

L2/00-119

Date: 2000-04-19

**Title:** Encoding Additional Mathematical Symbols in Unicode (revised)  
**Source:** Ken Whistler, Asmus Freytag, AMS (STIX)  
**Status:** Working Document (and Summary Proposal Form)  
**Action:** For review and comment by UTC and L2  
**Distribution:** Members of UTC and L2

### ***Introduction***

This document constitutes the consolidated proposal for completion of the set of mathematical symbols encoded in ISO/IEC 10646. It is an update of WG2 N2191R, which was reviewed and approved by WG2 in Beijing last month.

Additional alphanumeric symbols were added to the CD for 10646-2, and have been under ballot. This proposal provides for the complementary set – those math symbols, operators, and delimiters that are currently missing from the repertoire of math symbols encoded in the BMP of 10646-1.

This proposal is the culmination of a several-year process of collation and review of mathematical symbols, with close cooperation between the Unicode Technical Committee and the STIX Project, involving extensive expertise from the mathematical, scientific, and technical publishing industry. In our opinion, this proposal is now quite mature, having passed the technical scrutiny of the mathematicians and technical publishing experts of the STIX Project, and the character encoding scrutiny of the UTC. We urge consideration for a new subdivision of work for an Amendment to 10646-1 to add this repertoire to the UCS, to meet the expressed needs of the international mathematical, scientific, and technical publishing industry for the representation of mathematics using the ISO/IEC 10646 character encoding.

The document we present here is divided into six parts:

- Introduction, background, rationale, and references
- Annex 1: Proposal summary form
- Annex 2: Draft charts and names list, enumerating the proposed repertoire
- Annex 3: (dropped – no longer needed, since Annex 2 is complete)
- Annex 4: Symbol variants defined using a Variation Selector (VS)
- Annex 5: Letters of support from major mathematical organizations

### ***Background***

This proposal originated as the work of the STIX Project (Scientific and Technical Information eXchange), a working group reporting to STIPUB, a consortium of publishers of mathematical, scientific, and technical books and journals. The ultimate product of the STIX group will be the creation of one comprehensive set of fonts for scientific and technical publishing. This set of fonts should be adopted and supported by all major STM (scientific, technical, and mathematics) publishers internationally. It will also be made available for general use under license but free of charge, with the explicit aim to ease and foster the uninhibited flow, exchange, and linking of scientific information worldwide.

The symbol complement of the STIX font set will be based on the symbols in this proposal along with many other symbols already encoded in ISO/IEC 10646, as well as variant forms not included here (because they are required by publishing house styles without different meaning from symbols included above). Additional technical symbols from areas other than mathematics will also be included in the font definitions.

More information about the STIX Project can be found at the STIX web site, hosted by the American Mathematical Society (AMS): <http://www.ams.org/STIX/>

The Unicode Technical Committee worked closely with the STIX Project over the past two years, to refine the proposal into a character encoding proposal, suitable for addition to ISO/IEC 10646. During this process, duplicates have been identified and removed, and clarification of distinctions between characters, glyphs, and variants has been made. The original proposal was divided into two large portions: a proposal for the addition of alphanumeric symbols (under ballot for the CD for 10646-2), and this proposal for the addition of other mathematical symbols.

As this proposal has developed, it has been connected to other standardization efforts, which are now interdependent on the completion of mathematical symbol encoding in ISO/IEC 10646. In particular, the special problems of handling technical texts have been examined in detail by the W3C HTML Math Working Group; their MathML proposal, which is interdependent with this proposed repertoire of math symbols for ISO/IEC 10646, was accepted as a W3C Recommendation on 7 April 1998 [see <http://www.w3c.org/Math>]. The work of the HTML Math Working Group is also related to the work of the OpenMath Consortium. Major vendors of mathematical formatting software are also dependent on the resolution of the encoding of additional mathematical symbols in ISO/IEC 10646-1.

## **Rationale**

Scientific communication and publication via the World Wide Web are currently hindered by the absence both of suitable symbol fonts and of recognized methods of indicating particular symbols and their relationships to one another.

The availability of a complete UCS character encoding of mathematical symbols, and of a correlated universal font set for their rendering will benefit scientific and technical publishing in several ways:

- Elimination of certain legal problems with distributing PDF files and publishing on the World Wide Web
- Ease of exchange of documents from different publishers
- Simpler and more robust re-use of archived material

The STIX Project group has agreed that the basis for the organization of such a font set should be ISO/IEC 10646/Unicode. ISO/IEC 10646 is the reference character set for XML, and therefore for MathML as well. It is the character set of the programming language Java and underlies all current Windows operating systems, as well as many others. In XML documents, and most importantly for use in MathML, one must be able to identify all notation, either by numerical character reference or by entity reference. But numerical character references are ISO/IEC 10646 numbers, since that is the character set underlying XML. If entity names are used, they must still be mapped to something that applications will be able to handle and render. All of these considerations argue very strongly that the set of mathematical symbols encoded in the UCS should be completed, so as to enable the representation and presentation of mathematics and other technical materials dependent on mathematics – both for the World Wide Web and for data interchange dependent on XML.

In the charts and lists shown in the Annexes, we have included only what we believe to be unique symbols not currently covered by the repertoire of ISO/IEC 10646. The language of mathematics is fluid, and symbols are defined in context to represent particular mathematical concepts. The tool set of an active mathematician ideally consists of several alphabets, whose members can be distinguished from one another, to represent various classes of variables and constants, and a fairly extensive collection of similarly-sized shapes to represent various operations or delimitation of expressions. There are of course many fully standardized shapes that are now used almost exclusively to represent particular operations and relations, but even these are sometimes adopted in fields where they are not already in use and redefined to have some other particular meaning. For this reason, the names suggested for the symbols listed here are in some cases not functionally precise; where multiple varying meanings are possible, or a single precise meaning is not available, the name simply describes the shape of the proposed character.

## **Variants**

Many math symbols occur in two or more variant forms, with the same or similar meanings usually, but not always, attached to both. In order to accommodate the sometimes strong preferences of authors and publishers, a single Variation Selector (VS) is recommended, to be applied to a fixed list of symbols with predetermined results. The Variation Selector follows the symbol whose variant it specifies. As a character by itself, the Variation Selector has no independent appearance; it only functions to choose a particular variant for the character it follows. Only combinations defined by the standard should be meaningful. In any other context, the Variation Selector character should be ignored.

The Variation Selector (VS) in this proposal is completely analogous to the Mongolian Free Variation Selector (MVS) characters already in ISO/IEC 10646. The difference is merely that the MVS characters are only meaningful in combination with other Mongolian characters, to select variants of those characters. The VS is separately proposed, for use in combination with mathematical symbol characters, to select variants of those characters.

The exact list of variants currently known to be required for mathematical, scientific, and technical publishing is shown in Annex 4.

### ***Letter-like Symbols***

For a mathematician or other scientist, alphabets provide the symbols to represent ad hoc variables as well as a number of more well-defined concepts. Different styles of alphabets have different meanings, some of which have been formally standardized in some disciplines, but many of which follow only the strength of custom, or even current necessity.

The CD for ISO/IEC 10646-2 includes sets of mathematical alphanumeric symbols that are regularly used in mathematical and technical literature; those alphabets and digits will not be further dealt with here.

There remain, however, some individual letters from or related to these alphabets that are routinely used in a turned or inverted orientation, as well as a few symbols in the style of a particular math alphabet but not part of its normal alphabetic complement. These are considered distinct letter-like symbols, and are therefore candidates for code assignments. They are included in this proposal, along with the larger collection of general mathematical symbols and operators.

### ***Brace Parts***

A small collection of brace and bracket parts has also been included in this proposal. These characters are intended to complete the coverage of the PostScript symbol set, as well as some character-like entities used by TeX and other technical typesetting systems. These brace parts are explicitly intended as compatibility characters to match those preexisting repertoires. Their inclusion facilitates the interconversion of data from such systems with systems using the ISO/IEC 10646 character encoding.

### ***References***

International Organization for Standardization, ISO 31/XI-1992. Mathematical signs and symbols for use in the physical sciences and technology, 2nd edition, 1992. (by ref. in ANSI/IEEE P1324)

American Society of Mechanical Engineers, ANSI Y10.20-1975. Mathematical signs and symbols for use in physical sciences and technology, 1975.

Institute of Electrical and Electronics Engineers, ANSI/IEEE P1324 (draft revision of Y10.20), Draft standard mathematical signs and symbols for use in physical sciences and technology, 1992.

ISO/IEC 8879:1986, Information Processing --- Text and Office Systems --- Standard Generalized Markup Language (SGML), Annex D: Public text

ISO/IEC 9573-13, Information Technology --- SGML Support Facilities --- Techniques for Using SGML --- Part 13: Public entity sets for mathematics and science

Stepney, Susan (editor), Proposal to add the ISO Standard Z character set to Unicode/ISO-IEC 10646

SC2 N3393, Committee Draft ISO/IEC CD 10646-2.

L2/98-405, Request for assignment of codes to mathematical and technical symbols that do not appear in Unicode 2.0 or ISO/IEC 10646

L2/98-406, Proposal to encode mathematical variant tags

L2/99-045, Proposal to encode mathematical alphanumeric symbols

L2/99-049, Addendum to L2/98-405: Request for assignment of codes to mathematical and technical symbols

L2/99-159, Request for assignment of codes to mathematical and technical symbols that do not appear in Unicode 2.0 or ISO/IEC 10646 (revised)

L2/99-160, Proposal to encode mathematical variant tags

L2/99-195, Proposal to encode mathematical alphanumeric symbols

L2/99-199, Mathematical Alphabets (for L2/99-195)

L2/99-244R, Request for assignment of codes to mathematical and technical symbols that do not appear in Unicode 2.0 or ISO/IEC 10646

L2/99-346, Mathematical brace pieces.

L2/00-002, Request for assignment of codes to mathematical and technical symbols that do not appear in Unicode 2.0 or ISO/IEC 10646 (supersedes L2/99-244R)

WG2 N2191R, Proposal for Encoding Additional Mathematical Symbols in the BMP (supersedes L2/00-002R).

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# ISO/IEC JTC 1/SC 2/WG 2 PROPOSAL SUMMARY FORM TO ACCOMPANY SUBMISSIONS FOR ADDITIONS TO THE REPERTOIRE OF ISO/IEC 10646

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Please fill Sections A, B and C below. Section D will be filled by SC 2/WG 2.

For instructions and guidance for filling in the form please see the document " Principles and Procedures for Allocation of New Characters and Scripts" (<http://www.dkuug.dk/JTC1/SC2/WG2/prot>)

## A. Administrative

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1. Title: **Proposal for Encoding Additional Mathematical Symbols in the BMP**

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2. Requester's name: **U.S.**

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3. Requester type (Member body/Liaison/Individual contribution): **Member body**

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4. Submission date: **2000-03-14**

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5. Requester's reference (if applicable): **WG2 N2191**

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6. **This is a complete proposal.**

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## B. Technical - General

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1. (Choose one of the following:)

b. The proposal is for addition of character(s) to an existing block.

Name of the existing block:

Greek and Coptic (3)  
General Punctuation (14)  
Combining Diacritical Marks for Symbols (4)  
Letterlike Symbols (15)  
Arrows (12)  
Mathematical Operators (14)  
Miscellaneous Technical (29)  
Geometric Shapes (8)  
Supplemental Arrows [New block 2900..297F] (128)  
Miscellaneous Math Symbols [New block 2980..29FF] (117)  
Supplemental Math Operators [New block 2A00..2AFF] (247)

Note that the proposed new blocks are conceptually extensions of the existing Arrows and Mathematical Operators blocks, and do not constitute new scripts.

