allowed

11 Analysis

connect to the symbol. In other cases there must be a space between the symbol and the argument.

In principle, it is permissible to form these symbols using the general introductory character for short word symbols %7 and the letters usual in black print. For example, % 7log can also be written for % 6l (see "3.6 Shortword symbols"). These expressions are longer, but can be useful where a distinction is made between capitalized and lowercase short word symbols, where a closer correspondence with the black text is to be maintained, or where the reader cannot be assumed to be familiar with isolated symbols.

Example 11.2 B01

$$\begin{aligned} &^{10} \\ &\log 3 \\ &|,)6l\#c \backslash [^{\wedge}10]\log \\ &3\backslash \end{aligned}$$

Example 11.2 B02

ln(3) ÿ x

$$\begin{aligned} &6(l\ 2\#c -x` \\ &\backslash [\ln (3 -x)] \end{aligned}$$

Example 11.2 B03

$$\begin{aligned} &a \log x = a \log b + b \log x \\ &|a56l'x =|a56l'b .|b56l'x \backslash [^{\wedge}\{a\}\log x =^{\wedge}\{a\}\log b \cdot ^{\wedge}\{b\}\log \\ &x\backslash \end{aligned}$$

Example 11.2 B04

$$\begin{aligned} &\exp'() \exp() \quad \text{With} \\ &6e*2z` =6e 2z` \\ &\backslash [\exp'(z) =\exp (z)] \end{aligned}$$

Example 11.2 B05

$$\exp : \text{With} = \sum_{k=0}^{\infty} \frac{z^k}{k!}$$

$$\exp z := \sum_{k=0}^{\infty} \frac{z^k}{k!}$$

11.3 Integral and Differential Calculus

%~	$\int$	Integral
%~~	$\iint$	Doppelintegral
%~)	$\oint$	circulation integral
%~~)	$\oiint$	Envelope integral
%~<:	$\int_{\cdot}$	lower integral
%~:	$\int^{\cdot}$	oberes Integral
%>~		Integral of special kind lower
%1		limit (lower index) upper limit (upper
%		index)
%"l	$\int^{\cdot}$	integral line
%*	$\dot{}$	Derivative dash
%;	$\dot{}$	Derivation point
%"d	∂	round d (for partial derivative) large delta
%&d	Δ	as difference sign
%#l	$\lim$	Limes
%#l<:	$\liminf$	Limes inferior
%#l:	$\limsup$	Limes superior

Lower and upper bounds are rendered as lower and upper indices according to the template.

Following the way of speaking, you first state the lower limit. There is usually a space before the following expression.

Example 11.3 B01

b

$\ddot{y} \dots$

a

$\sim 1a|b \dots$

$\int \int a^b \dots$

Example 11.3 B02

x_{k+1}

$\ddot{y}$

x_{k-1}

$\sim x^k - \frac{1}{5}x^k + \frac{1}{5}x^5$

$\int x_{k-1}^{x_{k+1}}$

Example 11.3 B03

$$\int_0^3 x^2 dx = \left. \frac{1}{3} x^3 \right|_0^3$$

$> a = -1) | : x | ; dx'$

$= | \# a : x | : l_1) | :$

$\int_0^3 x^2 dx = \left| \frac{1}{3} x^3 \right|_0^3$

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Example 11.3 B04

It is $a + \frac{x f_u(1)}{0.2}$ of

$$e^{\alpha} |a + 1| x; f_1, 2u^8 f_1; 2u^< du^5$$

$$\left[e^{\alpha} \int_0^x \frac{f_1(u)}{f_2(u)} du \right]$$

Example 11.3 B05

$\lim_{n \rightarrow \infty} \lim_{h \rightarrow 0}$

$$\#1n^{\cdot}, \#0', \#1h^{\cdot}, \#j$$

$$\left[\lim_{n \rightarrow \infty}, \lim_{h \rightarrow 0} \right]$$

Example 11.3 B06

It is $\lim_{x \rightarrow 0} (f(x))$

$$e^{\alpha} |1x^{\cdot}, x1)|^5 f_2x^5$$

$$\left[e^{\alpha} \lim_{x \rightarrow x_0} f(x) \right]$$

12 Mengenlehre

%{		opening curly brace
%}	{ }	closing curly brace
%%n		Set of natural numbers
%%z		Set of integers
%%q		Set of rational numbers
%%r		Set of real numbers
%%c		Set of complex numbers
%%h	H	Quantity of quaternions
%%p	P	Projective line
%&o	$\emptyset$	empty set
%&a	A	Aleph
%&,	$\forall, \exists$	for all, there
%&?	are	
%&it is	$\in$	is element of*
%*&it is	$\notin$	is not an element of*
%&*		has to the element*
%2.	$\subset$	is contained in, is a subset of*
%2=	$\subseteq$	contained in or equal to*
%` ,	$\supset$	contains, is a superset of*
%`=	$\supseteq$	contains or is equal to*
%3.	$\cup$	united with*
%0.	$\cap$	intersected with*
%1.	$\setminus$	reduced by, without*
% .	Δ	symmetrical difference*
%(	$\times$	Cartesian product (painting cross)*
%"l		vertical line, so that
%*	'	Line as a marker for complementary quantities
% c	^c	superscript c as a marker for complementary sets

12 Mengenlehre

* A space must be placed before these symbols, but not after them (see "5 operation and relation symbols").

The symbols for the standard sets (set of natural numbers, integers, etc.) are solid structures made up of three Braille characters. They are not to be understood as letters with an announcement. Similar symbols that are not listed here may be created analogously.

Example 12 B01

A B $\dot{\cup}$

$\dot{\cup} a \dot{\cup} b$

$\dot{\cup} [A \dot{\cup} B]$

Example 12 B02

L M $\dot{\cap}$ L M $\dot{\cup}$ (N) $\dot{\cup}$ = $\dot{\cup}$, (

$\dot{\cup} | 1.2 \dot{\cup} m \dot{\cup} 0. \dot{\cup} n \dot{\cup} = 2 \dot{\cup} | 1. \dot{\cup} m \dot{\cup} 3.2 \dot{\cup} |$
 $1. \dot{\cup} n \dot{\cup}$

$\dot{\cup} [L \dot{\cup} \text{setminus} (M \dot{\cup} N)]$

$= (L \dot{\cup} \text{setminus} M) \dot{\cup} (L \dot{\cup} \text{setminus} N)$

Example 12 B03

A B B A =

$\dot{\cup} a \dot{\cup} b \dot{\cup} = b \dot{\cup} a$

$\dot{\cup} [A \dot{\cup} \text{triangle} B \dot{\cup} B \dot{\cup} \text{triangle} A]$

Example 12 B04

A U $\dot{\cup}$ = {3,5,7}

$\dot{\cup} a \dot{\cup} 0. \dot{\cup} u \dot{\cup} = \{ \dot{\cup} c', \dot{\cup} e', \dot{\cup} g! \}$

$\dot{\cup} [A \dot{\cup} U \dot{\cup} = \{3,5,7\}]$

12 Mengenlehre

Example 12 B05

$\{\text{red, green}\} \cup \{\text{yellow, blue}\} = \{\text{red, green, yellow, blue}\}$

$\{\text{root, gr8n}\} \cup \{\text{yellow, blue}\} = \{\text{root, gr8n, yellow, blue}\}$

$\{\text{red, green}\} \cap \{\text{yellow, blue}\} = \emptyset$

Example 12 B06

$\{\text{even numbers}\} \cap \{\text{odd numbers}\} = \emptyset$

$\{\text{even numbers}\} \cup \{\text{odd numbers}\} = \mathbb{N}$

$\{\text{even numbers}\} \cap \{\text{odd numbers}\} = \emptyset$

Example 12 B07

$\forall x \in B$

$\forall x \in B$

$\forall x \in B$

Example 12 B08

$(ABAB)^c = \bar{A} \bar{B} \bar{A} \bar{B}$

$2 > a \mid . > b \mid c \Rightarrow a \mid c \mid 3 > b$

$\{(A \triangle B)^c\} = A^c \cup B$

Example 12 B09

$\bar{y} \bar{y}$

$\mathbb{N} \subseteq \mathbb{Z} \subseteq \mathbb{Q}$

$\mathbb{N} \subseteq \mathbb{Z} \subseteq \mathbb{Q}$

13 Logic

$\%0,$	$\dot{\vee}$	and
$\%3,$	$\dot{\vee}$	or
$\%.*$	$\neg$	not
$\%==0$	$\dot{\rightarrow}$	Right arrow with double Shaft and simple tip (Implication arrow)
$\%9==0$	$\dot{\leftrightarrow}$	Double arrow with double shaft (equivalence arrow)

The symbols for "and", "or" and "not" are written after a space followed by the following character (see "5 operation and relation symbols").

The implication and equivalence arrows are between spaces. Crossed-out arrows are displayed as modular arrows (see "7.1 Modular arrows").

Example 13 B01

3 divides 10 $x \dot{\vee} \dot{\vee}$

$\#c \text{ teilt } x \text{ 0, } x \text{ 9}=\# \text{ also}$

or in full or shorthand:

$\#c \text{ t3lt } x \text{ 0, } x \text{ 9}=\# \text{ aj}$

or.:

$\#c \text{ 't3lt'. } x \text{ 0, } x \text{ 9}=\# \text{ aj}$

$\backslash[3 \text{ \; \; \text{\textit{split}} \; \; } x \text{ \; \; \text{\textit{and}} } x \text{ \; \; \text{\textit{leq}} } 10 \text{ \; \; }]$

Example 13 B02

$A \dot{\vee} \neg \dot{\vee} \quad A \dot{\vee} \dot{\vee}$

$>a :: o >b \text{ 9}==o : * >a \text{ 3, } >b$

$\backslash[A \text{ \; \; \text{\textit{rightarrow}} } B \text{ \; \; \text{\textit{Leftrightarrow}} } \text{\textit{not}} A \text{ \; \; \text{\textit{lor}} } B \text{ \; \; }]$

14 geometry, trigonometry and Vectors

14.1 Geometric symbols

%7/		triangle
%7)	•	Circle
%7=		Square
%7%		Rectangle (The second full character is part of the symbol.)
%7?	◊	Rhombus
%7+		Parallelogramm
%7*	⌀	diameter
%79	⌘, , ⌘	Store
%7(		right angle clockwise
%7:,		counterclockwise
%7!:		summary mark for
%\$:	—	
		Distance (horizontal line over several letters)
%%\$2summary marker for		
		Arch (arch over several Symbols)
	⤴⤵	
%\$:,		summary mark for Vector (arrow over several Symbols)
	↖	
%:,		Marker for vector (arrow above a symbol) vertically
%#.	↗	
%"%%		parallel to (The second full character is part of the symbol.)