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2. Number of characters in proposal: **951**

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3. Proposed category (see section II, Character Categories):

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4. Proposed Level of Implementation (see clause 15, ISO/IEC 10646-1): **Level 3**

Is a rationale provided for the choice? **Yes**

If Yes, reference:

The repertoire includes 4 combining characters, which can be used in free combinations with other existing 10646 characters. Many relational operators are intended to be usable with overlaid combining marks U+0338 COMBINING LONG SOLIDUS OVERLAY or U+20D2 COMBINING LONG VERTICAL LINE OVERLAY to productively indicate negation. Finally, the mathematical repertoire in general is intended for complex rendering, with the productive application of other combining marks to indicate derivatives, vectors, and many other concepts.

Limited subsets of the mathematical symbols can, of course, be used for Level 1 implementations, but the repertoire addressed by this proposal is aimed at full and complete mathematical rendering and interchange. (Note that this proposal encompasses the symbols needed for mathematical content, but is not intended to cover mathematical markup languages or layout controls.)

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5. Is a repertoire including character names provided? **Yes. See Annex 2.**

a. If YES, are the names in accordance with the 'character naming guidelines' in Annex K of ISO/IEC 10646-1?  
**Yes**

b. Are the character shapes attached in a reviewable form? **Yes. See Annexes 2 and 3.**

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6. Who will provide the appropriate computerized font (ordered preference: True Type, PostScript or 96x96 bit-mapped format) for publishing the standard?

The Unicode Consortium, working in collaboration with STIPUB and various professional font vendors.

If available now, identify source(s) for the font (include address, e-mail, ftp-site, etc.) and indicate the tools used:

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7. References:

a. Are references (to other character sets, dictionaries, descriptive texts etc.) provided? **Yes**

c. Are published examples (such as samples from newspapers, magazines, or other sources) of use of proposed characters attached?

No, not in WG2 N2191. However, a very large collection of source citations has been collected by the STIX Project group of STIPUB. That group constitutes a consortium of mathematical, scientific, and technical publishers who have refined this repertoire on the basis of their publication requirements for symbol usage.

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8. Special encoding issues:

Use of a VARIATION SELECTOR. The use of this character is described in the proposal.

Does the proposal address other aspects of character data processing (if applicable) such as input, presentation, sorting, searching, indexing, transliteration etc. (if yes please enclose information)? **Yes**

There are no new input or presentation issues not already present for the existing repertoire of math symbols. Sorting, indexing, and transliteration are generally not an issue for math symbols. Some special letterlike symbols are provided in the repertoire to facilitate searching for some common key mathematical concepts in text documents.

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## C. Technical - Justification

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1. Has this proposal for addition of character(s) been submitted before? **No (with a few exceptions)**

If YES explain.

Note that a few individual characters among the repertoire of 951 may appear in other proposals before WG2. For example, the Q-shaped koppa letters have independently been requested. Several arrow characters from a recent Japanese proposal for symbols to cover JIS X 0213 are also included. The vast majority of the 951 characters in this proposal are requested here for the first time.

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2. Has contact been made to members of the user community (for example: National Body, user groups of the script or characters, other experts, etc.)? **Yes**

If YES, with whom?

STIPUB (Scientific and Technical Information Publishing Consortium), representing mathematical and other major technical publishing interests. American Mathematical Society. International Mathematical Union. major mathematical software vendors. W3C MathML participants.

If YES, available relevant documents? See the references and appended approval letters in the proposal.

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3. Information on the user community for the proposed characters (for example: size, demographics, information technology use, or publishing use) is included?

The repertoire is intended for all international mathematical information technology use and for mathematical, scientific, and technical publishing worldwide. It is intended to complete the base symbol set for MathML. It is also intended as the underlying symbol encoding for all major mathematical layout software programs.

Reference:

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4. The context of use for the proposed characters (type of use; common or rare):

Common to rare, depending on the particular subfield of mathematics involved.

Reference:

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5. Are the proposed characters in current use by the user community? **Yes**

If YES, where?

Books, journals, articles, online documents. Reference: STIPUB can provide voluminous references. This constitutes the complete world community of mathematical users: all books, journals, magazines, and other publications in mathematics and scientific and technical disciplines that make use of mathematics, worldwide.

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6. After giving due considerations to the principles in N 1352 must the proposed characters be entirely in the BMP? **Yes**

If YES, is a rationale provided? **Yes**

If YES, reference: **See WG2 N2191.**

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7. Should the proposed characters be kept together in a contiguous range (rather than being scattered)? **Yes and No.**

Exact details of the proposed distribution of the characters into existing and new blocks of 10646 are provided in Annex 2.

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8. Can any of the proposed characters be considered a presentation form of an existing character or character



sequence? **Yes (a few)**

If YES, is a rationale for its inclusion provided? **No**

In these instances, the precedents are already clearly established in the standard. For example, a quadruple integral character is requested; the double and triple integral are already encoded as characters.

If YES, reference:

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9. Can any of the proposed character(s) be considered to be similar (in appearance or function) to an existing character? **Yes**

If YES, is a rationale for its inclusion provided? **No, not in detail.**

There are numerous instances among mathematical symbols where one symbol is generically similar to another in appearance, but where it is well understood in mathematical practice to **not** be the same symbol. Annex 2 provides a number of cross-references, where there might be confusions regarding the distinctiveness of a particular character, either with respect to existing encoded characters in 10646, or with respect to other characters in this proposal. Mathematical symbols are also replete with examples where the same *function* can be represented by different symbols. Multiplication, for example, can already be represented by U+00D7 MULTIPLY or U+2219 BULLET OPERATOR. However, it can also be represented by a zero-width operator, such as in  $xy$  where this expression represents the variable  $x$  multiplied by the variable  $y$ . Multiple symbols corresponding to the same abstract mathematical functions are requested for encoding as separate characters when their *form* is distinct in different mathematical traditions or subfields.

If YES, reference:

WG2 2191 does provide a detailed rationale for the request for two additional sets of squares as geometric shape characters.

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10. Does the proposal include use of combining characters and/or use of composite sequences (see clause 4.11 and 4.13 in ISO/IEC 10646-1)? **Yes**

If YES, is a rationale for such use provided? **Yes**

If YES, reference: **See B.4 above.**

Is a list of composite sequences and their corresponding glyph images (graphic symbols) provided? **No**

Such a list would be unmanageably long, since combining marks are intended for productive use in mathematics.

If YES, reference:

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11. Does the proposal contain characters with any special properties such as control function or similar semantics? **Yes**

If YES, describe in detail (include attachment if necessary)

The VARIATION SELECTOR is described in WG2 N2191, and the list of variants it selects is detailed in

Annex 4.

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## **D. SC 2/WG 2 Administrative (To be completed by SC 2/WG 2)**

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1. Relevant SC 2/WG 2 document numbers:

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2. Status (list of meeting number and corresponding action or disposition):

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3. Additional contact to user communities, liaison organizations etc:

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4. Assigned category and assigned priority/time frame:

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## Math Symbols Proposal

### Second Draft MTHM000417.lst

Revised with feedback from AMS experts.

Deleted 2050 ◊ TWO DOT LEAD ◊ R ON EM

29E6 ◊ moved to 2050 ◊ and renamed to CLOSE UP

2052 ◊ through 2055 ◊ moved to 29F6 7 through 29F9 \

Added 29F5 ◊ SET DIFFERENCE

Moved 2056 ◊ TURNED AMPERSAND to 214B ⌘

Deleted 2997 \ and 2998 † moustaches

Deleted 29D8 ∼ through 29DB ≅ and 2A6E ≡ controversial lazy s's

### File Statistics:

Total Characters:	584
Lines in file:	842
+ Generated:	8
Name lines:	592
Characters:	584
Reserved:	0
Unassigned:	8
Secondary lines:	201
Aliases:	36
Comments:	26
Cross Refs:	122
Can. Decomps:	0
Compatibility:	17
Ignored:	0
Header Lines:	57
Blocks:	11
Subheaders:	44
Notices:	0
Title lines:	1
Subtitles:	1
Page breaks:	0
Empty lines:	0
Iso Comments	0
AnnexP Notes	0

	037	038	039	03A	03B	03C	03D	03E	03F
0									
1									
2									
3									
4									Ⲑ 03F4
5									
6									
7									
8							Ⲙ 03D8		
9							ⲙ 03D9		
A									
B									
C									
D									
E									
F									

**Archaic Greek letters**

03D8 Ϟ GREEK LETTER Q-SHAPED KOPPA

03D9 ϟ GREEK SMALL LETTER Q-SHAPED KOPPA

- the Q-shaped koppas are the ordinary alphabetic letters

**Greek symbol**

03F4 Θ GREEK CAPITAL THETA SYMBOL WITH STRAIGHT BAR

→ 0472 Ɽ cyrillic capital letter fita

≈ 03B8 θ

	200	201	202	203	204	205	206																																															
0																																																						
						2050																																																
1																																																						
											2051	2061																																										
2																	2062																																					
3																							2063																															
4																																																						
5																																																						
6																																																						
7																																									2057													
8																																																						
9																																																						
A																																																						
B																																																						
C																																																						
D																																																						
E																																																						
F																																																						
																															204F	205F																						

**Punctuation**

- 204E \* LOW ASTERISK  
 204F ; REVERSED SEMICOLON  
     → 003B ; semicolon  
 2050 ◌ CLOSE UP  
     • editing mark  
 2051 ⁂ TWO ASTERISKS ALIGNED  
     VERTICALLY  
 2052 ◻ <reserved>  
 2053 ◻ <reserved>  
 2054 ◻ <reserved>  
 2055 ◻ <reserved>  
 2056 ◻ <reserved>  
 2057 ⁂ QUADRUPLE PRIME  
     ≈ 2035 ` 2035 ` 2035 ` 2035 `

**Space**





- 205F ◻ MEDIUM MATHEMATICAL SPACE  
     • four-eighteenths of an em  
     ≈ 0020 ◻

**Invisible operators**

- 2061 ◻ FUNCTION APPLICATION  
     • contiguity operator indicating application  
     of a function  
 2062 ◻ INVISIBLE TIMES  
     • contiguity operator indicating  
     multiplication

**Variation selector**

- 2063 ◻ VARIATION SELECTOR  
     • in conjunction with preceding character  
     indicates variant choice

	20D	20E	20F
0			
1			
2			
3			
4			
5		 20E5	
6		 20E6	
7		 20E7	
8		 20E8	
9			
A			
B			
C			
D			
E			
F			















**Combining Symbols**

- 20E5  $\backslash$  COMBINING REVERSE SOLIDUS  
OVERLAY
- 20E6  $\#$  COMBINING DOUBLE VERTICAL  
STROKE OVERLAY  
= z notation finite function
- 20E7  $\curvearrowright$  COMBINING ANNUITY SYMBOL  
= actuarial bend
- 20E8  $\dots$  COMBINING TRIPLE UNDERDOT

	210	211	212	213	214
0					$\Sigma$ 2140
1					$\mathfrak{G}$ 2141
2					$\daleth$ 2142
3					$\lrcorner$ 2143
4					$\blackwedge$ 2144
5					$\mathcal{D}$ 2145
6					$\mathcal{d}$ 2146
7					$e$ 2147
8					$i$ 2148
9					$j$ 2149
A					
B				$\epsilon$ 213B	$\mathfrak{B}$ 214B
C				$\mathfrak{E}$ 213C	
D				$\gamma$ 213D	
E				$\Gamma$ 213E	
F				$\Pi$ 213F	

**Letterlike symbols**

- 213B  $\epsilon$  GREEK SYMBOL STRAIGHT EPSILON  
 $\approx$  <font> 03B5  $\epsilon$
- 213C  $\varepsilon$  GREEK SYMBOL REVERSED  
 STRAIGHT EPSILON
- 213D  $\gamma$  OPEN-FACE GREEK SMALL GAMMA  
 $\approx$  <font> 03B3  $\gamma$
- 213E  $\Gamma$  OPEN-FACE GREEK CAPITAL GAMMA  
 $\approx$  <font> 0393  $\Gamma$
- 213F  $\Pi$  OPEN-FACE GREEK CAPITAL PI  
 $\approx$  <font> 03A0  $\Pi$
- 2140  $\Sigma$  OPEN-FACE GREEK CAPITAL SIGMA  
 $\approx$  <font> 03A3  $\Sigma$
- 2141  $\mathcal{G}$  TURNED SANS SERIF CAPITAL G  
 = game
- 2142  $\mathcal{L}$  TURNED SANS SERIF CAPITAL L
- 2143  $\mathcal{L}$  REVERSED SANS SERIF CAPITAL L
- 2144  $\mathcal{Y}$  INVERTED SANS SERIF CAPITAL Y
- 2145  $\mathcal{D}$  CAPITAL DIFFERENTIAL D  
 $\approx$  <font> 0044  $\mathcal{D}$
- 2146  $d$  DIFFERENTIAL D  
 $\approx$  <font> 0064  $d$
- 2147  $e$  EXPONENTIAL E  
 $\approx$  <font> 0065  $e$
- 2148  $i$  IMAGINARY I  
 $\approx$  <font> 0069  $i$
- 2149  $j$  IMAGINARY J  
 $\approx$  <font> 006A  $j$
- 214A  $\mathcal{R}$  <reserved>
- 214B  $\mathcal{R}$  TURNED AMPERSAND  
 • used in linear logic  
 $\rightarrow$  0026 & ampersand

	219	21A	21B	21C	21D	21E	21F		
0									
1									
2									
3									
4									21F4
5									21F5
6									21F6
7									21F7
8									21F8
9									21F9
A									21FA
B									21FB
C									21FC
D									21FD
E									21FE
F									21FF

**Arrows**

- 21F4 ↵ DOWNWARDS WHITE ARROW WITH  
CORNER LEFTWARDS  
= return  
→ 21B5 ↵ downwards arrow with corner  
leftwards
- 21F5 ⇕ DOWNWARDS ARROW LEFTWARDS  
OF UPWARDS ARROW
- 21F6 ≡ THREE RIGHTWARDS ARROWS
- 21F7 ⇐ LEFTWARDS ARROW WITH  
VERTICAL STROKE
- 21F8 → RIGHTWARDS ARROW WITH  
VERTICAL STROKE  
= z notation partial function
- 21F9 ⇔ LEFT RIGHT ARROW WITH VERTICAL  
STROKE  
= z notation partial relation
- 21FA ⇐ LEFTWARDS ARROW WITH DOUBLE  
VERTICAL STROKE
- 21FB ⇒ RIGHTWARDS ARROW WITH DOUBLE  
VERTICAL STROKE  
= z notation finite function
- 21FC ⇔ LEFT RIGHT ARROW WITH DOUBLE  
VERTICAL STROKE  
= z notation finite relation
- 21FD ← LEFTWARDS OPEN-HEADED ARROW
- 21FE → RIGHTWARDS OPEN-HEADED  
ARROW
- 21FF ↔ LEFT RIGHT OPEN-HEADED ARROW


	220	221	222	223	224	225	226	227
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
A								
B								
C								
D								
E								
F								

	228	229	22A	22B	22C	22D	22E	22F		
0										
1										
2									€	22F2
3									⊄	22F3
4									⊅	22F4
5									€̇	22F5
6									€̄	22F6
7									€̅	22F7
8									⊆	22F8
9									⊇	22F9
A									⊃	22FA
B									⊄	22FB
C									⊅	22FC
D									⊆	22FD
E									⊇	22FE
F									⊈	22FF

**Mathematical operators**

22F2	∈	ELEMENT OF WITH LONG HORIZONTAL STROKE
22F3	⊋	ELEMENT OF WITH VERTICAL BAR AT END OF HORIZONTAL STROKE
22F4	⊍	SMALL ELEMENT OF WITH VERTICAL BAR AT END OF HORIZONTAL STROKE
22F5	⋈	ELEMENT OF WITH DOT ABOVE
22F6	⊃̄	ELEMENT OF WITH OVERBAR
22F7	⊂̄	SMALL ELEMENT OF WITH OVERBAR
22F8	⊆̄	ELEMENT OF WITH UNDERBAR
22F9	⊇̄	ELEMENT OF WITH TWO HORIZONTAL STROKES
22FA	⊃̄	CONTAINS WITH LONG HORIZONTAL STROKE
22FB	⊋̄	CONTAINS WITH VERTICAL BAR AT END OF HORIZONTAL STROKE
22FC	⊍̄	SMALL CONTAINS WITH VERTICAL BAR AT END OF HORIZONTAL STROKE
22FD	⊃̄̄	CONTAINS WITH OVERBAR
22FE	⊂̄̄	SMALL CONTAINS WITH OVERBAR
22FF	⊆̄̄	Z NOTATION BAG MEMBERSHIP



	230	231	232	233	234	235	236	237
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
A								
B								
C								
D							237C	
E								
F								

	238	239	23A	23B	23C	23D	23E	23F
0			$\int$ 23A0	$\int$ 23B0				
1			$\lrcorner$ 23A1	$\lrcorner$ 23B1				
2			$\lvert$ 23A2					
3			$\llcorner$ 23A3					
4			$\lrcorner$ 23A4	$\lrcorner$ 23B4				
5			$\lrcorner$ 23A5	$\lrcorner$ 23B5				
6			$\lrcorner$ 23A6	$\lrcorner$ 23B6				
7			$\int$ 23A7					
8			$\} $ 23A8					
9			$\lrcorner$ 23A9					
A			$\lrcorner$ 23AA					
B		$\lrcorner$ 239B	$\lrcorner$ 23AB					
C		$\lrcorner$ 239C	$\} $ 23AC					
D		$\lrcorner$ 239D	$\int$ 23AD					
E		$\lrcorner$ 239E	$\lrcorner$ 23AE					
F		$\lrcorner$ 239F						

**Miscellaneous technical**

237C  $\lrcorner$  RIGHT ANGLE WITH DOWNWARDS  
ZIGZAG ARROW

**Brace pieces**









239B  $($  LEFT PARENTHESIS UPPER HOOK  
 239C  $|$  LEFT PARENTHESIS EXTENSION  
 239D  $\backslash$  LEFT PARENTHESIS LOWER HOOK  
 239E  $)$  RIGHT PARENTHESIS UPPER HOOK  
 239F  $|$  RIGHT PARENTHESIS EXTENSION  
 23A0  $)$  RIGHT PARENTHESIS LOWER HOOK  
 23A1  $[$  LEFT SQUARE BRACKET UPPER  
CORNER  
 23A2  $|$  LEFT SQUARE BRACKET EXTENSION  
 23A3  $L$  LEFT SQUARE BRACKET LOWER  
CORNER  
 23A4  $]$  RIGHT SQUARE BRACKET UPPER  
CORNER  
 23A5  $|$  RIGHT SQUARE BRACKET  
EXTENSION  
 23A6  $]$  RIGHT SQUARE BRACKET LOWER  
CORNER  
 23A7  ${$  LEFT CURLY BRACKET UPPER HOOK  
 23A8  $\}$  LEFT CURLY BRACKET MIDDLE  
PIECE  
 23A9  $\}$  LEFT CURLY BRACKET LOWER HOOK  
 23AA  $|$  CURLY BRACKET EXTENSION  
 23AB  $)$  RIGHT CURLY BRACKET UPPER  
HOOK  
 23AC  $\}$  RIGHT CURLY BRACKET MIDDLE  
PIECE  
 23AD  $)$  RIGHT CURLY BRACKET LOWER  
HOOK  
 23AE  $|$  INTEGRAL EXTENSION  
 23AF HORIZONTAL LINE EXTENSION  
 23B0  $\}$  UPPER LEFT OR LOWER RIGHT  
CURLY BRACKET SECTION  
= left moustache  
 23B1  $\}$  UPPER RIGHT OR LOWER LEFT  
CURLY BRACKET SECTION  
= right moustache

**Summation sign parts**

23B2 SUMMATION TOP  
 23B3 SUMMATION BOTTOM

































































































































**Vertical brackets**

23B4  $\top$  TOP SQUARE BRACKET  
 23B5  $\perp$  BOTTOM SQUARE BRACKET  
 23B6  $\equiv$  BOTTOM SQUARE BRACKET OVER  
TOP SQUARE BRACKET

	25A	25B	25C	25D	25E	25F
0						
1						
2						
3						
4						
5						
6						
7						
8						 25F8
9						 25F9
A						 25FA
B						 25FB
C						 25FC
D						 25FD
E						 25FE
F						 25FF

**Geometric shapes**

25F8	▵	UPPER LEFT TRIANGLE
25F9	▾	UPPER RIGHT TRIANGLE
25FA	▴	LOWER LEFT TRIANGLE
25FB	□	WHITE MEDIUM SQUARE
25FC	■	BLACK MEDIUM SQUARE
25FD	◻	WHITE VERY SMALL SQUARE
25FE	▪	BLACK VERY SMALL SQUARE
25FF	◊	WHITE DIAMOND WITH CENTRED DOT

	290	291	292	293	294	295	296	297
0	 2900	 2910	 2920	 2930	 2940	 2950	 2960	 2970
1	 2901	 2911	 2921	 2931	 2941	 2951	 2961	 2971
2	 2902	 2912	 2922	 2932	 2942	 2952	 2962	 2972
3	 2903	 2913	 2923	 2933	 2943	 2953	 2963	 2973
4	 2904	 2914	 2924	 2934	 2944	 2954	 2964	 2974
5	 2905	 2915	 2925	 2935	 2945	 2955	 2965	 2975
6	 2906	 2916	 2926	 2936	 2946	 2956	 2966	 2976
7	 2907	 2917	 2927	 2937	 2947	 2957	 2967	 2977
8	 2908	 2918	 2928	 2938	 2948	 2958	 2968	 2978
9	 2909	 2919	 2929	 2939	 2949	 2959	 2969	 2979
A	 290A	 291A	 292A	 293A	 294A	 295A	 296A	 297A
B	 290B	 291B	 292B	 293B	 294B	 295B	 296B	 297B
C	 290C	 291C	 292C	 293C	 294C	 295C	 296C	 297C
D	 290D	 291D	 292D	 293D	 294D	 295D	 296D	 297D
E	 290E	 291E	 292E	 293E	 294E	 295E	 296E	 297E
F	 290F	 291F	 292F	 293F	 294F	 295F	 296F	 297F
































































































