14 Geometry, trigonometry and vectors

The symbols formed with key characters %7 can be written with or without a preceding and/or following space. However, they must be clearly separated from letters immediately to the right of them, for example by a letter indicating upper or lower case.

Summary marks over multiple symbols appear immediately before the first of these symbols and are projectives. The end of the marking follows the general rules for projectives (see "10 Projective technique").

The symbols for "perpendicular to" and "parallel to" are relational symbols (see "5 operation and relational symbols").

Example 14.1 B01

ABCD

$\Rightarrow abcd$

$\square ABCD$

Example 14.1 B02 °

$\angle PQR$ 30

$\angle pqr = 30^\circ$

$\angle PQR = 30^\circ$

14.2 Angular, hyperbolic functions and inverses

%6a	arc	Arcus
%6s	sin	Sinus
%6c	cos	Cosine
%6t	tan, tg	Tangent
%68	cot, cot, ctg	Cotangent
%6-	sec	Sequence
%62	cosec	Kosekans
%6,s	arcsin	In your chest
%6,c	arccos	Cosine cosine

14 Geometry, trigonometry and vectors

$\%6,t$	arctg	Arkustangens
$\%6,8$	arccot, arcctg	Arkuskotangens
$\%6,-$	arcsec	Ark sequence
$\%6,2$	arccosec	Arkuskosekans
$\%6(s$	born, sh	Hyperbolic sine cosh,
$\%6(c$	ch	Hyperbolic cosine tanh, th Hyperbolic
$\%6(t$	tangent coth, th Hyperbolic cotangent	$\%6,$
$\%6(8$	(s arsinh, arsh	Hyperbolic area sine $\%6,(c$
	arcosh, arch	Hyperbolic area cosine $\%6,(t artanh, arth$
	Hyperbolic	area tangent $\%6, (8 arcoth, hyperbolic area cotangent arcth$

These symbols apply to all variants of the relevant short word symbols in black letters, for example for tangents spelled "tan" or "tg". The symbol also applies to both uppercase and lowercase short words.

If the argument begins with an announcement character (as for numbers or upper or lower case letters), it may follow the symbol. In other cases, a space must be placed between the symbol and the argument.

It is permissible to reproduce these symbols with the general introductory character for short word symbols $\%7$ and the letters usual in black script. Expressions created in this way are longer, but can be useful where a closer correspondence to the black script is required or where familiarity with isolated symbols cannot be assumed.

The symbols are structured. Cotangent, secant and cosecant are mathematical reciprocals of tangent, cosine and sine. This is represented by the reflection of the second character around the horizontal axis. The hyperbolic functions are formed by inserting the character $\%($ (a subscript h for "hyperbolicus"). For the trigonometric functions, an inserted, subscript a $\%$ means "Arcus...", for the hyperbolic functions "Area.".

14 Geometry, trigonometry and vectors

Example 14.2 B01

$$\sin 30^\circ = 0,5$$

$$\sin 30^\circ = 0,5$$

$$\sin 30^\circ = 0,5$$

Example 14.2 B02

$$\tan x = \frac{\sin x}{\cos x}$$

$$\tan x = \frac{\sin x}{\cos x}$$

oder

$$\tan x = \frac{\sin x}{\cos x}$$

$$\tan x = \frac{\sin x}{\cos x}$$

Example 14.2 B03

$$\sin \frac{\pi}{2} = \sin 90^\circ = 1$$

$$\sin \frac{\pi}{2} = \sin 90^\circ = 1$$

$$\sin \frac{\pi}{2} = \sin 90^\circ = 1$$

Example 14.2 B04

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

Example 14.2 B05

$$\sin a + \sin b = 2 \sin \frac{a+b}{2} \cos \frac{a-b}{2}$$

$$\sin a + \sin b = 2 \sin \frac{a+b}{2} \cos \frac{a-b}{2}$$

$$\sin a + \sin b = 2 \sin \frac{a+b}{2} \cos \frac{a-b}{2}$$

$$\sin a + \sin b = 2 \sin \frac{a+b}{2} \cos \frac{a-b}{2}$$

$$\sin a + \sin b = 2 \sin \frac{a+b}{2} \cos \frac{a-b}{2}$$

14 Geometry, trigonometry and vectors

Example 14.2 B06

$$\arctan 1 = \frac{\pi}{4} (0.7854)$$

$$\arctan 1 = \frac{\pi}{4} (=0.7854)$$

Example 14.2 B07

$$2 \cos^2 \alpha - 1 = 2 \cos^2 \alpha - 1 = 1 - 2 \sin^2 \alpha$$

$$2 \cos^2 \alpha - 1 = 2 \cos^2 \alpha - 1 = 1 - 2 \sin^2 \alpha$$

$$2 \cos^2 \alpha - 1 = 2 \cos^2 \alpha - 1 = 1 - 2 \sin^2 \alpha$$

14.3 Vectors

Labeling of vectors

%:	$\vec{y}$	Right arrow (marker)
%:	—	horizontal line (marking) 1. special
%!		typographical award 2. special
%_		typographical award

Wortsymbole

%g	grad	grad (gradient)
%d	div	div (divergence)
%r	rot, curl	red, curl (rotation)

Other symbols

%<8		Start of a new line
%&n	∇	Nabla

14 Geometry, trigonometry and vectors

When transferring the vectors to Braille, the notation of the vectors is adopted from the black font template. Lines or arrows above the symbols belonging to the vector are considered simple or summary markings are reproduced (see "8 Simple and summary markings").

Vectors shown with bold or gothic letters are accompanied by one of the two special typographic awards announcement marks %! or %_ (see "3.4 Special typographic awards").

Example 14.3 B01

ÿ ÿ

a b

a:, .b:,

$\backslash[\vec{a} \cdot \vec{b}]$

Example 14.3 B02

ÿ

x x̄y z ()

x:, =2xyz`

$\backslash[\vec{x} = (x \ ; \ y \ ; \ z)]$

Example 14.3 B03 ÿ ÿ

ÿ
and = ÿ ÿ ÿ ÿ 3

ÿ ÿ

y:, =2#a<8#b<8#c`

$\backslash[\vec{y} = \left(\begin{array}{c} 1 \\ 2 \\ 3 \end{array} \right)]$

$\backslashend{array} \right)]$

$$\ddot{\mathbf{M}}_d > m; 1d$$

$\overline{AB}$ or $\vec{AB}$

`$:>ab or $:,>ab \[\overline{AB} \]; \text{or} \;`
`\vec{AB}\]`

$\ddot{y} \ddot{y} \ddot{y} \ddot{y} \ddot{y} \ddot{y}$ **tourist Office**
 $\text{IN} = \ddot{y} = +\text{IN}$ 1 2 3 div
 $\ddot{y} \ddot{y} \ddot{y}$
 xy z
 $6d >v:, =\&n:, >v:, = "d >v1,8"dx' + "d >v1;8"dy + "d >v1:8"dz$

$$|k\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$$

14 Geometry, trigonometry and vectors

In shorthand:

'<=- fgcdc ,wc fett &d\$(bu4}abc
 t e ptc #d,e,f %_ u goti5e t pt #e %! &kcnz34net.'<= _>kj) =!b.6r!t \

$$[\mathbf{K}^0] = \frac{b}{\text{rot}} \cdot \frac{t}{\text{rot}} \cdot \frac{t}{\text{rot}}$$

\]

15 placeholders and horizontal

Summaries

15.1 Wildcards

Placeholders are primarily used in textbooks. They usually take the place of digits, numbers or other symbols that need to be figured out. Due to their diverse uses and appearances, they cannot be conclusively defined. This is why we only show an example of how placeholders can be displayed.

Since neither symbols nor procedures are standardized for placeholders, transmitters must explain their chosen representations in Braille notes.

When choosing symbols, it is advisable to ensure that they can be handled in Braille like the elements they represent. For example, placeholders for operation symbols should possibly follow a space like operation symbols and connect to the next character.

Example 15.1 B01

7 + ... = 15

#g +... =#ae

or

'<=the completion is for the number to be added.'<= #g +%
=#ae

\[7 +... =15\]

15 placeholders and horizontal summaries

Example 15.1 B02

(the b) = 2

'<=Legend: 7= w3~es
 quadrat _7= 5 warzes quadrat 7/
 w3~es dr3eck _7/ 5 warzes dr3eck'<= 2a
 7=b` \_7/2a 7/b` _7=c =#b'b

$\lfloor (a \text{ \textbackslash square } b) \text{ \textbackslash blacktriangle } (a \text{ \textbackslash triangle } b) \text{ \textbackslash blacksquare } c = 2b \rfloor$

15.2 Horizontal summaries and horizontal brackets

%&:	Horizontal summary announcement sign
%&'=...'=	Discontinuation symbols for horizontal summaries with Explanation as text
%&2...`	Discontinuation symbols for horizontal summaries with Explanation as mathematical Expression

In black print, several terms are often marked to explain a mathematical expression using brackets or typographic highlighting (color, boldface or similar).

Such summaries can be reproduced in mathematics writing as follows: • Immediately before the summarized expression is the

- Character %&: set.
- Immediately after the summarized expression the character %& along with the explanation (or description) in parentheses.

15 placeholders and horizontal summaries

- Depending on whether the explanation is written as a text or as a mathematical expression, it is in text or mathematical brackets. • Horizontal brackets are not reproduced directly.

In many cases, reproduction using this technique is possible, but other - non-standardized - techniques may be more useful, for example because inserting the explanation reduces clarity - and for this very reason misses the goal of summarizing in black text.

Examples of alternative techniques are: • the separate listing of the marked terms in a type Legend and • the breakdown of a commented calculation step in several steps.

Example 15.2 B01

aba $\ddot{y} = + + + \dots a$

b times

a.b = &a + a + ... + a &'='b-mal'='

$\backslash[a \cdot b = \underbrace{a + a + \dots + a}_{b-}$
 $\backslash\text{template}}]$

Example 15.2 B02

A	=	0.25	,	$\sqrt{3}$	,	s ²	,	0.433	s ²
		exact values						Approximate value	

'<= in the following 1sprint are

#j,be and 3#c exact values, #j,dcc the approximate value.'<='>a
 =#j,be.3#c5.s|; ??#j,dccs|;

or in shorthand:

'<=- fgcdc |d\$ sd #j,be u !,3#c'. xak(w7(, #j,dcc r n`h7us- w7t.'<='>a
 =#j,be.3#c5.s|; ??#j,dccs|;

15 placeholders and horizontal summaries

$\underbrace{A}_{\text{values}} = \underbrace{0.25}_{\text{exact}} \cdot \underbrace{\sqrt{3}}_{\text{approximate value}} \cdot s^2 \approx \underbrace{0.433}_{\text{approximate value}} s^2$

Example 15.2 B03

$$\sum_{k=1}^n \cos\left(\frac{\pi k}{n}\right) = \frac{1}{2} \left(1 + \cos\left(\frac{2\pi}{n}\right) + \cos\left(\frac{4\pi}{n}\right) + \dots + \cos\left(\frac{(n-1)\pi}{n}\right) \right)$$

The summary

&s1k"=#a|n &:6c 2<p'k`" &2=2-#a`|k`k|;' =&:-#a + #d
 -#i + ...' +2-#a`|n5n|;" &'='n
 summanden'='

or

&s1k"=#a|n 6c 2<p'k`k|;'
 =-#a + #d -#i + ...' +2-#a`|n5n|;' '<=in the
 template the following is held
 using 4 horizontal brackets:'<=' 6c 2<p'k` =2-#a`|k`'.and'. -#a
 + #d -#i + ... +2-#a`|n5n|;' '.are'. n \$summands

$\sum_{k=1}^n \overbrace{\cos(\pi k)}^{(-1)^k} k^2 = \underbrace{-1 + 4 - 9 + \dots + (-1)^n n^2}_{n \text{ \textit{Summanden}}}$

15 placeholders and horizontal summaries

Example 15.2 B04

$$\int_0^{2\pi} \frac{\cosh^2 x - \sinh^2 x}{\cosh^2 x} dx = \pi$$

$$= \int_0^{2\pi} \sin^2 x dx$$

$$\int_0^{2\pi} \sin^2 x dx = \pi$$

or

$$\int_0^{2\pi} \sin^2 x dx = \pi$$

$$\int_0^{2\pi} \sin^2 x dx = \pi$$

$$\int_0^{2\pi} \sin^2 x dx = \pi$$

$$\int_0^{2\pi} \sin^2 x dx = \pi$$

Attachments

A1 Written calculation procedures over several lines

What all written calculation methods have in common is that the digits of the numbers in question are placed in a spatial relationship to one another.

This makes it easier to select which number parts to manipulate. However, neither the representation practices nor the algorithms on which they are based are universal. Even within the German-speaking area, they are not uniform.

In Braille, written calculation methods pursue the same goals as in black print. In most cases, their presentation methods and algorithms reflect the use of black text. To illustrate this, a black-print calculation method could even be shown and explained in Braille.

The media differences between Braille and black print lead to minor differences in the respective procedures in daily practice. For example: • With the ballpoint pen you can easily jump from

one line to another. In order to switch to an earlier line again with the Braille machine, the paper must be turned back. Due to mechanical inaccuracies in the machine, new characters slip relative to the ones already in place

written. In addition, the characters on the following lines cannot be read until the paper is turned out and the lines appear again. For these reasons, processes that do not require turning the paper back are often chosen.

- In black letters, numbers or digits can be deleted and new ones written immediately above or below. Noting down carry numbers in a small space is also not a problem. Such procedures - which are also used when abbreviating fractions - are only possible to a limited extent in Braille. • Certain Braille symbols are only recognizable when their position within the Braille form is clear. Especially in

A1 Written calculation procedures

With regard to written calculation procedures, point 1 (number 1), point 2 (decimal point) and point 3 (outline symbols) should be mentioned as potential "stumbling blocks". Vertical movements of the fingers, which are unavoidable in written arithmetic procedures, make the row of dots within the shape even more difficult to recognize. This is one of the reasons why written arithmetic procedures in Braille are more often without outline symbols than in black print.

- The representation of numbers with numerals differs in principle from black writing and requires your own considerations.

Number symbols immediately before numbers mean that they are often in columns of numbers (for example in the hundreds column) and disrupt the clear calculation picture. That's why they are often written at a distance from the following numbers or even omitted. Since the basic operation symbols have the same shape (but not position in Braille form) as numbers, placing them directly in front of a number symbol facilitates position recognition and therefore the differentiation of numbers.

If a child often confuses the decimal point with the number 1, it may be useful to write a full character instead of the comma in billing statements for a while.

Several variants for written calculation methods in Braille are shown, without them being prescriptive.

Linear addition is also explained as an example of a method that differs significantly from the black text.

A1.1 Addition

When adding whole numbers, there are only small differences in the different forms of representation in Braille and black text. They mainly concern the placement of the number characters, the repetition of the plus sign and the underlining of the result.

For larger numbers, it is advisable to omit structure symbols (thousand separators) because they can easily be confused with a number 1.

A1 Written calculation procedures

Since Braille is technically more difficult, carryover numbers are not noted as often as in black. For example, placing or moving an object on the table can remind you that a carry still needs to be added. If the carryover numbers are still noted, a line must be left blank for this purpose. In order to distinguish carryovers from the other numbers, the number sign can be omitted from this line. Alternatively, the carries can be written in the line of the total dash.

If the numbers have large differences in their length, it can be useful to fill the empty spaces with zeros. These serve to orient the finger between the digits of the same place value above and below.

Example A1.1 B01

<pre>#ade +# be ... #agj</pre>	<pre>#ade +# be --u- #agj</pre>
<pre>#ade +# be ... #agj =====</pre>	<pre>#ade +# be a ... :::: =#agj</pre>

Example A1.1 B02

<pre># id,geahi # h,i +# a,fce # aje,bhfhi</pre>	<pre># id,geahi +# h,ijjjj +# a,fcej aab #aje,bhfhi</pre>
--	---

A1.2 Subtraction

Two fundamentally different algorithms can be recognized in written subtraction. They only differ in cases where a digit in the lower number (subtrahend) is larger than the corresponding digit in the upper number (minuend), as in "45 minus 27".

The supplementary procedure is most widespread in the German-speaking area. In this procedure, ten is added to the top number. In the example of "45 minus 27", 15 is used instead of 5 and 1 is added to the lower number in the column to the left of it: the 2 becomes a 3.

The other method that is predominantly used internationally is the unbundling method. Here the bottom number is not added, but the 1 (actually 10) for the 5 is taken from the number to the left of it. In our example, the 4 becomes a 3.

From a purely Braille perspective, the supplementary process has the advantage that only 1 is always counted, which is easier to remember and write down than the changes in the unbundling process.

In the following examples, "carry lines" refer only to the supplementary procedure.

Example A1.2 B01

#de	#de
-#bg	-#bg a
:::	
#ah	::: #ah
===	

Example A1.2 B02

#fcdej -#	#fc.dej -#
bbaj ::::: #fabdj	b.baj ::::: #fa.bdj
	=====

A1 Written calculation procedures

Example A1.2 B03

$\begin{array}{r} \#ajj -\# \\ b,e : : : : : \#ig,e \\ ===== \end{array}$	$\begin{array}{r} \#ajj,j -\# b,e \\ aaa \\ : : : : : \\ =\# ig,e \end{array}$	$\begin{array}{r} \#ajj\%j -\# \\ b\%e : : : : : \#ig,e \\ ===== \end{array}$
---	--	---

A1.3 Multiplication

When it comes to written multiplication, differences can be observed primarily in the positioning of the partial results as well as in the order of the partial steps - from the largest to the smallest value or vice versa.

Please note that enough space is left on the left for the result. If you start with the one digit, it can be advantageous to fill in the spaces to the right of the partial results with zeros.

Example A1.3 B01

$\begin{array}{r} \#bgc.\#ahd \\ : : : : : \\ \# bgc \# bahd \\ \# ajib \\ : : : : : \\ \#ejbcb \\ : : : : : \# \\ ajib \# bahd \# \\ bgc : : : : : \\ : : : : : \\ \#ejbcb \\ ===== \end{array}$	$\begin{array}{r} \#bgc.\#ahd \\ : : : : : \\ \# bgc +\# \\ bahd +\# ajib \\ : : : : : \\ \# ejbcb \\ : : : : : \#bgc.\#ahd : : : : : \\ \#ajib \#bahdj \\ \#bgcjj : : : : : \\ : : : : : \\ \#ejbcb \\ ===== \end{array}$
---	--

A1.4 Division

When it comes to written division, the number of intermediate steps that are noted and the way the remaining amount is handled vary in German-speaking countries.

In Braille, the line change upwards makes it difficult to note down the partial and final results. Partial results are often first written in the lines of the intermediate steps and only then combined to form a number (final result).

The result is written either as in the black text above or below.

Without a certain amount of practice and basic experience in practical work with the Braille machine, it may be difficult to estimate whether there is still enough writing space available on the sheet surface for complete division with all intermediate steps.

Example A1.4 B01

```
#eeb :#bd =#bc #eeb :#bd =#bc -#dh #b
                                     # gb # j          #b
...                                     #c
# gb #
gb ::: #          #c
j
```

Example A1.4 B02

```
#cea :#ae =#bc >r#f #cj ::: # ea # de
                                     #b

                                     #c
....
# f          re}
```

A1 Written calculation procedures

```
#cea :#ae #b #cj
--- # she #c
# de
```

```
....
% # fj #d # fj
```

```
....
#      j      =#bc,d
=====
```

A1.5 Lineare Addition

In addition to the calculation methods that are closely based on black writing, techniques adapted to the Braille machine were also developed. Linear addition will serve as an example here. The process can also be used, with a slight modification, for computing on the computer.

Example A1.5 B01

The two decimal numbers 9.73 and 3.46 should be added. First the task is set:

```
#i,gc +#c,df =#
```

Step 1: The number of digits of the longest number (including decimal separators) is determined and one is added. This gives the maximum length of the result. The writing head of the Braille machine (represented here by all six dots) is moved far enough to the right to accommodate the result. In the example, the space bar is pressed four times. (When calculating on a computer, the cursor does not need to be moved to the right.)

```
#i,gc +#c,df =#
```

```
%
```

Step 2: The digits of the last digit are added and the result is written down. Then press Backspace twice

A1 Written calculation procedures

operated. (When calculating on the computer, the cursor is moved once to the left.)