**Supplemental arrows**

































































































































2900	↔	RIGHTWARDS TWO-HEADED ARROW WITH VERTICAL STROKE = z notation partial surjection	291C	↗	RIGHTWARDS DOUBLE ARROW-TAIL
2901	↔	RIGHTWARDS TWO-HEADED ARROW WITH DOUBLE VERTICAL STROKE = z notation finite surjection	291D	←	LEFTWARDS ARROW TO FILLED DIAMOND
2902	⇌	LEFTWARDS DOUBLE ARROW WITH VERTICAL STROKE	291E	→	RIGHTWARDS ARROW TO FILLED DIAMOND
2903	⇌	RIGHTWARDS DOUBLE ARROW WITH VERTICAL STROKE	291F	←	LEFTWARDS ARROW FROM BAR TO FILLED DIAMOND
2904	⇌	LEFT RIGHT DOUBLE ARROW WITH VERTICAL STROKE	2920	→	RIGHTWARDS ARROW FROM BAR TO FILLED DIAMOND
2905	→	RIGHTWARDS TWO-HEADED ARROW FROM BAR = maps to	2921	↖	NORTH WEST AND SOUTH EAST ARROW
2906	←	LEFTWARDS DOUBLE ARROW FROM BAR = maps from	2922	↗	NORTH EAST AND SOUTH WEST ARROW
2907	⇒	RIGHTWARDS DOUBLE ARROW FROM BAR = maps to	2923	↖	NORTH WEST ARROW WITH HOOK
2908	↓	DOWNWARDS ARROW WITH HORIZONTAL STROKE	2924	↗	NORTH EAST ARROW WITH HOOK
2909	↑	UPWARDS ARROW WITH HORIZONTAL STROKE	2925	↖	SOUTH EAST ARROW WITH HOOK
290A	≡	UPWARDS TRIPLE ARROW	2926	↗	SOUTH WEST ARROW WITH HOOK
290B	≡	DOWNWARDS TRIPLE ARROW	2927	⊗	NORTH WEST ARROW AND NORTH EAST ARROW
290C	↔	LEFTWARDS DOUBLE DASH ARROW	2928	⊗	NORTH EAST ARROW AND SOUTH EAST ARROW
290D	→	RIGHTWARDS DOUBLE DASH ARROW	2929	⊗	SOUTH EAST ARROW AND SOUTH WEST ARROW
290E	↔	LEFTWARDS TRIPLE DASH ARROW	292A	⊗	SOUTH WEST ARROW AND NORTH WEST ARROW
290F	→	RIGHTWARDS TRIPLE DASH ARROW	292B	⊗	RISING DIAGONAL CROSSING FALLING DIAGONAL
2910	↔	RIGHTWARDS TWO-HEADED TRIPLE DASH ARROW	292C	⊗	FALLING DIAGONAL CROSSING RISING DIAGONAL
2911	→	RIGHTWARDS ARROW WITH DOTTED STEM	292D	⊗	SOUTH EAST ARROW CROSSING NORTH EAST ARROW
2912	↑	UPWARDS ARROW TO BAR	292E	⊗	NORTH EAST ARROW CROSSING SOUTH EAST ARROW
2913	↓	DOWNWARDS ARROW TO BAR	292F	⊗	FALLING DIAGONAL CROSSING NORTH EAST ARROW
2914	↔	RIGHTWARDS ARROW WITH TAIL WITH VERTICAL STROKE = z notation partial injection	2930	⊗	RISING DIAGONAL CROSSING SOUTH EAST ARROW
2915	↔	RIGHTWARDS ARROW WITH TAIL WITH DOUBLE VERTICAL STROKE = z notation finite injection	2931	⊗	NORTH EAST ARROW CROSSING NORTH WEST ARROW
2916	↔	RIGHTWARDS TWO-HEADED ARROW WITH TAIL = bijective mapping	2932	⊗	NORTH WEST ARROW CROSSING NORTH EAST ARROW
2917	↔	RIGHTWARDS TWO-HEADED ARROW WITH TAIL WITH VERTICAL STROKE = z notation surjective injection	2933	~	WAVE ARROW POINTING DIRECTLY TO THE RIGHT → 219D ~ rightwards wave arrow
2918	↔	RIGHTWARDS TWO-HEADED ARROW WITH TAIL WITH DOUBLE VERTICAL STROKE = z notation finite surjective injection	2934	↗	ARROW POINTING RIGHTWARDS THEN CURVING UPWARDS
2919	↗	LEFTWARDS ARROW-TAIL	2935	↘	ARROW POINTING RIGHTWARDS THEN CURVING DOWNWARDS
291A	↘	RIGHTWARDS ARROW-TAIL	2936	↙	ARROW POINTING DOWNWARDS THEN CURVING LEFTWARDS
291B	↖	LEFTWARDS DOUBLE ARROW-TAIL	2937	↘	ARROW POINTING DOWNWARDS THEN CURVING RIGHTWARDS
			2938	↻	RIGHT-SIDE ARC CLOCKWISE ARROW
			2939	↺	LEFT-SIDE ARC ANTICLOCKWISE ARROW
			293A	↺	TOP ARC ANTICLOCKWISE ARROW
			293B	↺	BOTTOM ARC ANTICLOCKWISE ARROW

































































































































293C	↷	TOP ARC CLOCKWISE ARROW WITH MINUS	2958	↑	UPWARDS HARPOON WITH BARB LEFT TO BAR
293D	↶	TOP ARC ANTICLOCKWISE ARROW WITH PLUS	2959	↓	DOWNWARDS HARPOON WITH BARB LEFT TO BAR
293E	↻	LOWER RIGHT SEMICIRCULAR CLOCKWISE ARROW	295A	←	LEFTWARDS HARPOON WITH BARB UP FROM BAR
293F	↺	LOWER LEFT SEMICIRCULAR ANTICLOCKWISE ARROW	295B	→	RIGHTWARDS HARPOON WITH BARB UP FROM BAR
2940	⦿	ANTICLOCKWISE CLOSED CIRCLE ARROW → 20DA ⦿ combining anticlockwise ring overlay	295C	↑	UPWARDS HARPOON WITH BARB RIGHT FROM BAR
2941	⦿	CLOCKWISE CLOSED CIRCLE ARROW → 20D9 ⦿ combining clockwise ring overlay	295D	↓	DOWNWARDS HARPOON WITH BARB RIGHT FROM BAR
2942	↗	RIGHTWARDS ARROW ABOVE SHORT LEFTWARDS ARROW	295E	←	LEFTWARDS HARPOON WITH BARB DOWN FROM BAR
2943	↖	LEFTWARDS ARROW ABOVE SHORT RIGHTWARDS ARROW	295F	→	RIGHTWARDS HARPOON WITH BARB DOWN FROM BAR
2944	↗	SHORT RIGHTWARDS ARROW ABOVE LEFTWARDS ARROW	2960	↑	UPWARDS HARPOON WITH BARB LEFT FROM BAR
2945	↖	RIGHTWARDS ARROW WITH PLUS BELOW	2961	↓	DOWNWARDS HARPOON WITH BARB LEFT FROM BAR
2946	↗	LEFTWARDS ARROW WITH PLUS BELOW	2962	⇌	LEFTWARDS HARPOON WITH BARB UP ABOVE LEFTWARDS HARPOON WITH BARB DOWN
2947	↗	RIGHTWARDS ARROW THROUGH X	2963	↑	UPWARDS HARPOON WITH BARB LEFT BESIDE UPWARDS HARPOON WITH BARB RIGHT
2948	↖	LEFT RIGHT ARROW THROUGH SMALL CIRCLE	2964	⇌	RIGHTWARDS HARPOON WITH BARB UP ABOVE RIGHTWARDS HARPOON WITH BARB DOWN
2949	↕	UPWARDS TWO-HEADED ARROW FROM SMALL CIRCLE	2965	↓	DOWNWARDS HARPOON WITH BARB LEFT BESIDE DOWNWARDS HARPOON WITH BARB RIGHT
294A	↖	LEFT BARB UP RIGHT BARB DOWN HARPOON	2966	⇌	LEFTWARDS HARPOON WITH BARB UP ABOVE RIGHTWARDS HARPOON WITH BARB UP
294B	↗	LEFT BARB DOWN RIGHT BARB UP HARPOON	2967	⇌	LEFTWARDS HARPOON WITH BARB DOWN ABOVE RIGHTWARDS HARPOON WITH BARB DOWN
294C	↕	UP BARB RIGHT DOWN BARB LEFT HARPOON	2968	⇌	RIGHTWARDS HARPOON WITH BARB UP ABOVE LEFTWARDS HARPOON WITH BARB UP
294D	↑	UP BARB LEFT DOWN BARB RIGHT HARPOON	2969	⇌	RIGHTWARDS HARPOON WITH BARB DOWN ABOVE LEFTWARDS HARPOON WITH BARB DOWN
294E	↖	LEFT BARB UP RIGHT BARB UP HARPOON	296A	⇌	LEFTWARDS HARPOON WITH BARB UP ABOVE LONG DASH
294F	↗	UP BARB RIGHT DOWN BARB RIGHT HARPOON	296B	⇌	LEFTWARDS HARPOON WITH BARB DOWN BELOW LONG DASH
2950	↖	LEFT BARB DOWN RIGHT BARB DOWN HARPOON	296C	⇌	RIGHTWARDS HARPOON WITH BARB UP ABOVE LONG DASH
2951	↑	UP BARB LEFT DOWN BARB LEFT HARPOON	296D	⇌	RIGHTWARDS HARPOON WITH BARB DOWN BELOW LONG DASH
2952	←	LEFTWARDS HARPOON WITH BARB UP TO BAR	296E	↑	UPWARDS HARPOON WITH BARB LEFT BESIDE DOWNWARDS HARPOON WITH BARB RIGHT
2953	→	RIGHTWARDS HARPOON WITH BARB UP TO BAR	296F	↓	DOWNWARDS HARPOON WITH BARB LEFT BESIDE UPWARDS HARPOON WITH BARB RIGHT
2954	↑	UPWARDS HARPOON WITH BARB RIGHT TO BAR			
2955	↓	DOWNWARDS HARPOON WITH BARB RIGHT TO BAR			
2956	←	LEFTWARDS HARPOON WITH BARB DOWN TO BAR			
2957	→	RIGHTWARDS HARPOON WITH BARB DOWN TO BAR			



2970	$\Rightarrow$	RIGHT DOUBLE ARROW WITH ROUNDED HEAD → 2283 $\supset$ superset of
2971	$\Rightarrow$	EQUALS SIGN ABOVE RIGHTWARDS ARROW
2972	$\Rightarrow$	TILDE OPERATOR ABOVE RIGHTWARDS ARROW
2973	$\Leftarrow$	LEFTWARDS ARROW ABOVE TILDE OPERATOR
2974	$\Rightarrow$	RIGHTWARDS ARROW ABOVE TILDE OPERATOR
2975	$\Rightarrow$	RIGHTWARDS ARROW ABOVE ALMOST EQUAL TO
2976	$\Leftarrow$	LESS-THAN ABOVE LEFTWARDS ARROW
2977	$\Leftarrow$	LEFTWARDS ARROW THROUGH LESS-THAN
2978	$\Rightarrow$	GREATER-THAN ABOVE RIGHTWARDS ARROW
2979	$\Subset$	SUBSET ABOVE RIGHTWARDS ARROW
297A	$\Leftarrow$	LEFTWARDS ARROW THROUGH SUBSET
297B	$\Supset$	SUPERSET ABOVE LEFTWARDS ARROW
297C	$\Leftarrow$	LEFT FISH TAIL
297D	$\rightarrow$	RIGHT FISH TAIL
297E	$\Uparrow$	UP FISH TAIL
297F	$\Downarrow$	DOWN FISH TAIL