#i,gc + #c,df =# %i

Step 3: The digits of the second to last digit are added and the result is written. In the example, the carryover must be noted or noted on the right edge of the line. The writing head is placed to the left of the written number of the result. (When calculating on the computer, the cursor is moved once to the left.)

#i,gc + #c,df =# %ai

Step 4: The comma is written and the backspace key is pressed twice. (When calculating on the computer, the cursor is moved once to the left.)

#i,gc + #c,df =# %,ai

Step 5: The digits to the left of the decimal point are added and the carry is added. The number is written down.

#i,gc + #c,df =# ac,ai

A1.6 Solving equations

When solving equations, there are hardly any other techniques than in black letters. On the other hand, options for working within the line - such as crossing out elements and writing new ones - are largely eliminated, so that the solution can take up more lines than in black letters. A vertical bar %"l (sometimes known as an "operator bar") can be written to separate an operation to be performed from the equation. The usual placement of such bars one below the other in black writing is not useful in Braille; it is best two or three spaces are left before and none after the line.

A1 Written calculation procedures

Example A1.6 B01

#cx -#g =#da "l+#g #cx =#dh "l:#cx =#ah

Example A1.6 B02

2x8#b +#d`|; =#ajj "l3 x8#b +#d =+ -#aj "l-#d x8#b
=#f oder -#ad "l.#b x =#ab oder -#bh

A2 Changes in mathematic font

A2.1 Changed symbols

%{		curly opening bracket
%!}	{ }	curly closing bracket acute opening
#{ %	<	bracket acute closing bracket
\$}	>	obtuse angle opening bracket
%'{'		
%'}	ŷ ŷ	obtuse-angled closing brackets more
%#{		curly special opening Braille paper clip
%#!}		curly special closing Braille paper clip
%"l		Vertical line (in all places) Vertical
%"%"		double line (in all places) (The second full character is part of the symbol.)
%4!	>	Wedge with tip on the right as a
%4,	<	marking Wedge with tip on the left as
%_")	°	a marking Degree (squiggle)
%_ " *	'	minute (dash)
%_ " **	"	Second (double dash)
%_rad	rad	Radiant (rad)
%_rad ;	rad ²	Square radian is
%<It is	ŷ	an element of (set theory)

A2 Changes in mathematics writing

$\% $		upper index or exponent (formerly only upper index)
$\% "d$	$\ddot{y}$	round d (for partial derivative)
$\%4!;$	$\ddot{y}$	up arrow
$\%4,;$	$\ddot{y}$	Down arrow
$\%!($	$\ddot{y}$	times (star)

A2.2 Neue Symbole

$\%!\>\{$		Gaussian opening bracket (upper limit)
$\%!\>\}$		Gaussian closing bracket (upper limit) Gaussian
$\%!\<\{$		opening bracket (lower limit) Gaussian closing
$\%!\<\}$		bracket (lower limit)
$\%\$ \{$	$\ddot{y}$	Line summary bracket: multiple lines summarizing large left curly bracket clockwise counterclockwise
$\%7:,$		
$\%7!:$		
$\%7?$	$\ddot{y}$	Rhombus
$\%7+$		Parallelogram
$\%>$		small crossbar of an assignment arrow $\ddot{y}$
$\%::O$		arrow to the right with a simple Shaft and simple tip $\ddot{y}$ Left
$\%9::$		arrow with simple Shaft and simple tip $\ddot{y}$ left
$\%9::o$		and right arrow with simple shaft and simple sharpen

A2 Changes in mathematics writing

$\Rightarrow$		Right arrow with double Shaft and simple tip (Implication arrow)
$\Leftarrow$		Left arrow with double Shaft and simple tip
$\Leftrightarrow$		Double arrow with double shaft (equivalence arrow)
$\dashrightarrow$		Right arrow with dashed Shaft and simple tip
$\dashleftarrow$		Left arrow with dashed Shaft and simple tip
$\longleftrightarrow$		Left and right arrow with dashed shaft and simple sharpen

A2.3 Zahlen

The already practiced use of round brackets to represent periodic decimal fractions has been adopted (see "2.1.4 Periodic Decimal Fractions").

The different practice for decimal and structure symbols in monetary amounts in Switzerland and Liechtenstein is discussed (see "2.1.3 Decimal fractions" and "2.1.5 Structure of long numbers").

Roman numerals are treated in the same way as other letter sequences and are not introduced with the number symbol.

A2.4 Exponents and indices

Exponents are rewritten with the same character $\%|$ like upper indices introduced.

A minus sign without a point 4 (cohesion point) can now follow an index character. Negative integers may also be written after an index in lowered notation (see "2.1.2 Numbers in lowered notation" and "10.3.3 Indices from integers").

A2.5 Fractions

The numerator and denominator must now have the same design in relation to the distance to the fraction line. Fraction start and end characters must always be used in pairs. A denominator consisting of an integer may not appear in lowered notation after a fraction dash. The character %%< was defined to terminate all fractions in a multiple fraction . (See "9 Fractions.")

A2.6 letters

The labeling of upper and lower case letters has been reorganized. It is now more compatible with text font.

The marking for Gothic letters has been deleted. Gothic letters are now treated like other letters with a special typographic distinction.

(See "3.4 Special Typographic Awards.")

Greek letters are now announced uniformly with the previous lowercase Greek letter announcement character %< . Capitalization is marked with the usual announcement symbols. The previous Greek capital letter announcement character has been deleted. The previous alternative characters apply to Eta, Theta and Chi. (See "3.3 Greek letters.")

The previous print marks were replaced by two announcement marks for unspecified special typographic awards. The meaning of each should be recorded in a note. (See "3.4 Special typographical awards".)

A2.7 Brackets and vertical bars

In order to ensure the greatest possible compatibility with innovations in the text font, the symbols for curly, pointed and obtuse brackets have been adapted. Additions to the basic character are now always placed before it, even with closing brackets. (See "6 Brackets and Pipes.")

A2 Changes in mathematics writing

A new symbol has been defined for a large left curly brace that "holds" multiple lines together (see "6.4 Multiline Bracket Expressions").

Horizontal brackets are now treated as horizontal summaries and are not distinguished in their type (see "15.2 Horizontal summaries and horizontal brackets").

The symbol for a vertical bar is now generally represented with $\%|$, so the two amount bars in a pair are the same. Double bars (not two single bars) are consistently written with $\%''\%$. The previous alternative symbol has been deleted. (See "6.5 Vertical lines.")

A2.8 units

The previous unit key symbol has been deleted.

All units are introduced with the character $\%_$. For unit complexes, the symbol is only used once. (See "4.1 Identification of unit symbols.")

Currency units have also been added.

Neudegrees, Neuwinkelminute and Neuwinkelsecond are no longer listed.

A2.9 Arrows

The "detailed arrow symbology" was renamed "modular arrows", made more consistent and expanded with a line for assignment arrows. The up arrow and down arrow symbols are now also written as modular arrows. (See "7.1 Modular Arrows.")

Defined symbols for some arrows were also adopted from the text font (see "7.2 Defined arrows").

A2.10 Projektivtechnik

The number of gain levels for projectives has been reduced from two to one. However, there are two different announcements available for reinforcement, which are also different

A2 Changes in mathematics writing

can be used nested. The character %5 was defined for the termination of all projectives . (See "10.2 Amplified Projectives.")

A2.11 Switch between text and Mathematics writing

The various methods for marking the change between fonts are now explicitly stated. The double space technique and the marking by layout are regulated. (See "1.1 Switching between text and math writing.")

The return to text writing for a single or a few words in a mathematics passage has been redefined and must now not only be announced, but also canceled (see "1.1.3 Announcement and cancellation signs for text writing").

A2.12 Other

It is maintained that the previous "through" sign %/ will not be included again.

The painting star is redefined as %!(.

The separation of the argument from the function symbol for sine, logarithm and the like has been regulated (see "3.6 Short word symbols", "11.2 Logarithm and exponential functions" and "14.2 Angular, hyperbolic functions and reversals").

Any short word symbols may now be formed explicitly with the short word key character %7 (see "3.6 Short word symbols").

The various functions of point 4 are explained (see "1.2 Separating and keeping mathematical expressions together" and "3.5 Letter-like symbols").

The brackets introduced in the text font in 2011 for comments by the transmitter are now also used in the mathematics font (see "1.3 Notes on Braille transfer").

A2 Changes in mathematics writing

Braille technical terminology has been adapted. For example, we are talking about Braille and not braille. Without changing the rules themselves, the terms “cellular” and “adjustable” were omitted.

A3 Glossar

The glossary contains explanations of Braille terms used in this book.

Terms that are explained in more detail elsewhere in the glossary are marked with *.

Discontinuation symbol: Braille* character* that does not itself represent a symbol* of black writing*, but rather indicates that the insertion into text* or mathematical* writing has been completed and thus the change to the other Braille writing system* has taken place.

Announcement and discontinuation technology: Braille writing* technology that does not itself have an equivalent in black writing* and is used to temporarily change the meaning of characters* by switching to another Braille writing system*.

Announcement symbol: Braille character* that does not itself represent a symbol* of black script, but rather shows how the following character(s)* are to be read.

Basic font: See degree of truncation.

Braille: See Braille.

Braille shape: The space marked by a Braille sign* is taken. It consists of a vertical field in which the points are arranged in two columns.
See also Braille characters.

Braille point: One of the six or eight points of a Braille sign*.

Braille: Haptically perceptible writing system* in which the Braille characters* are formed from six or eight dots. A distinction is made between 6-point and 8-point Braille.

Braille brackets, special: See Special Braille brackets.

Braille transmission brackets: characters* the Braille writing*, which does not itself contain symbols* of black writing*

A3 Glossar

reproduce. They enable explanatory additions to Braille transmission (see "1.3 Notes on Braille transmission").

Braille system: System in which the characters* are written with a view to their intended use (mathematics, chemistry, foreign language, etc.) are assigned concrete meanings in accordance with the respective set of rules.

Braille character: One of the 64 (6-point Braille) or 256 (8-point Braille) possible combinations of placed Braille points* in a Braille form* including the space*.

Double space technique: A form of labeling the change between mathematical* and text font* or vice versa by two consecutive spaces* (see "1.1.4 Double space technique").

Outline symbols: Characters for structuring large numbers regardless of the outline symbols selected in the black font template (see "2.1.5 Outlining long numbers").

Index: A number, variable or similar that is placed in the black font* as a superscript or subscript, before or after a mathematical expression (see "10.3 Indices and Exponents").

Shorthand: See degree of abbreviation.

Degree of truncation: One of the following three levels of detail for the reproduction of text in German Braille*: - Basic font: Each letter is written into a Braille form* wrote.

- Full writing: The letter groups au, äu, ch, ei, eu, ie, sch and st are each written with their own Braille character*.

- Shorthand: Abbreviations are used that represent groups of letters and entire words.

LaTeX: A typesetting system that can also be used to create mathematical texts. Mathematical expressions (e.g. Fractions) are written in linear notation. In this set of rules, the LaTeX notation fulfills the function of a second form of representation of the examples for Braille readers. However, they do not serve as writing instructions for LaTeX.

A3 Glossar

Layout technique: A form of marking the change between mathematical* and text writing* or vice versa through the targeted use of design means, e.g. b.

Indents and outdents or tables (see "1.1.1 Layout").

Space: Braille character* in which no periods are placed are.

Marking: An addition to a symbol* that appears in the Black writing* is above or below or superscript or subscript behind this. A distinction is made between simple and summary markings. While simple markings are only assigned to one symbol*, summary markings always refer to several symbols* (see "8 Simple and summary markings").

Mathematical writing: A system of German Braille* for reproducing mathematical content. Here Braille characters* can have different meanings than in other Braille writing systems* (e.g. text writing*). They are therefore subject to special rules that are set out in this work.

Passage: A sequence of contiguous characters* in text-* or mathematics writing*.

Projective technique: A technique for mathematical writing* one-dimensional reproduction of:

- Symbols* that extend over other symbols*
(for example the root symbol) and - the degree of superscript or subscript of indices.

A distinction is made between simple and amplified projectives (see "10 Projective Technique").

Black writing: The writing of the sighted in contrast to Braille*.

Special Braille brackets: characters* from mathematical writing* that do not themselves represent symbols* from black writing*. They are inserted to clearly depict the typographic or spatial design elements of black writing*, e.g. B. Labeling on arrows (see "7.3 Labeling of arrows").

A3 Glossar

Symbol: Defined here as a character* in black writing* or its equivalent in Braille*. As a result, characters* in Braille* are also symbols as long as they have a black text equivalent, e.g. B. Sum sign.

On the other hand, characters* that only appear in Braille*, e.g. B. Announcement signs*, no symbols. In Braille*, symbols can consist of several Braille characters*.

Text writing: The basic system of German Braille writing* (regulated in "The System of German Braille Writing"), with which text is mainly reproduced in various degrees of abbreviation*, but also numbers and other characters* of black writing. It is supplemented by additional Braille systems* (e.g. this mathematics text*).

Full text: See degree of reduction*.

Character: Here, an element of black* or Braille* that has its own meaning assigned to it. In Braille*, a character can consist of one or more Braille characters*. See also symbol*.

Line separator: Character* in Braille* that does not itself represent a symbol* in black writing*, but is placed at the end of the Braille line. It indicates that the mathematical expression is not yet completed and is continued in the following line (see "1.2 Separating and keeping mathematical expressions together").

Coherence point: Braille character* that does not itself represent a symbol* of black script*, but replaces a space* in order to hold the content of a mathematical expression together. It can also hold together characters that, for technical reasons in Braille, are not allowed to meet directly. (See "1.2 Separating and keeping mathematical expressions together.")

A4 Mathematical symbols, sorted by the 6 point Braille table

In this register, the math symbols are arranged according to the Braille symbols they consist of. They are ranked according to the following list, which goes back to Louis Braille. It should be noted that, unlike the other letters of the alphabet, the letter w is not in the first three rows, but at the end of the fourth.

List of Braille characters in Braille technical order

a b c d

e f g h i j k l m n o p q r s t

u v x y z & % { ~ } 1 2 3 4 5

6 7 8 9 w , , ; : / ? + = (*) |

0 # ` . - " > _ ! \$ % < '

The rows are composed as follows: • 1st row:

The first ten letters. These are the same characters used for

numbers. They all have at least one dot at the top, at least one dot in the left half of the braille shape, and no dot at the bottom. • 2nd row: The characters from the 1st row

with an additional one

Point 3.

• 3rd row: The characters from the 1st row with additional dots 3

and 6. The letter w is omitted. • 4th row: The

characters from the 1st row with an additional one

Point 6. At the end of this row is the letter

ln.

• 5th row: The characters of the 1st row are one row of dots lower written. • 6th

row: All remaining characters with a dot on the left

Half of the Braille form.

A4 Mathematical Signs

- 7th row: All characters only dots in the right half the Braille form.

%a	1	2.1.1	Number one
	A, a	3.3	Alpha
%b	2	2.1.1	Number two
	B, b	3.3	Beta
%c	3	2.1.1	Number three
	C, c	2.2	Roman numeral hundred
	X, X	3.3	Spend
%d	4	2.1.1	Number four
	D, d	2.2	Roman numeral five-hundred
	D, d 3.3		Delta
%lt is	5	2.1.1	Number five
	EU	3.3	Epsilon
%f	6	2.1.1	Number six
	FF Phi	3.3	Phi
%g	7	2.1.1	Number seven
	C, c 3.3		Gamma
%h	8	2.1.1	Number eight
	Th, th, Ÿ	3.3	Theta
%i	9	2.1.1	Number nine
	I, i	2.2	Roman numeral one

A4 Mathematical Signs

	I, i	3.3	Iota
%j	0	2.1.1	Digit zero
	The, the	3.3	And
%k	K, Mr	3.3	Kappa
%l	L, l	2.2	Roman numeral fifty
	L, l 3.3		Lambda
%m	M, m 2.2		Roman numeral thousand
	M, m	3.3	My
%n	N, n 3.3		The
%O	The, the	3.3	Omikron
%O,		5C	big against
%O,	>	5A, 5C	greater than
%O,9.	ÿ	5C	greater or less than
%O=	ÿ	5C	greater than or equal to
%O=9.		5C	larger, equal or smaller
%p	P, p	3.3	Pi
%q	Q, q	3.3	Trug
%r	R, r	3.3	Rho
%s	P, p 3.3		Sigma
%t	T, t	3.3	Yes
%in	Y	3.3	Ypsilon

A4 Mathematical Signs

$\%in$	V, v 2.2	Roman numeral five
	3.3	Digamma
$\%x$	X, x 2.2	Roman numeral ten
	XX 3.3	Xi
$\%and$	Ps, ps 3.3	Psi
$\%With$	ZZ 3.3	Zeta
$\%\&$	X, X 3.3	Spend
$\%\&a$	A 12	Aleph
$\%\&d$	Δ 3.5, 11, 11.3	large delta as a difference sign
$\%\&It is$	∈ 3.5, 5E, 12, A2.1	is an element of (set theory)
$\%\&n$	∇ 14.3	Nabla
$\%\&O$	∅ 12	empty set
$\%\&p$	∏ 3.5, 11, 11.1	Product mark
$\%\&s$	∑ 3.5, 11, 11.1	Sum sign
$\%\&2...\`$	15.2	Discontinuation mark for horizontal summaries with explanation as mathematical
		Expression
$\%\&,$	∀ 12	for all
$\%\&:$	15.2	Horizontal summary announcement sign

A4 Mathematical Signs

%&?	ÿ ÿ, 12		there are
%&*		5E, 12	has to the element
%&'=...'=		15.2	Discontinuation mark for horizontal summaries with explanation as text
%%5		10	Final sign for all projectives (The second full sign is part of the sign.)
%%<		9	End of all fractions (The second full sign is part of the symbol.)
%{	[	6	square opening bracket
%~	ÿ	11, 11.3	Integral
%~~	ÿÿ	11, 11.3	Doppelintegral
%~~)	ÿÿ	11, 11.3	Shell integral
%~:	ÿ	11, 11.3	oberes Integral
%~)	ÿ	11, 11.3	Circulation integral
%~<:	ÿ	11, 11.3	lower integral
%}	]	6	square closing bracket more
%1		10	lower index (rear)

A4 Mathematical Signs

		11, 11.1, 11.3	lower limit (back lower index)
		10	front lower index
%1.	$\backslash$	5E, 12	reduced by, without
%2	$($	6	round opening bracket
		2.1.4	Beginning of the period of a periodic decimal fraction
		8	The book
%2=	$\ddot{y}$	5E, 12	is included in or equal to
%2.	$\ddot{y}$	5E, 12	is contained in, is a subset of
%3	$\sqrt{\quad}$	10	root
%3,	$\ddot{y}$	5F, 13	or
%3:		5E	skin (bond theory)
%3.	$\ddot{y}$	5E, 12	united with
%4	Th, th	3.3	Theta
		7.1	Key symbol for Arrow representations
	$\neg$	8	Hook (actuarial mathematics)
%4,	$<$	8, A2.1	Wedge with tip on the left as mark
%4:,	$\ddot{y}$	5H, A2.1	Down arrow

A4 Mathematical Signs

$\Rightarrow$	$\Rightarrow$ 5H		Implication arrow (arrow to the right with double shaft)
$\triangleright$	$\triangleright$	8, A2.1	Wedge with point on the right as mark
$\Uparrow$	$\Uparrow$	5H, A2.1	Up arrow
$\Leftrightarrow$	$\Leftrightarrow$ 5H		Equivalence arrow (double arrow with double Shaft)
$\&$	The, the	3.3	And
		8	Discontinuation mark for summary markings
		10	Terminator for simple projectives
$\hat{}$	$\hat{}$	5B	Faculty
$\overset{\frown}{}$	arc	14.2	Arcus
$\cos$	cos	14.2	Cosine
div	div	14.3	div (divergence)
$\exp$	exp	11, 11.2	Exponential function
grad	grad	14.3	grad (Gradient)
$\lg$	log, lg	11, 11.2	Logarithmus
$\#$	whether	11, 11.2	Number
rot	rot, curl	14.3	rot, curl (Rotation)
$\sin$	sin	14.2	Sinus
$\circ$	so, tg	14.2	Touching