	298	299	29A	29B	29C	29D	29E	29F
0	 2980	 2990	 29A0	 29B0	 29C0	 29D0	 29E0	 29F0
1	 2981	 2991	 29A1	 29B1	 29C1	 29D1	 29E1	 29F1
2	 2982	 2992	 29A2	 29B2	 29C2	 29D2	 29E2	 29F2
3	 2983	 2993	 29A3	 29B3	 29C3	 29D3	 29E3	 29F3
4	 2984	 2994	 29A4	 29B4	 29C4	 29D4	 29E4	 29F4
5	 2985	 2995	 29A5	 29B5	 29C5	 29D5	 29E5	
6	 2986	 2996	 29A6	 29B6	 29C6	 29D6		 29F6
7	 2987		 29A7	 29B7	 29C7	 29D7	 29E7	 29F7
8	 2988		 29A8	 29B8	 29C8		 29E8	 29F8
9	 2989	 2999	 29A9	 29B9	 29C9		 29E9	 29F9
A	 298A	 299A	 29AA	 29BA	 29CA		 29EA	
B	 298B	 299B	 29AB	 29BB	 29CB		 29EB	
C	 298C	 299C	 29AC	 29BC	 29CC	 29DC	 29EC	
D	 298D	 299D	 29AD	 29BD	 29CD	 29DD	 29ED	
E	 298E	 299E	 29AE	 29BE	 29CE	 29DE	 29EE	
F	 298F	 299F	 29AF	 29BF	 29CF	 29DF	 29EF	

	2A0	2A1	2A2	2A3	2A4	2A5	2A6	2A7
0	 2A00	 2A10	 2A20	 2A30	 2A40	 2A50	 2A60	 2A70
1	 2A01	 2A11	 2A21	 2A31	 2A41	 2A51	 2A61	 2A71
2	 2A02	 2A12	 2A22	 2A32	 2A42	 2A52	 2A62	 2A72
3	 2A03	 2A13	 2A23	 2A33	 2A43	 2A53	 2A63	 2A73
4	 2A04	 2A14	 2A24	 2A34	 2A44	 2A54	 2A64	 2A74
5	 2A05	 2A15	 2A25	 2A35	 2A45	 2A55	 2A65	 2A75
6	 2A06	 2A16	 2A26	 2A36	 2A46	 2A56	 2A66	 2A76
7	 2A07	 2A17	 2A27	 2A37	 2A47	 2A57	 2A67	 2A77
8	 2A08	 2A18	 2A28	 2A38	 2A48	 2A58	 2A68	 2A78
9	 2A09	 2A19	 2A29	 2A39	 2A49	 2A59	 2A69	 2A79
A	 2A0A	 2A1A	 2A2A	 2A3A	 2A4A	 2A5A	 2A6A	 2A7A
B	 2A0B	 2A1B	 2A2B	 2A3B	 2A4B	 2A5B	 2A6B	 2A7B
C	 2A0C	 2A1C	 2A2C	 2A3C	 2A4C	 2A5C	 2A6C	 2A7C
D	 2A0D	 2A1D	 2A2D	 2A3D	 2A4D	 2A5D	 2A6D	 2A7D
E	 2A0E	 2A1E	 2A2E	 2A3E	 2A4E	 2A5E	 2A6E	 2A7E
F	 2A0F	 2A1F	 2A2F	 2A3F	 2A4F	 2A5F	 2A6F	 2A7F

	2A8	2A9	2AA	2AB	2AC	2AD	2AE	2AF
0	 2A80	 2A90	 2AA0	 2AB0	 2AC0	 2AD0	 2AE0	 2AF0
1	 2A81	 2A91	 2AA1	 2AB1	 2AC1	 2AD1	 2AE1	 2AF1
2	 2A82	 2A92	 2AA2	 2AB2	 2AC2	 2AD2	 2AE2	 2AF2
3	 2A83	 2A93	 2AA3	 2AB3	 2AC3	 2AD3	 2AE3	 2AF3
4	 2A84	 2A94	 2AA4	 2AB4	 2AC4	 2AD4	 2AE4	 2AF4
5	 2A85	 2A95	 2AA5	 2AB5	 2AC5	 2AD5	 2AE5	 2AF5
6	 2A86	 2A96	 2AA6	 2AB6	 2AC6	 2AD6	 2AE6	 2AF6
7	 2A87	 2A97	 2AA7	 2AB7	 2AC7	 2AD7	 2AE7	
8	 2A88	 2A98	 2AA8	 2AB8	 2AC8	 2AD8	 2AE8	
9	 2A89	 2A99	 2AA9	 2AB9	 2AC9	 2AD9	 2AE9	
A	 2A8A	 2A9A	 2AAA	 2ABA	 2ACA	 2ADA	 2AEA	
B	 2A8B	 2A9B	 2AAB	 2ABB	 2ACB	 2ADB	 2AEB	
C	 2A8C	 2A9C	 2AAC	 2ABC	 2ACC	 2ADC	 2AEC	
D	 2A8D	 2A9D	 2AAD	 2ABD	 2ACD	 2ADD	 2AED	
E	 2A8E	 2A9E	 2AAE	 2ABE	 2ACE	 2ADE	 2AEE	
F	 2A8F	 2A9F	 2AAF	 2ABF	 2ACF	 2ADF	 2AEF	

**N-ary operators**

- 2A00  $\odot$  N-ARY CIRCLED DOT OPERATOR  
→ 2299  $\odot$  circled dot operator
- 2A01  $\oplus$  N-ARY CIRCLED PLUS OPERATOR  
→ 2295  $\oplus$  circled plus
- 2A02  $\otimes$  N-ARY CIRCLED TIMES OPERATOR  
→ 2297  $\otimes$  circled times
- 2A03  $\cup$  N-ARY UNION OPERATOR WITH DOT
- 2A04  $\sqcup$  N-ARY UNION OPERATOR WITH PLUS  
→ 228E  $\sqcup$  multiset union
- 2A05  $\sqcap$  N-ARY SQUARE INTERSECTION OPERATOR  
→ 2293  $\sqcap$  square cap
- 2A06  $\sqcup$  N-ARY SQUARE UNION OPERATOR  
→ 2294  $\sqcup$  square cup
- 2A07  $\pitchfork$  TWO LOGICAL AND OPERATOR  
= merge  
→ 2A55  $\pitchfork$  two intersecting logical and
- 2A08  $\wp$  TWO LOGICAL OR OPERATOR  
→ 2A56  $\wp$  two intersecting logical or
- 2A09  $\times$  N-ARY TIMES OPERATOR  
→ 00D7  $\times$  multiplication sign

**Summations and integrals**

- 2A0A  $\sum_2$  MODULO TWO SUM  
→ 2211  $\sum$  n-ary summation
- 2A0B  $\int$  SUMMATION WITH INTEGRAL
- 2A0C  $\iiint$  QUADRUPLE INTEGRAL OPERATOR  
≈ 222B  $\int$  222B  $\int$  222B  $\int$  222B  $\int$
- 2A0D  $\int$  FINITE PART INTEGRAL
- 2A0E  $\int$  INTEGRAL WITH DOUBLE STROKE
- 2A0F  $\int$  INTEGRAL AVERAGE WITH SLASH
- 2A10  $\int$  CIRCULATION FUNCTION
- 2A11  $\int$  ANTICLOCKWISE INTEGRATION
- 2A12  $\int$  LINE INTEGRATION WITH RECTANGULAR PATH AROUND POLE
- 2A13  $\int$  LINE INTEGRATION WITH SEMICIRCULAR PATH AROUND POLE
- 2A14  $\int$  LINE INTEGRATION NOT INCLUDING THE POLE
- 2A15  $\int$  INTEGRAL AROUND A POINT OPERATOR
- 2A16  $\int$  QUATERNION INTEGRAL OPERATOR
- 2A17  $\int$  INTEGRAL WITH LEFTWARDS ARROW WITH HOOK
- 2A18  $\int$  INTEGRAL WITH TIMES SIGN
- 2A19  $\int$  INTEGRAL WITH INTERSECTION
- 2A1A  $\int$  INTEGRAL WITH UNION
- 2A1B  $\int$  INTEGRAL WITH OVERBAR
- 2A1C  $\int$  INTEGRAL WITH UNDERBAR

**Miscellaneous large operators**

- 2A1D  $\bowtie$  JOIN  
= large bowtie  
• relational database theory  
→ 22C8  $\bowtie$  bowtie

- 2A1E  $\triangleleft$  LARGE LEFT TRIANGLE OPERATOR  
• relational database theory  
→ 25C1  $\triangleleft$  white left-pointing triangle
- 2A1F  $\zeta$  Z NOTATION SCHEMA COMPOSITION  
→ 2A3E  $\zeta$ ; z notation relational composition
- 2A20  $\gg$  Z NOTATION SCHEMA PIPING  
→ 226B  $\gg$  much greater-than
- 2A21  $\upharpoonright$  Z NOTATION SCHEMA PROJECTION  
→ 21BE  $\upharpoonright$  upwards harpoon with bar rightwards

**Plus and minus sign operators**

- 2A22  $\ddagger$  PLUS SIGN WITH SMALL CIRCLE ABOVE
- 2A23  $\dagger$  PLUS SIGN WITH CIRCUMFLEX ACCENT ABOVE
- 2A24  $\ddagger$  PLUS SIGN WITH TILDE ABOVE
- 2A25  $\dagger$  PLUS SIGN WITH DOT BELOW  
→ 2214  $\dagger$  dot plus
- 2A26  $\ddagger$  PLUS SIGN WITH TILDE BELOW
- 2A27  $\ddagger$  PLUS SIGN WITH SUBSCRIPT TWO  
= nim-addition
- 2A28  $\dagger$  PLUS SIGN WITH FILLED TRIANGLE
- 2A29  $\ddagger$  MINUS SIGN WITH COMMA ABOVE
- 2A2A  $\ddagger$  MINUS SIGN WITH DOT BELOW  
→ 2238  $\ddagger$  dot minus
- 2A2B  $\ddagger$  MINUS SIGN WITH FALLING DOTS
- 2A2C  $\ddagger$  MINUS SIGN WITH RISING DOTS
- 2A2D  $\oplus$  PLUS SIGN IN LEFT HALF CIRCLE
- 2A2E  $\oplus$  PLUS SIGN IN RIGHT HALF CIRCLE

**Multiplication and division sign operators**

- 2A2F  $\times$  VECTOR OR CROSS PRODUCT  
→ 00D7  $\times$  multiplication sign
- 2A30  $\times$  MULTIPLICATION SIGN WITH DOT ABOVE
- 2A31  $\times$  MULTIPLICATION SIGN WITH UNDERBAR
- 2A32  $\times$  SEMIDIRECT PRODUCT WITH BOTTOM CLOSED
- 2A33  $\times$  SMASH PRODUCT
- 2A34  $\oplus$  MULTIPLICATION SIGN IN LEFT HALF CIRCLE
- 2A35  $\oplus$  MULTIPLICATION SIGN IN RIGHT HALF CIRCLE
- 2A36  $\otimes$  CIRCLED MULTIPLICATION SIGN WITH CIRCUMFLEX ACCENT
- 2A37  $\otimes$  MULTIPLICATION SIGN IN DOUBLE CIRCLE
- 2A38  $\oplus$  CIRCLED DIVISION SIGN

**Miscellaneous math operators**

- 2A39  $\triangle$  PLUS SIGN IN TRIANGLE
- 2A3A  $\triangle$  MINUS SIGN IN TRIANGLE
- 2A3B  $\triangle$  MULTIPLICATION SIGN IN TRIANGLE

- 2A3C  $\lrcorner$  INTERIOR PRODUCT  
→ 230B  $\lrcorner$  right floor
- 2A3D  $\llcorner$  RIGHTHAND INTERIOR PRODUCT  
→ 230A  $\llcorner$  left floor  
→ 2319  $\llcorner$  turned not sign
- 2A3E  $\textcircled{;}$  Z NOTATION RELATIONAL COMPOSITION  
→ 2A1F  $\textcircled{;}$  z notation schema composition
- 2A3F  $\sqcup$  AMALGAMATION OR COPRODUCT  
→ 2210  $\sqcup$  n-ary coproduct

### Intersections and unions

- 2A40  $\cap$  INTERSECTION WITH DOT
- 2A41  $\cup$  UNION WITH MINUS SIGN  
= z notation bag subtraction  
→ 228E  $\cup$  multiset union
- 2A42  $\bar{\cup}$  UNION WITH OVERBAR
- 2A43  $\bar{\cap}$  INTERSECTION WITH OVERBAR
- 2A44  $\bar{\cap}$  INTERSECTION WITH LOGICAL AND
- 2A45  $\bar{\cup}$  UNION WITH LOGICAL OR
- 2A46  $\bar{\times}$  UNION ABOVE INTERSECTION
- 2A47  $\bar{\circ}$  INTERSECTION ABOVE UNION
- 2A48  $\bar{\times}$  UNION ABOVE BAR ABOVE INTERSECTION
- 2A49  $\bar{\theta}$  INTERSECTION ABOVE BAR ABOVE UNION
- 2A4A  $\bar{\omega}$  UNION BESIDE AND JOINED WITH UNION
- 2A4B  $\bar{\cap}$  INTERSECTION BESIDE AND JOINED WITH INTERSECTION
- 2A4C  $\bar{\sqcup}$  CLOSED UNION WITH SERIFS  
→ 222A  $\bar{\sqcup}$  union
- 2A4D  $\bar{\cap}$  CLOSED INTERSECTION WITH SERIFS  
→ 2229  $\bar{\cap}$  intersection
- 2A4E  $\bar{\sqcap}$  DOUBLE SQUARE INTERSECTION
- 2A4F  $\bar{\sqcup}$  DOUBLE SQUARE UNION
- 2A50  $\bar{\sqcup}$  CLOSED UNION WITH SERIFS AND SMASH PRODUCT

### Logical ands and ors

- 2A51  $\hat{\wedge}$  LOGICAL AND WITH DOT ABOVE
- 2A52  $\hat{\vee}$  LOGICAL OR WITH DOT ABOVE
- 2A53  $\hat{\wedge}$  DOUBLE LOGICAL AND
- 2A54  $\hat{\vee}$  DOUBLE LOGICAL OR
- 2A55  $\hat{\wedge}$  TWO INTERSECTING LOGICAL AND  
→ 2A07  $\hat{\wedge}$  two logical and operator
- 2A56  $\hat{\vee}$  TWO INTERSECTING LOGICAL OR  
→ 2A08  $\hat{\vee}$  two logical or operator
- 2A57  $\sloper$  SLOPING LARGE OR
- 2A58  $\sloper$  SLOPING LARGE AND
- 2A59  $\times$  LOGICAL OR OVERLAPPING LOGICAL AND
- 2A5A  $\wedge$  LOGICAL AND WITH MIDDLE STEM
- 2A5B  $\vee$  LOGICAL OR WITH MIDDLE STEM
- 2A5C  $\wedge$  LOGICAL AND WITH HORIZONTAL DASH

- 2A5D  $\vee$  LOGICAL OR WITH HORIZONTAL DASH
- 2A5E  $\bar{\wedge}$  LOGICAL AND WITH DOUBLE OVERBAR  
→ 2306  $\bar{\wedge}$  perspective
- 2A5F  $\triangle$  LOGICAL AND WITH UNDERBAR
- 2A60  $\triangle$  LOGICAL AND WITH DOUBLE UNDERBAR  
→ 2259  $\triangle$  estimates
- 2A61  $\underline{\vee}$  SMALL VEE WITH UNDERBAR
- 2A62  $\bar{\vee}$  LOGICAL OR WITH DOUBLE OVERBAR
- 2A63  $\underline{\vee}$  LOGICAL OR WITH DOUBLE UNDERBAR  
→ 225A  $\underline{\vee}$  equiangular to

### Miscellaneous math operators

- 2A64  $\Leftarrow$  Z NOTATION DOMAIN ANTIRESTRICTION
- 2A65  $\Rightarrow$  Z NOTATION RANGE ANTIRESTRICTION  
→ 2332  $\Rightarrow$  conical taper

### Relational operators

- 2A66  $\doteq$  EQUALS SIGN WITH DOT BELOW  
→ 2250  $\doteq$  approaches the limit
- 2A67  $\doteq$  IDENTICAL WITH DOT ABOVE
- 2A68  $\#$  TRIPLE HORIZONTAL BAR WITH DOUBLE VERTICAL STROKE  
= identical and parallel to  
→ 22D5  $\#$  equal and parallel to  
→ 29E5  $\#$  congruent and parallel to
- 2A69  $\#$  TRIPLE HORIZONTAL BAR WITH TRIPLE VERTICAL STROKE
- 2A6A  $\sim$  TILDE OPERATOR WITH DOT ABOVE
- 2A6B  $\sim$  TILDE OPERATOR WITH RISING DOTS  
→ 223B  $\sim$  homothetic
- 2A6C  $\approx$  SIMILAR MINUS SIMILAR
- 2A6D  $\doteq$  CONGRUENT WITH DOT ABOVE  
→ 2245  $\doteq$  approximately equal to
- 2A6E  $\boxtimes$  <reserved>
- 2A6F  $\approx$  ALMOST EQUAL TO WITH CIRCUMFLEX ACCENT
- 2A70  $\approx$  APPROXIMATELY EQUAL OR EQUAL TO
- 2A71  $\bar{=}$  EQUALS SIGN ABOVE PLUS SIGN
- 2A72  $\pm$  PLUS SIGN ABOVE EQUALS SIGN
- 2A73  $\approx$  EQUALS SIGN ABOVE TILDE OPERATOR
- 2A74  $\equiv$  DOUBLE COLON EQUAL  
 $\approx$  003A : 003A : 003D =
- 2A75  $\equiv$  TWO CONSECUTIVE EQUALS SIGNS  
 $\approx$  003D = 003D =
- 2A76  $\equiv$  THREE CONSECUTIVE EQUALS SIGNS  
 $\approx$  003D = 003D = 003D =
- 2A77  $\equiv$  EQUALS SIGN WITH TWO DOTS ABOVE AND TWO DOTS BELOW

2A78	≡	EQUIVALENT WITH FOUR DOTS ABOVE	2A94	≡	GREATER-THAN ABOVE SLANTED EQUAL ABOVE LESS-THAN ABOVE SLANTED EQUAL
2A79	⋈	LESS-THAN WITH CIRCLE INSIDE	2A95	⋈	SLANTED EQUAL TO OR LESS-THAN → 22DC ⋈ equal to or less-than
2A7A	⋉	GREATER-THAN WITH CIRCLE INSIDE	2A96	⋉	SLANTED EQUAL TO OR GREATER-THAN → 22DD ⋉ equal to or greater-than
2A7B	⋊	LESS-THAN WITH QUESTION MARK ABOVE	2A97	⋈	SLANTED EQUAL TO OR LESS-THAN WITH DOT INSIDE
2A7C	⋋	GREATER-THAN WITH QUESTION MARK ABOVE	2A98	⋉	SLANTED EQUAL TO OR GREATER-THAN WITH DOT INSIDE
2A7D	⋌	LESS-THAN OR SLANTED EQUAL TO → 2264 ≤ less-than or equal to	2A99	≡	DOUBLE-LINE EQUAL TO OR LESS-THAN → 22DC ⋈ equal to or less-than
2A7E	⋍	GREATER-THAN OR SLANTED EQUAL TO → 2265 ≥ greater-than or equal to	2A9A	≡	DOUBLE-LINE EQUAL TO OR GREATER-THAN → 22DD ⋉ equal to or greater-than
2A7F	⋎	LESS-THAN OR SLANTED EQUAL TO WITH DOT INSIDE	2A9B	≡	DOUBLE-LINE SLANTED EQUAL TO OR LESS-THAN
2A80	⋏	GREATER-THAN OR SLANTED EQUAL TO WITH DOT INSIDE	2A9C	≡	DOUBLE-LINE SLANTED EQUAL TO OR GREATER-THAN
2A81	⋐	LESS-THAN OR SLANTED EQUAL TO WITH DOT ABOVE	2A9D	≈	SIMILAR OR LESS-THAN
2A82	⋑	GREATER-THAN OR SLANTED EQUAL TO WITH DOT ABOVE	2A9E	≈	SIMILAR OR GREATER-THAN
2A83	⋒	LESS-THAN OR SLANTED EQUAL TO WITH DOT ABOVE RIGHT	2A9F	≡	SIMILAR ABOVE LESS-THAN ABOVE EQUALS SIGN
2A84	⋓	GREATER-THAN OR SLANTED EQUAL TO WITH DOT ABOVE LEFT	2AA0	≡	SIMILAR ABOVE GREATER-THAN ABOVE EQUALS SIGN
2A85	⋔	LESS-THAN OR APPROXIMATE	2AA1	⋈	DOUBLE NESTED LESS-THAN = absolute continuity → 226A ⋈ much less-than
2A86	⋕	GREATER-THAN OR APPROXIMATE	2AA2	⋉	DOUBLE NESTED GREATER-THAN → 226B ⋉ much greater-than
2A87	⋖	LESS-THAN AND SINGLE-LINE NOT EQUAL TO → 2268 ≉ less-than but not equal to	2AA3	⋌	DOUBLE NESTED LESS-THAN WITH UNDERBAR
2A88	⋗	GREATER-THAN AND SINGLE-LINE NOT EQUAL TO → 2269 ≉ greater-than but not equal to	2AA4	⋍	GREATER-THAN OVERLAPPING LESS-THAN
2A89	⋘	LESS-THAN AND NOT APPROXIMATE	2AA5	⋎	GREATER-THAN BESIDE LESS-THAN
2A8A	⋙	GREATER-THAN AND NOT APPROXIMATE	2AA6	⋏	LESS-THAN CLOSED BY CURVE
2A8B	⋚	LESS-THAN ABOVE DOUBLE-LINE EQUAL ABOVE GREATER-THAN → 22DA ≡ less-than equal to or greater-than	2AA7	⋐	GREATER-THAN CLOSED BY CURVE
2A8C	⋛	GREATER-THAN ABOVE DOUBLE-LINE EQUAL ABOVE LESS-THAN → 22DB ≡ greater-than equal to or less-than	2AA8	⋑	LESS-THAN CLOSED BY CURVE ABOVE SLANTED EQUAL
2A8D	⋜	LESS-THAN ABOVE SIMILAR OR EQUAL	2AA9	⋒	GREATER-THAN CLOSED BY CURVE ABOVE SLANTED EQUAL
2A8E	⋝	GREATER-THAN ABOVE SIMILAR OR EQUAL	2AAA	⋌	SMALLER THAN
2A8F	⋞	LESS-THAN ABOVE SIMILAR ABOVE GREATER-THAN	2AAB	⋍	LARGER THAN
2A90	⋟	GREATER-THAN ABOVE SIMILAR ABOVE LESS-THAN	2AAC	⋎	SMALLER THAN OR EQUAL TO
2A91	⋠	LESS-THAN ABOVE GREATER-THAN ABOVE DOUBLE-LINE EQUAL	2AAD	⋏	LARGER THAN OR EQUAL TO
2A92	⋡	GREATER-THAN ABOVE LESS-THAN ABOVE DOUBLE-LINE EQUAL	2AAE	≡	EQUALS SIGN WITH BUMPY ABOVE → 22AF ⋈ approaches the limit
2A93	⋢	LESS-THAN ABOVE SLANTED EQUAL ABOVE GREATER-THAN ABOVE SLANTED EQUAL	2AAF	⋌	PRECEDES ABOVE SINGLE-LINE EQUALS SIGN → 227C ⋌ precedes or equal to
			2AB0	⋍	SUCCEEDS ABOVE SINGLE-LINE EQUALS SIGN → 227D ⋍ succeeds or equal to
			2AB1	⋖	PRECEDES ABOVE SINGLE-LINE NOT EQUAL TO