A4 Mathematical Signs

$\arg$	arg	11, 11.2 Argument	
cosec	cosec 14.2		Kosekans
$\cot, \operatorname{cot}, \operatorname{ctg}$	cot, cot, 14.2 ctg		Kotangens
$\arccos$	arccos 14.2		Cosine cosine
$\operatorname{antilog}$	antilog 11, 11.2 Antilogarithmus		
$\arcsin$	arcsin 14.2		In your chest
arctg	arctg 14.2		Arc tangent
$\operatorname{arccosec}$	arccosec 14.2		Sheet music sequence
$\operatorname{arccot}, \operatorname{arcctg}$	arccot, 14.2 arcctg		Arc tangent
$\operatorname{arcosh}, \operatorname{arch}$	arcosh, 14.2 arch		Areakosinus hyperbolicus
$\operatorname{Arsinh}, \operatorname{arsh}$	Arsinh, 14.2 arsh		Areasinus hyperbolicus
$\operatorname{Arth}, \operatorname{arth}$	Arth, 14.2 arth		Areatangens hyperbolicus
$\operatorname{arcoth}, \operatorname{arcth}$	arcoth, 14.2 arcth		area cotangent hyperbolicus
arcsec	arcsec 14.2		Ark sequence
cpllog	cpllog 11, 11.2 Supplementary or complementary logarithm		
ld	ld 11, 11.2 Dual logarithm		
$\cosh, \operatorname{ch}$	cosh, ch 14.2		Cosine hyperbolicus
$\ln$	ln 11, 11.2 Natural logarithm		
$\operatorname{born}, \operatorname{sh}$	born, sh 14.2		Sinus hyperbolicus

A4 Mathematical Signs

%6(t	fishy, th 14.2		Hyperbolic tangent
%6(8	coth, th 14.2		Kotangens hyperbolicus
%6-	sec	14.2	Sequence
%7		3.6	Key symbol for Kurzwoortsymbols
%7%		14	Rectangle (The second solid character is part of the symbol.)
%79	ÿ, ,	14	Store
%7:,		14, A2.2 clockwise	
%7/		14	triangle
%7?	ÿ	14, A2.2 Rhombus	
%7+		14, A2.2 Parallelogramm	
%7=		14	square
%7(	ÿ 14		Judge Shop
%7*	ÿ 14		diameter
%7)	•	14	Circle
%7!:		14, A2.2 counterclockwise	
%8	/, ÿ 5B, 9		Fraction bar
%99.		5C	small against
%9,,	←---	7.2, A2.2 Arrow pointing to the left with dashed shaft and simple tip	

A4 Mathematical Signs

%9,,0	↔	7.2, A2.2	Left and right arrows with dashed shaft and simple tips
%9::	↵	5H, 7.2, A2.2	Arrow pointing to the left with a simple shaft and a simple tip
%9::0	↔	5H, 7.2, A2.2	Double arrow with single shaft
%9=	≤	5C	Smaller or equal
%9=0,	≤	5C	smaller, equal or larger
%9==	↔	7.2, A2.2	Arrow to the left with double shaft and single tip
%9==0	↔	5H, 7.2, 13, A2.2	Double arrow with double shaft (equivalent arrow)
%9.	<	5A, 5C	less than
%9.0,	≤	5C	smaller or larger than
%ln	Ω	Oh, oh 3.3	Omega
%,	₁	2.1.2	Number one (lowered spelling)
	,	2.1.3	Decimal separator (Come)
		7.1	simple tip to the right or up
%,,		7.1	double tip to the right or up

A4 Mathematical Signs

$\rightarrow$		7.2, A2.2	Right arrow with dashed shaft and simple tip
$\cdot$		11, 11.3	Derivation point
2		2.1.2	Number two (lowered spelling)
$\uparrow$		7.1	simple vertical arrow shaft
$\cdot$		8	Point
$\cdot$		9	Bruchanfang
$\dashv$		7.1	dashed simple vertical arrow shaft
$\colon$		8, 14.3	horizontal line (marking)
3		2.1.2	Number three (lowered spelling)
$\div$		5A, 5B	divided by, is equal to (colon)
$\rightarrow$		7.1	easier horizontal arrow shaft
$\rightarrow$		8, 14, 14.3	Right arrow (marking)
$\rightarrow$		5H, 7.1	Right arrow with single shaft and single tip
$\dashv$		7.1	dashed simple horizontal arrow shaft

A4 Mathematical Signs

$\rightarrow$	$\rightarrow$ 5H, 7.2, A2.2	Right arrow with single shaft and single tip
$\coloneqq$	$\coloneqq$ 5C	by definition the same (colon equal sign)
$\equiv$	$\equiv$ 5C	interchangeable (colon equal sign colon)
$\neg$	$\neg$ 5F, 13	not
$\rightarrow$	$\rightarrow$ 5G	projective to
4	4 2.1.2	Number four (lowered spelling)
$\ast$	$\ast$ 8	Stern
5	5 2.1.2	Number five (lowered spelling)
$\sim$	$\sim$ 5C	similar, equivalent, proportional
$\nearrow$	$\nearrow$ 7.1	simple diagonal Arrow shaft (top left/ bottom right)
$\sim$	$\sim$ 8	Serpentine (tilde)
$\approx$	$\approx$ 5C	about the same
$\dashrightarrow$	$\dashrightarrow$ 7.1	dashed simple diagonal arrow shaft (top left/ bottom right)
$\cong$	$\cong$ 5G	congruent (Geometry)
6	6 2.1.2	Number six (lowered spelling)

A4 Mathematical Signs

	+	5A, 5B, 8	plus
% ₀ + -	±	5B	plus/minus
% ₀ =	7	2.1.2	Number seven (lowered spelling)
	=	5A, 5C, 8	same
		7.1	double horizontal arrow shaft
% ₀ :=	::	5C	by definition the same (equal sign double dot)
% ₀ ==	≡	5C	identical equal, congruent (number theory)
		7.1	dashed double horizontal arrow shaft
% ₀ ==0	⇒	5H, 7.2, 13, A2.2	Right arrow with double shaft and single tip (implication arrow)
% ₀ =0		5G	perspective too
% ₀ (	8	2.1.2	Number eight (lowered spelling)
	×	5B, 12	times (cross)
	×	8	Cross (diagonal) (marking)
% ₀ *	9	2.1.2	Number nine (lowered spelling)
	.	8, 11, 11.3, 12	Dash (marker/derivative)

A4 Mathematical Signs

		7.1	simple diagonal Arrow shaft (bottom left/ top right)
%*O,	5C		not greater than
%*&It is	5E, 12		is not an element of
%*9.	5C		not smaller than
%*?	5C		not similar, not equivalent, not proportional
%*?=	5G		incongruent (Geometry)
%*=	5C		unequal
%*==	5C		not identical same, in- congruent (number theory)
%**		7.1	dashed simple diagonal arrow shaft (bottom left/ top right)
%*'	5D		doesn't share
%)	0	2.1.2	Digit zero (lowered spelling)
		11, 11.1	linked to (circle, cultural to read)
		5B	linked to (Kuller, concatenation characters, Kreisoperator)
		8	Circle, Kuller (marker)
%		10, A2.1	upper index (back) or exponent

A4 Mathematical Signs

		11, 11.1, 11.3	upper limit (back upper index)
		10	front upper index
% c	c	12	Superscript c as a marker for complementary quantities
% .	ÿ	5E, 12	symmetrical difference
%0	^	8	roof (marking)
%0,	ÿ	5F, 13	and
%0:		5E	et (association theory)
%0??	ÿ	5C	corresponds approximately
%0=		5C	corresponds
%0.	ÿ	5E, 12	cut with
%#		2.1.1	Number symbol
%# 	lim	11, 11.3	Limes
%# :	lim	11, 11.3	Limes superior
%# <:	lim	11, 11.3	Limes inferior
%#%	ÿ	11, 11.1 infinity (The second full sign is part of the symbol.)	
%#{		6, 6.3	square special opening ones Braille paper clip
%#}		6, 6.3	square special closing braille clipboard more
%#1		10	front lower index

A4 Mathematical Signs

$\% \# 2$		6, 6.3	round special opening ones Braille paper clip
$\% \# $		10	front upper index
$\% \# `$		6, 6.3	round special closing Braille paper clip
$\% \# .$	$\ddot{y}$ 5G, 14		vertically
$\% \# \dots 2 \dots `$		2.1.4	periodic decimal fraction
$\% \# ! \{$		6, 6.3, A2.1	Curly special opening braille clapboard more
$\% \# ! \}$		6, 6.3, A2.1	Curly special closing Braille bracket
$\% `$	)	6	round closing bracket more
$\% ` ,$	$\ddot{y}$ 5E, 12		contains is superset from
$\% ` =$	$\ddot{y}$ 5E, 12		contains or is the same
$\% .$	.	2.1.3	Decimal separator (period) in exceptional cases
		2.1.5	Outline symbols
	.	5A, 5B	times (point)
$\% -$	.	5A, 5B, 8 minus	
		7.1	Line through the arrow shaft
$\% - +$	$\ddot{y}$	5B	minus/plus

A4 Mathematical Signs

%"		1.2	Line separator between two immediately adjacent characters
		1.2	point of cohesion
		4.4	Accent marks
%"d	ÿ	3.5, 11, 11.3, A2.1	round d (for partial derivation)
%"h		3.5	h-bar, reduced Planck's constant
%		6, 6.5, A2.1	vertical line (in all places)
		12	vertical line, so that
		5D	Splits
		11, 11.3	integral bar
%"p	ÿ	3.5	weierstrass p
%""%		5G, 14	parallel to (The second full character is part of the symbol.)
		6, 6.5, A2.1	vertical double line (in all places) (The second full character is part of the symbol.)
%""%=	≡	5G	parallel and equal (The second full character is part of the symbol.)
%>		3.1, 3.2	one or more capital letters

A4 Mathematical Signs

		8	Announcement sign for simple top markings
		7.1, A2.2	small horizontal bar one assignment arrow
%>~		11, 11.3	Integral of a special kind
%>:,		5H, 7.1	Assignment arrow
%_		8, 10	Summary bottom markers announcement sign
		3.1, 3.4, 14.3	2. special typographical award
		4.1	Unit symbol identifier
%_ct	ct	4.6	Euro-Cent (Eurozone)
%_DKK	dkr	4.6	Crown (Denmark)
%_e>v	eV	4.4	It was electronic
%_i>r	and R	4.6	Rupees (Indian)
%_k\$hz	kHz	4.4	Kilohertz
%_k<>w	k Ω	4.4	Kiloohm
%_m	m	4.4	Meter
%_min	min	4.4	Minute
%_mm	mm	4.4	Millimeter
%_m>a	mA	4.4	Milliamps
%_rad	rad	4.3, A2.1	Radiant(rad)