2AB2	≠	SUCCEEDS ABOVE SINGLE-LINE NOT EQUAL TO
2AB3	≠	PRECEDES ABOVE EQUALS SIGN
2AB4	≠	SUCCEEDS ABOVE EQUALS SIGN
2AB5	≠	PRECEDES ABOVE NOT EQUAL TO
2AB6	≠	SUCCEEDS ABOVE NOT EQUAL TO
2AB7	≈	PRECEDES ABOVE ALMOST EQUAL TO
2AB8	≈	SUCCEEDS ABOVE ALMOST EQUAL TO
2AB9	≈	PRECEDES ABOVE NOT ALMOST EQUAL TO
2ABA	≈	SUCCEEDS ABOVE NOT ALMOST EQUAL TO
2ABB	≠	DOUBLE PRECEDES
2ABC	≠	DOUBLE SUCCEEDS

### Subset and superset relations

2ABD	⊂	SUBSET WITH DOT
2ABE	⊃	SUPERSET WITH DOT
2ABF	⊆	SUBSET WITH PLUS SIGN BELOW
2AC0	⊇	SUPERSET WITH PLUS SIGN BELOW
2AC1	⊆	SUBSET WITH MULTIPLICATION SIGN BELOW
2AC2	⊇	SUPERSET WITH MULTIPLICATION SIGN BELOW
2AC3	⊆	SUBSET OF OR EQUAL TO WITH DOT ABOVE
2AC4	⊆	SUPERSET OF OR EQUAL TO WITH DOT ABOVE
2AC5	⊆	SUBSET OF ABOVE EQUALS SIGN
2AC6	⊆	SUPERSET OF ABOVE EQUALS SIGN
2AC7	⊆	SUBSET OF ABOVE TILDE OPERATOR
2AC8	⊆	SUPERSET OF ABOVE TILDE OPERATOR
2AC9	⊆	SUBSET OF ABOVE ALMOST EQUAL TO
2ACA	⊆	SUPERSET OF ABOVE ALMOST EQUAL TO
2ACB	⊆	SUBSET OF ABOVE NOT EQUAL TO
2ACC	⊆	SUPERSET OF ABOVE NOT EQUAL TO
2ACD	⊆	SQUARE LEFT OPEN BOX OPERATOR
2ACE	⊆	SQUARE RIGHT OPEN BOX OPERATOR
2ACF	⊆	CLOSED SUBSET → 2282 ⊂ subset of
2AD0	⊆	CLOSED SUPERSET → 2283 ⊃ superset of
2AD1	⊆	CLOSED SUBSET OR EQUAL TO
2AD2	⊆	CLOSED SUPERSET OR EQUAL TO
2AD3	⊆	SUBSET ABOVE SUPERSET
2AD4	⊆	SUPERSET ABOVE SUBSET
2AD5	⊆	SUBSET ABOVE SUBSET
2AD6	⊆	SUPERSET ABOVE SUPERSET
2AD7	⊆	SUPERSET BESIDE SUBSET
2AD8	⊆	SUPERSET BESIDE AND JOINED BY DASH WITH SUBSET

### Forks

2AD9	⊆	ELEMENT OF OPENING DOWNWARDS → 2208 ∈ element of
2ADA	⊆	PITCHFORK WITH TEE TOP → 22D4 ⊆ pitchfork
2ADB	⊆	TRANSVERSAL INTERSECTION → 22D4 ⊆ pitchfork
2ADC	⊆	FORKING • symbol is slashed although positive
2ADD	⊆	NONFORKING • symbol is negative although not slashed

### Tacks and turnstiles

2ADE	⊆	SHORT LEFT TACK → 22A3 ⊆ left tack
2ADF	⊆	SHORT DOWN TACK → 22A4 ⊆ down tack
2AE0	⊆	SHORT UP TACK → 22A5 ⊆ up tack
2AE1	⊆	PERPENDICULAR WITH S
2AE2	⊆	VERTICAL BAR TRIPLE RIGHT TURNSTILE = ordinarily satisfies
2AE3	⊆	DOUBLE VERTICAL BAR LEFT TURNSTILE → 22A9 ⊆ forces
2AE4	⊆	VERTICAL BAR DOUBLE LEFT TURNSTILE → 22A8 ⊆ true
2AE5	⊆	DOUBLE VERTICAL BAR DOUBLE LEFT TURNSTILE
2AE6	⊆	LONG DASH FROM LEFT MEMBER OF DOUBLE VERTICAL → 22A9 ⊆ forces
2AE7	⊆	SHORT DOWN TACK WITH OVERBAR → 22A4 ⊆ down tack → 2351 ⊆ apl functional symbol up tack overbar
2AE8	⊆	SHORT UP TACK WITH UNDERBAR → 22A5 ⊆ up tack → 234A ⊆ apl functional symbol down tack underbar
2AE9	⊆	SHORT UP TACK ABOVE SHORT DOWN TACK
2AEA	⊆	DOUBLE DOWN TACK
2AEB	⊆	DOUBLE UP TACK = independence • probability theory
2AEC	⊆	DOUBLE STROKE NOT SIGN → 00AC ⊆ not sign
2AED	⊆	REVERSED DOUBLE STROKE NOT SIGN → 2310 ⊆ reversed not sign

### Vertical line operators

2AEE	⊆	DOES NOT DIVIDE WITH REVERSED NEGATION SLASH → 2224 ⊆ does not divide
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2AEF	⋈	VERTICAL LINE WITH CIRCLE ABOVE
2AF0	⋇	VERTICAL LINE WITH CIRCLE BELOW
2AF1	⋉	DOWN TACK WITH CIRCLE BELOW
2AF2	∥	PARALLEL WITH HORIZONTAL STROKE → 2226 ∥ not parallel to
2AF3	∥̃	PARALLEL WITH TILDE OPERATOR
2AF4	≡	TRIPLE VERTICAL BAR BINARY RELATION = interleave → 2980 ≡ triple vertical bar delimiter
2AF5	≡	TRIPLE VERTICAL BAR WITH HORIZONTAL STROKE

### Miscellaneous math operator

2AF6	:	TRIPLE COLON • logic → 22EE : vertical ellipsis
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@@ 2980 Miscellaneous Math Symbols 29FF  
 @ Miscellaneous math symbols  
 2980 TRIPLE VERTICAL BAR DELIMITER  
 x (triple vertical bar binary relation - 2AF4)  
 2981 Z NOTATION SPOT  
 \* medium-sized filled circle  
 x (bullet operator - 2219)  
 x (black circle - 25CF)  
 2982 Z NOTATION TYPE COLON  
 x (tibetan sign rnam bcad - 0F7F)  
 @ Brackets  
 2983 LEFT WHITE CURLY BRACKET  
 2984 RIGHT WHITE CURLY BRACKET  
 2985 LEFT WHITE PARENTHESIS  
 2986 RIGHT WHITE PARENTHESIS  
 \* used for Bourbakist intervals  
 2987 Z NOTATION LEFT IMAGE BRACKET  
 2988 Z NOTATION RIGHT IMAGE BRACKET  
 2989 Z NOTATION LEFT BINDING BRACKET  
 298A Z NOTATION RIGHT BINDING BRACKET  
 298B LEFT SQUARE BRACKET WITH UNDERBAR  
 298C RIGHT SQUARE BRACKET WITH UNDERBAR  
 298D LEFT SQUARE BRACKET WITH TICK IN TOP CORNER  
 298E RIGHT SQUARE BRACKET WITH TICK IN BOTTOM CORNER  
 298F LEFT SQUARE BRACKET WITH TICK IN BOTTOM CORNER  
 2990 RIGHT SQUARE BRACKET WITH TICK IN TOP CORNER  
 2991 LEFT ANGLE BRACKET WITH DOT  
 2992 RIGHT ANGLE BRACKET WITH DOT  
 2993 LEFT ARC LESS-THAN BRACKET  
 2994 RIGHT ARC GREATER-THAN BRACKET  
 2995 DOUBLE LEFT ARC GREATER-THAN BRACKET  
 2996 DOUBLE RIGHT ARC LESS-THAN BRACKET  
 @ Fences  
 2999 DOTTED FENCE  
 \* four close dots vertical  
 299A VERTICAL ZIGZAG LINE  
 x (wavy line - 2307)  
 @ Angles  
 299B MEASURED ANGLE OPENING LEFT  
 x (measured angle - 2221)  
 299C RIGHT ANGLE VARIANT WITH SQUARE  
 x (right angle - 221F)  
 299D MEASURED RIGHT ANGLE WITH DOT  
 299E ANGLE WITH S INSIDE  
 299F ACUTE ANGLE  
 29A0 SPHERICAL ANGLE OPENING LEFT  
 x (spherical angle - 2222)  
 29A1 SPHERICAL ANGLE OPENING UP  
 29A2 TURNED ANGLE  
 x (angle - 2220)  
 29A3 REVERSED ANGLE  
 29A4 ANGLE WITH UNDERBAR  
 29A5 REVERSED ANGLE WITH UNDERBAR  
 29A6 OBLIQUE ANGLE OPENING UP  
 29A7 OBLIQUE ANGLE OPENING DOWN  
 29A8 MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING UP AND TO THE RIGHT  
 29A9 MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING UP AND TO THE LEFT  
 29AA MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING DOWN AND TO THE  
 RIGHT

29AB MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING DOWN AND TO THE LEFT  
 29AC MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING RIGHT AND UP  
 29AD MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING LEFT AND UP  
 29AE MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING RIGHT AND DOWN  
 29AF MEASURED ANGLE WITH OPEN ARM ENDING IN ARROW POINTING LEFT AND DOWN  
 @ Empty sets  
 29B0 REVERSED EMPTY SET  
     x (empty set - 2205)  
     x (apl functional symbol circle backslash - 2349)  
 29B1 EMPTY SET WITH OVERBAR  
 29B2 EMPTY SET WITH SMALL CIRCLE ABOVE  
 29B3 EMPTY SET WITH RIGHT ARROW ABOVE  
 29B4 EMPTY SET WITH LEFT ARROW ABOVE  
 @ Circle symbols  
 29B5 CIRCLE WITH HORIZONTAL BAR  
     x (circled minus - 2296)  
 29B6 CIRCLED VERTICAL BAR  
 29B7 CIRCLED PARALLEL  
 29B8 CIRCLED REVERSE SOLIDUS  
 29B9 CIRCLED PERPENDICULAR  
 29BA CIRCLE DIVIDED BY HORIZONTAL BAR AND TOP HALF DIVIDED BY VERTICAL BAR  
 29BB CIRCLE WITH SUPERIMPOSED X  
     x (circled times - 2297)  
 29BC CIRCLED ANTICLOCKWISE-ROTATED DIVISION SIGN  
 29BD UP ARROW THROUGH CIRCLE  
 29BE CIRCLED WHITE BULLET  
     x (circled ring operator - 229A)  
     x (apl functional symbol circle jot - 233E)  
     x (bullseye - 25CE)  
 29BF CIRCLED BULLET  
     x (fisheye - 25C9)  
 29C0 CIRCLED LESS-THAN  
 29C1 CIRCLED GREATER-THAN  
 29C2 CIRCLE WITH SMALL CIRCLE TO THE RIGHT  
 29C3 CIRCLE WITH TWO HORIZONTAL STROKES TO THE RIGHT  
 @ Square symbols  
 29C4 SQUARED RISING DIAGONAL SLASH  
     x (apl functional symbol quad slash - 2341)  
 29C5 SQUARED FALLING DIAGONAL SLASH  
     x (apl functional symbol quad backslash - 2342)  
 29C6 SQUARED ASTERISK  
 29C7 SQUARED SMALL CIRCLE  
     x (apl functional symbol quad circle - 233B)  
 29C8 SQUARED SQUARE  
 29C9 TWO JOINED SQUARES  
 @ Triangle symbols  
 29CA TRIANGLE WITH DOT ABOVE  
 29CB TRIANGLE WITH UNDERBAR  
 29CC S IN TRIANGLE  
 29CD TRIANGLE WITH SERIFS AT BOTTOM  
     x (white up-pointing triangle - 25B3)  
 29CE RIGHT TRIANGLE ABOVE LEFT TRIANGLE  
 29CF LEFT TRIANGLE BESIDE VERTICAL BAR  
 29D0 VERTICAL BAR BESIDE RIGHT TRIANGLE  
 @ Bowtie symbols  
 29D1 LEFT FILLED BOWTIE  
     x (bowtie - 22C8)  
 29D2 RIGHT FILLED BOWTIE  
 29D3 FILLED BOWTIE

29D4 LEFT FILLED TIMES  
 x (left normal factor semidirect product - 22C9)

29D5 RIGHT FILLED TIMES  
 x (right normal factor semidirect product - 22CA)

29D6 WHITE HOURGLASS  
 = vertical bowtie  
 = white framus  
 x (hourglass - 231B)

29D7 FILLED HOURGLASS  
 @ Miscellaneous math symbols

29DC INCOMPLETE INFINITY  
 = ISOTech entity &iinfin;  
 x (infinity - 221E)

29DD TIE OVER INFINITY

29DE INFINITY NEGATED WITH VERTICAL BAR

29DF DOUBLE-ENDED MULTIMAP  
 x (multimap - 22B8)

29E0 SQUARE WITH CONTOURED OUTLINE  
 = D'Alembertian  
 x (lower right drop-shadowed white square - 274F)

29E1 INCREASES AS  
 x (normal subgroup of or equal to - 22B4)

29E2 SHUFFLE PRODUCT  
 x (z notation bag membership - 22FF)

29E3 EQUALS SIGN AND SLANTED PARALLEL  
 x (number sign - 0023)  
 x (equal and parallel to - 22D5)

29E4 EQUALS SIGN AND SLANTED PARALLEL WITH TILDE ABOVE

29E5 IDENTICAL TO AND SLANTED PARALLEL  
 x (triple horizontal bar with double vertical stroke - 2A68)

29E7 THERMODYNAMIC  
 \* vertical bar crossed by two horizontals  
 x (not equal to - 2260)

29E8 DOWN-POINTING TRIANGLE WITH LEFT HALF BLACK  
 x (up-pointing triangle with left half black - 25ED)

29E9 DOWN-POINTING TRIANGLE WITH RIGHT HALF BLACK  
 x (up-pointing triangle with right half black - 25EE)

29EA FILLED DIAMOND WITH DOWN ARROW

29EB FILLED LOZENGE  
 x (lozenge - 25CA)

29EC CIRCLE WITH DOWN ARROW

29ED FILLED CIRCLE WITH DOWN ARROW  
 @ Error bar symbols

29EE ERROR-BARRED WHITE SQUARE

29EF ERROR-BARRED FILLED SQUARE

29F0 ERROR-BARRED WHITE DIAMOND

29F1 ERROR-BARRED FILLED DIAMOND

29F2 ERROR-BARRED WHITE CIRCLE

29F3 ERROR-BARRED FILLED CIRCLE  
 @ Miscellanous math symbols

29F4 RULE-DELAYED  
 = colon right arrow

29F5 SET DIFFERENCE  
 = ISOamsb entity &ssetmn; or &sbsol;  
 \* glyph is distinctively flatter than a reverse solidus or set minus  
 x (reverse solidus - 005C)  
 x (set minus - 2216)

29F6 SOLIDUS WITH OVERBAR

29F7 REVERSE SOLIDUS WITH HORIZONTAL STROKE

@           Large operators  
29F8   BIG SOLIDUS  
      x (division slash - 2215)  
29F9   BIG REVERSE SOLIDUS  
      = z notation schema hiding  
      x (set minus - 2216)

## Symbol variants defined using a Variation Selector (VS)

- 2268  $\nless$  + VS  $\rightarrow$   $\nlessv$  less-than and not double equal - with vertical stroke
- 2269  $\ngtr$  + VS  $\rightarrow$   $\ngtrv$  greater-than and not double equal - with vertical stroke
  
- 22DA  $\nlessgtr$  + VS  $\rightarrow$   $\nlessgtrv$  less-than above slanted equal above greater-than
- 22DB  $\ngtrless$  + VS  $\rightarrow$   $\ngtrlessv$  greater-than above slanted equal above less-than
- 2272  $\lesssim$  + VS  $\rightarrow$   $\lesssimslant$  less-than or similar - following the slant of the lower leg
- 2273  $\gtrsim$  + VS  $\rightarrow$   $\gtrsimslant$  greater-than or similar - following the slant of the lower leg
- 2A9D  $\approx$  + VS  $\rightarrow$   $\approxslant$  similar - following the slant of the upper leg - or less-than
- 2A9E  $\gtrapprox$  + VS  $\rightarrow$   $\gtrapproxslant$  similar - following the slant of the upper leg - or greater-than
- 2AAC  $\leqslant$  + VS  $\rightarrow$   $\leqslant$  smaller than or slanted equal
- 2AAD  $\geqslant$  + VS  $\rightarrow$   $\geqslant$  larger than or slanted equal
  
- 228A  $\subsetneq$  + VS  $\rightarrow$   $\subsetneq\text{-stroke}$  subset not equals - variant with stroke through bottom members
- 228B  $\supsetneq$  + VS  $\rightarrow$   $\supsetneq\text{-stroke}$  superset not equals - variant with stroke through bottom members
- 2ACB  $\subsetneqq$  + VS  $\rightarrow$   $\subsetneqq\text{-stroke}$  subset not two-line equals - variant with stroke through bottom members
- 2ACC  $\supsetneqq$  + VS  $\rightarrow$   $\supsetneqq\text{-stroke}$  superset not two-line equals - variant with stroke through bottom members
  
- 2A3B  $\lrcorner$  + VS  $\rightarrow$   $\lrcorner\text{-tall}$  interior product - tall variant with narrow foot
- 2A3C  $\llcorner$  + VS  $\rightarrow$   $\llcorner\text{-tall}$  righthand interior product - tall variant with narrow foot
  
- 2295  $\oplus$  + VS  $\rightarrow$   $\oplus\text{-white}$  circled plus with white rim
- 2297  $\otimes$  + VS  $\rightarrow$   $\otimes\text{-white}$  circled times with white rim
- 229C  $\ominus$  + VS  $\rightarrow$   $\ominus\text{-circle}$  equal sign inside and touching a circle
  
- 2225  $\parallel$  + VS  $\rightarrow$   $\parallel\text{-slanted}$  slanted parallel
- $\parallel$  + VS + 20E5  $\backslash$   $\rightarrow$   $\parallel\text{-reverse}$  slanted parallel with reverse slash
  
- \*\* • 222A  $\cup$  + VS  $\rightarrow$   $\cup\text{-serifs}$  union with serifs
- \*\* • 2229  $\cap$  + VS  $\rightarrow$   $\cap\text{-serifs}$  intersection with serifs
- \*\* • 2293  $\sqcap$  + VS  $\rightarrow$   $\sqcap\text{-serifs}$  square intersection with serifs
- \*\* • 2294  $\sqcup$  + VS  $\rightarrow$   $\sqcup\text{-serifs}$  square union with serifs

Notes:

- \*\* The shape is incorrect, owing to unavailability of a suitable font; the correct shape will be provided as soon as possible. The associated text correctly describes the desired shape.



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March 13, 2000

Ms. Barbara Beeton  
American Mathematical Society  
201 Charles Street  
Providence, RI 02901 2297  
USA  
Fax No. 001/401/331-3842

Ihre Zeichen

Ihr Schreiben vom

Unsere Zeichen

Datum

Dear Barbara Beeton:

In addition to disseminating mathematics electronically and in print, the German Mathematical Society (DMV) is actively involved in various activities concerning the presentation of mathematics on the Web. We are very unhappy about the current situation with regard to the encoding of mathematical symbols. In order for mathematics to be communicated effectively and accurately on the Web, there is a vital need for unambiguous encoding of mathematical notation so that there is no confusion to the reader as to what a text might mean. Mathematics, with its highly condensed symbolism and its trend to irredundant presentations, needs a very precise symbolism. The German Mathematical Society hopes that UNICODE can provide encoding that eliminates the ambiguity of the current schemes.

By glancing through the UNICODE proposals, my colleagues and I noticed that many symbols used in mathematical publishing do not occur in UNICODE, and thus, cannot be represented directly in many Web-based documents. We do hope that this situation can be changed so that mathematics can be communicated fluently on the Web.

I am writing this letter to you with the hope that you will be able to distribute it to the committees and persons involved and to make the position of the German Mathematical Society known to those responsible for the development of UNICODE. The German Mathematical Society would appreciate consideration of our point of view.

Sincerely

Gernot Stroth  
President of the German Mathematical Society

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**John Ewing, Executive Director**  
Phone: 401-455-4100, Email: jhe@ams.org

*March 15, 2000*

Mr. Mike Ksar  
1501 Page Mill Road  
MS: 5UL  
Palo Alto, CA 94304

Dear Mr. Ksar:

The mathematically-oriented scientific community uses various styles of letters and symbols to concisely represent functions, variables, operations and other mathematical objects that comprise the language of mathematics. This presents an especially subtle problem because two different styles of the same letter or symbol can have completely different meanings. Thus it is very important to the community that there is a universally accepted standard encoding for the various styles of letters and symbols it uses in its publications. If multiple versions of these were being used in the literature, rather than a universally accepted version, it would significantly complicate the communication between researchers, especially in the Web environment.

It is for this reason that the American Mathematical Society has devoted significant resources to gathering the documentation for alpha/numeric and mathematical symbols and submitting it to the Unicode Technical Committee for its acceptance. Now that this has been accomplished we hope very much that they will be accepted by WG2.

Sincerely yours,



John Ewing