A4 Mathematical Signs

%_rad ;	rad ²	4.3, A2.1	Quadradiant
%_s	s	4.4	Seconds
%_sec	sec	4.4	Seconds
%_#j)	%	4.2	percent
%_#j))	‰	4.2	Blood alcohol level
%_"c	¢	4.6	cents (especially USA)
%_"It is	€	4.6	Euro (Eurozone)
%_"l	£	4.6	Pounds (especially Great Britain)
%_"s	\$	4.6	Dollar (especially USA)
%_"s>a	\$A	4.6	Dollar (Australia)
%_"and	¥	4.6	Yen (Japan)
%_"and	¥	4.6	Yuan (China)
%_"*	'	4.3, A2.1	Minute (Strich)
%_"**	"	4.3, A2.1	Sekunde (Doppelstrich)
%_"")	°	4.3, A2.1	Grad (Kringel)
%_>Aud	AUD	4.6	Dollar (Australia)
%_>chf	CHF	4.6	Franconia (Switzerland)
%_>cny	CNY	4.6	Yuan (China)
%_>czech	CZK	4.6	Crown (Czech Republic)
%_>et al	DKK	4.6	Crown (Denmark)
%_>eur	EUR	4.6	Euro (Eurozone)

A4 Mathematical Signs

$\pounds$	GBP 4.6	Pound (Great Britain)
₹	INR 4.6	Rupees (Indian)
¥	JPY 4.6	Yen (Japan)
mV	MV 4.4	I got it
MeV	MeV 4.4	Megaelectronvolt
$\text{\$NZD}$	NZD 4.6	Dollar (New Zealand)
$\text{\$NZ}$	NZ\$ 4.6	Dollar (New Zealand)
₺	TL 4.6	Pound/Lira (Türkiye)
₺	TRL 4.6	Pound/Lira (Türkiye)
$\text{\$}$	USD 4.6	Dollar (USA)
V	IN 4.4	Volt
Å	Oh 4.4	Angstrom
₣	Fr. 4.6	Franconia (Switzerland)
Hz	Hz 4.4	Hertz
Kč	Kc 4.6	Crown (Czech Republic)
MeV	MeV 4.4	Megaelectronvolt
μW	μW 4.4	Microwatts
μm	μm 4.4	Micrometer
Ω	Oh 4.4	Ohm
$\%$	10	second projective reinforcement sign
	3.1, 3.4, 14.3	1. special typographical award

A4 Mathematical Signs

		7.1	simple tip to the left or down
		8	second reinforcement character for summary markings for nesting
$\%{\{$	{	6, 12, A2.1	curly opening bracket
$\%!}$	}	6, 12, A2.1	curly closing bracket
$\%!5$		8	second discontinuation mark for reinforced summary markings
		10	End symbol for amplified projectives
$\%!,$		1.1, 1.1.2	Announcement symbol for a passage in math writing
$\%!:$	$\ddot{y}$	5H, 7.1, 8	Arrow to the left with single chem shaft and simple tip
$\%!:,$	$\ddot{y}$	5H, 7.1	Left and right arrow with simple Shaft and simple sharpen
$\%!($	$\ddot{y}$	5B, A2.1	mal (Stern)
$\%!>\{$		6, A2.2	Gaussian opening bracket (upper limit)
$\%!>\}$		6, A2.2	Gaussian closure bracket (upper limit)

A4 Mathematical Signs

$\%!!$		7.1	double tip to the left or down
$\%!<\{$		6, A2.2	Gaussian opening bracket (lower limit)
$\%!<\}$		6, A2.2	Gaussian closure Bracket (lower limit)
$\%\$$		3.1, 3.2	an uppercase letter followed by one or more lowercase letters
		8, 10	Summary top markers announcement sign
		8	Reinforcement symbols for summary markings
		10	Projective amplification sign
$\%\$ \{$	$<$	6, A2.1	angle opening bracket
$\%\$ \}$	$>$	6, A2.1	lace closing bracket
$\%\$214$	summary mar-		cation for arcs (arcs over several symbols)
$\%\$5$		8	Discontinuation sign for reinforced summary markings
		10	End symbol for amplified projectives

A4 Mathematical Signs			
$\%\$:$		14	summary Marking for route (horizontal line above several letters)
$\%\$:,$		14	summary marking for vector (arrow over several symbols)
$\%\$!\{$		6, A2.2	Line summary bracket: multiple Combine lines - the large left curly bracket
$\%\$\c		3.5, 12	Set of complex ones Pay
$\%\$\h	H	3.5, 12	Quantity of quaternions
$\%\$\n		3.5, 12	amount of natural Pay
$\%\$\p	P	3.5, 12	Projective line
$\%\$\q		3.5, 12	Set of rational ones Pay
$\%\$\r		3.5, 12	Set of real numbers
$\%\$\z		3.5, 12	Set of integers
$\%<$		3.1, 3.3	Greek letters
		8	Announcement sign for simple bottom marking ments
		9	Bruching
$\%<8$		6, 6.5, 14.3	Start of a new line

A4 Mathematical Signs

%'		3.1, 3.2 lowercase letters	
		3.7	Announcement sign for Punctuation marks
		1.2	Line separator in place of a space character
%'{	ŷ	6, A2.1	obtuse-angled opening bracket
%'}'	ŷ	6, A2.1	obtuse-angled closing bracket
%'.		1.1, 1.1.2 Termination mark for a passage in mathematics writing	
%'.		1.1, 1.1.3 Announcement symbol for a passage in text font	
		1.1, 1.1.3 Termination mark for a passage in text font	
		1.1, 1.1.2 Termination mark for a passage in mathematics writing	
%'<=		1.3, 6	opening and closing Bracket for comments on Braille transmission

A5 alphabetical index

Asterisks indicate entries in character lists and boldface indicates the most important entry if there are multiple references.

A

Termination: see announcement and termination

technique Derivative line: see

dashes Derivation point: see

point similar, equivalent, proportional: 5,

5C* Analysis:

11 Announcement and termination

technique: -

Fractions: 9.3 - Double space

**technique: 1.1.4 - Horizontal summaries with explanation as text :
15.2**

- Mathematical font: 1.1*, 1.1.2*, 1.1.5, 3.7, A2.11 - Text

font: 1.1*, 1.1.3*, 1.1.5, A2.11 - Markings,

**simple and summary: 8 - Projective: 10 Apostrophe (for
numbers) : 2.1.1, 2.1.5**

equivalent,

proportional, similar: 5, 5C* Arabic numerals: see numbers

argument (function): 11*, 11.2* arguments: see

functions

B

Sheets: 8*, 8.2, 14.1*

Braille note brackets: see notes on Braille transmission Braille

brackets, special: 6*, 6.3* Fractions: 9 -

start and end characters: 9*, 9.3

- detailed notation: 9*, 9.3

- Decimal fractions: 2.1.3

- simple notation: 9*, 9.2

A5 Sachregister

- Multiple fractions: 9*, 9.4
- Fractions: 2.1.2, 9.1
Letters: 3 -
Accent letters: 4.4 - General
information about identification: 3.1 - Letter-
like symbols: 3.5 - Greek: see Greek
letters - Upper and lower case letters: 2.2, 3.1, 3.2,
3.3, 3.4, 3.6, 3.8, "Foreword - compactness versus context independence
", A2.6 - short word symbols: 2.6 - Latin: 3.2 - typographic

markings: 3.4 letter-like
symbols: see letters

C

Cartesisches Produkt (Malkreuz): 5, 5B*, 12*

D

d, round (partial derivative): 3.5*, 11*, 11.3* Date: see
numbers Delta: 3.3* -

large as

difference sign: 3.5*, 11*, 11.3* Decimal fractions: see
fractions Decimal classifiers: see

numbers Decimal separators: see

numbers difference signs , Delta

(capital): 3.5*, 11, 11.3 Double space technique: 1.1.4

Triangle: 14.1* by, divided by, is the
same as (colon):

5, 5A*,

5B*, A2.12

Diameter: 14.1*

AND

Unit symbols: 4 - from
letters: 4.4 - marking: 4.1

Element of: 5, 5E*, 12*

contained in or equal to: 5,

5E*, 12* contained in, subset of: 5, 5E*, 12*

A5 Sachregister

corresponds to: 5, 5C*

Exponents: "For the use of this set of rules - LaTeX", 2.1.2, 5, 8.1, 10*, 10.3.1, A2.1, A2.4

Exponential function: 11*, 11.2*

F

Bold: see typographical markings, special functions: 11, 11.1, 11.2 -

Arguments: 3.6, 11.2, 14.2, A2.12

- Exponential function: 11*, 11.2*

G

counterclockwise: 14.1* Money: 2.1.3,

2.1.5, 4.6, A2.3 mixed numbers: see

numbers geometry: 3.6, 5G*, 14.1*

divided by: see by structure of long

numbers: see numbers outline

symbols: see numbers Gothic letters: see

typographic awards,

special

Boundaries, upper and lower (rear indexes): 11*, 11.1*, 11.3 Greek letters: 3.3*

Capital letters: see letters

H

horizontal line (marking): see lines h-across, reduced

Planck's constant: 3.5* hyperbolic functions: 14.2*

hyperbolicus: 14.2

I

identical equal, congruent (number theory): 5, 5C* clockwise:

14.1* Indices: - general: 10*,
10.3, A2.4

- as limits for integrals: 11.3*, A2.4 -

as limits for products and sums: 11.1*, A2.4 - from

whole numbers: 2.1.2, 10.3.3, A2.4 - front: 10*, 10.3.2, A2.4

A5 Sachregister

- rear: 10*, 10.3.3, A2.4

incongruent:

- operation and relation symbols (geometry): 5, 5G* -

number theory, not identical equal: 5, 5C*

integrals: 11*, 11.3*

integral bar: 11* , 11.3*

K

Wedge (marking): 8*, 8.1

Identification of unit symbols: 4.1*

Identification of letters: see letters Kilo-: 4.5 Brackets:

- square

brackets:

6* - square special

Braille brackets: 6*, 6.3* - simple brackets: 6*, 6.2

- Gaussian brackets (upper or lower limit): 6* - curly

brackets: 6*, 12* - curly brackets

over several lines: 6*, 6.4

- special curly Braille brackets: 6*, 6.3* - horizontal

brackets: 15.2* - matrices: 6.4

- multi-line

bracket expressions: 6.4 - round

brackets: 2.1.4, 6* - round

special Braille brackets: 6*, 6.3* - special Braille

brackets: 6* , 6.3* - obtuse brackets: 6* - text

brackets: 6.6 - vector brackets:

6.4, 14.3 - line

summary brackets: 6*, 6.4

small against: 5, 5C*

lowercase letters: see letters less

than: 5, 5A*, 5C* less

than or equal to: 5, 5C* less

than or greater than: 5, 5C* less

than, equal to or greater than: 5, 5C*

complementary quantities :

12* congruent (geometry): 5, 5G*

Koppa: 3.3*

A5 Sachregister

Circle:

- Geometry: 14.1* -

Marking: 8*, 8.1

Cross, oblique: -

Painting cross: 5,

5B* - Marking: 8*, 8.1

**Italics: see typographic markings, special short word symbols:
see letters**

L

**LaTeX, use in this work: "For use of this
Rules — LaTeX"**

Layout, correspondence by: 1.1.1

empty quantity:

12* spaces, suppression: 1.2

Liechtenstein:

- Swiss franc amounts: 2.1.3,

2.1.5 - numerical structure:

2.1.5 Limes: 11*,

11.3* logarithm functions: 11*, 11.2*

Logic: 5F*, 13*

M

times - Cartesian product (painting cross): 5, 5B*,

12* - Cross: 5,

5B* - Point: 5, 5A*, 5B*

- Star: 5, 5B*

Marks: 8 - Simple:

8*, 8.1

- summary: 8*, 8.2

Mathematics

publication: - Development: "Foreword - Development"

**- Basic features: "Foreword — Compactness versus
context independence"**

- Change to text font: see correspondence

matrices: 6.4

Mega-: 4.5

**large left curly bracket summarizing several lines (line summary
bracket): 6*, 6.4**

A5 Sachregister

multi-line bracket expressions: 6.4

Quantity:

- of integers: 3.5*, 12* - of complex numbers: 3.5*, 12* - of natural numbers: 3.5*, 12* - of quaternions: 3.5*, 12* - of rational numbers: 3.5*, 12* - the real numbers: 3.5*, 12* - empty: 12* set theory: 5, 5E*, 12* meter: 4.4* micro-: 4.5 milli-: 4.5

minus: 2.1.2, 5, 5A *, 5B*, A1.2

- as marking:

8*, 8.1

- in Indizes: 10.3.3, A2.4

Minute: 4.3*, 4.4*

N

Nabla: 14.3*

not: 5, 5F*, 13* not

similar, not equivalent, not proportional: 5, 5C* not equivalent,

not proportional, not similar: 5, 5C* not element of: 5, 5E*, 12* not

greater than: 5, 5C* not identical

equal, incongruent (number

theory): 5, 5C* not less than: 5, 5C* not proportional, not similar,

not equivalent: 5, 5C*

Number: 11*, 11.2*

O

Superset of, contains: 5, 5E*, 12* or: 5, 5F*,

13* Ohm: 4.4*

Operation

symbol: 5, 5B* Ordinal

numbers: see numbers

A5 Sachregister

P

parallel and equal: 5, 5G*

parallel to: 5, 5G*, 14.1*

parallelogram: 14.1* partial

derivative, round d: 3.5*, 11*, 11.3* passage in text:

1.1, 1.1.3 Periodic decimal fractions:

see numbers perspective to: 5, 5G* arrows: 7*

- labeling of: 7.3* -

defined:

5G*, 7, 7.2* - horizontal: 5G*,

7, 7.1* - logic: 13* - marking:

8*, 8.1, 8.2, 14.3* - modular: 7.1*

- operation

and relation symbols: 5H* - key

symbols: 7.1*

pounds: 4.6* Pi: 3.3* - as product symbols:

3.5*, 11*, 11.1* Planck's

constant:

3.5*

wildcard: 15.1 plus: 5, 5A*, 5B* - as marking:

8*, 8.1

- in indices: 10.1, 10.3.3 plus/

minus: 5, 5B* product

symbols: 3.5*, 11*, 11.1* projective to:

5, 5G* projective line:

3.5*, 12* projective technology:

10 - end of all

projectives: 10*, 10.2, A2.10 - simple projectives: 10.1

- indices and exponents: 10.3

- amplified projectives: 10.2 per mille:

4.2* proportional, equivalent,

similar: 5, 5C*

percent: 4.2* point: - derivation point: 8*, 8.1,

11*, 11.3* -

Painting

point: 5, 5A*, 5B* - Marking: 8*, 8.1

A5 Sachregister

- Sentence point:

3.7 - Thousands separator (structure symbol): 2.1.5* Point 4: - Accent

symbol: 1.2, 4.4* - Line

separator: 1.2* - Space

replacement: 1.2*, 10.1 - Symbol

component: 1.2 -

Consolidation point: 1.2* Point 6:

-

Punctuation, announcement for: 3.7* - Line

separator: 1.2*

Q

Quadrat: 14.1*

Quadratradiant: 4.3*

R

Radiant (rad): 4.3*

Edge marking: 1.1.1

Rectangle: 14.1*

Relation symbol: 5, 5C*

Rhombus: 14.1*

Roman numerals, digits: 2.2* red,

curl (rotation): 14.3* round d

(partial derivative): 3.5 *, 11*, 11.3*

S

Punctuation:

- Marking: 3.7

- Correspondence: 1.1.2, 1.1.4, 1.1.5

Serpentine, Tilde (marking): 8*, 8.1, 8.2 Key symbols:

- Units: A2.8 -

Geometric symbols:

14.1 - Abbreviations: 3.6*, A2.12 -

Arrows: 7.1* - Confusion with:

5 oblique line:

see lines Written

calculation procedures: 2.1.1, A1

Correspondence (mathematics and text):

1.1, 3.8, A2.11

A5 Sachregister

oblique cross: see cross, oblique Switzerland:
- Franc

amounts: 2.1.3, 2.1.5 - Number

structure: 2.1.5 Second: 4.3*,

4.4* vertical to: -

Operation and

relation symbols: 5G* - Geometric symbols:

14.1* vertical Lines: see lines Sigma:

3.3* - as a sum sign: 3.5*, 11*, 11.1* so

that, vertical

line: 6.5, 12* special braille bracket: 6*, 6.3*

standard quantities: 3.5*, 12* star: - as a

marking : 8*, 8.1

- Painting star: 5, 5B*, A2.1*, A2.12

Distance (marking): 8*, 8.2, 14.1* Lines: -

as a

marking for complementary sets: 8*, 8.1, 12 - Derivative lines

(marking): 8 *, 8.1, 11*, 11.3* - through the arrow shaft: 7.1* -

horizontal (marking): 8*, 8.1, 8.2,

14.3 - minute line: 4.3* - oblique (marking): 8*, 8.1

- second lines: 4.3* - vertical:

6*, 6.5*, 12* - so that (vertical

line): 6.5, 12* sum symbols: 3.5*, 11*, 11.1*

symbols: - letter-like: 3.5 - units: see

units -

geometric: 3.6, 5G*, 14.1*

symmetrical difference: 5, 5E*,

12*

T

Table columns: 1.1.1

Thousands separator: 2.1.5* divides:

5, 5D* does

not divide: 5, 5D*

subset of, contained in: 5, 5E*, 12*

A5 Sachregister

Temperature measurements:

4.3* Text font: see correspondence

Tilde, serpentine line (marking): 8*, 8.1, 8.2 Separators:

- Thousands

separator: 2.1.5* - Line separators

(Braille): 1.2* Trigonometry: 14.2* Typographical

awards, special: 3.1 *,

3.4*, 14.3

IN

Transmission in Braille: see notes on

Braille transmission

Times: see numbers and:

5, 5F*, 13* infinite:

11*, 11.1* approximately

equal: 5, 5C* unequal: 5,

5C*

IN

Variables, typographic marking: 3.4, 3.6, 3.8, 4.1 Vector: 14.3 - marking

(arrow over a symbol): 8*, 8.1, 8.2, 14.3* vel (association theory): 5,

5E* combined with: 5, 5E*, 12*

Magnification prefixes: 4.5

relates to (colon), divided by:

see by Diminished prefixes: 4.5 linked to (Kuller): 5, 5B*, 11*,

11.1* diminished by, without:

5, 5E*, 12* Nesting: - Markings: 8.2 - Projectives:

10.2 interchangeable (colon-equal sign-

colon):

5, 5C*

Volts: 4.4*

Front indices: 10*, 10.1, 10.2, 10.3.2, 10.3.3

IN**Currency symbols: 4.6*****horizontal line (marking): 8*, 14.3 switching
between text and mathematical font: see****Correspondence****Weierstrass p: 3.5* Angle:****-****Character: 14.1* -****Right: 14.1* -****Functions: 14.2* -****Dimensions:****4.3* Root: 10*, 10.4****WITH****Numbers:****2* - Arabic: 2.1 -****Date: 2.1.6 -****Decimal fractions: 2.1.3 -****Decimal classifiers: 2.1.6 - Decimal****separators: 2.1.1, 2.1.3*, 2.1.6, A1.5 - Integers: 2.1 .2 -****mixed numbers: 9.1 -****lowered notation: 2.1.2*, 9.1****- structure of long numbers: 2.1.1, 2.1.5*,****A1 - structure symbols: 2.1.1, 2.1.5*, A1 - sets (whole,
real numbers etc.): 3.5*, 12* - Ordinal numbers:****2.1.6 - Periodic decimal fractions: 2.1.4* - Roman: 2.2* -****Standard notation: 2.1.1* -****Time: 2.1.6 - shortened notation from the
text font: 2.1.6****- Number fractions: see Fractions****- Number signs: 2.1.1*****Number fractions: see Fractions****Number signs: see Numbers****signs: -****Sum signs: 3.5*, 11*, 11.1*****- Product symbols: 3.5*, 11*, 11.1*****- Difference characters: 3.5*, 5E*, 11*, 11.3*****Line separator (Braille): 1.2***

A5 Sachregister

Line break: -

Braille line breaks: 1.2* - Marking of

black line breaks: 6*, 6.4,

6.5*, 14.3*

Line summary bracket: 6*, 6.4

Digits: 2* -

Standard notation: 2.1.1* -

Lowered notation: 2.1.2* Allocation

arrow: 5H*, 7.1* Summaries,

horizontal: 15.2* Cohesion point: 1.2*