LESSON 5

Read about this PROVISIONAL EDITION in the front matter to this book.

- *MORE ABOUT LETTERS*
  - *Variables*
  - *Roman Numerals*
  - *Non-Decimal Bases*
- *OTHER ALPHABETS*
- *ENCLOSED LISTS*
- *MORE ABOUT ENGLISH LETTERS*
- *MORE ABOUT ABBREVIATIONS*
- *CODE SWITCHING, cont.*

FORMAT

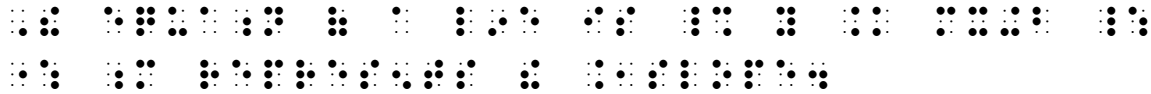
- *Keep Together—Enclosed List*

MORE ABOUT LETTERS

Variables

5.1 Mathematical Variables: An alphabetic character that represents an unspecified number is called a *variable*. Variables are usually printed in italics uniformly throughout a technical document or textbook. In both UEB and Nemeth braille, italics applied to a variable are disregarded unless other circumstances require the typeface to be retained.

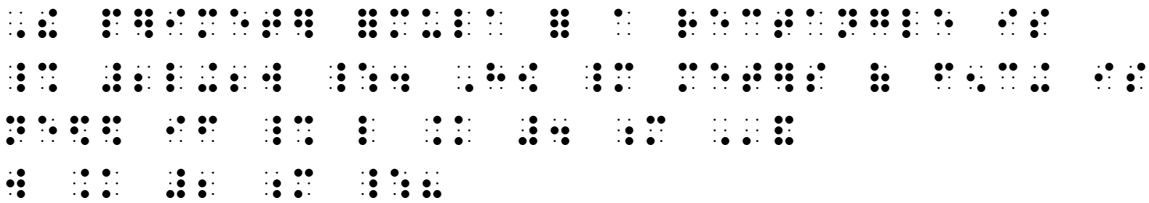
Example 5.1-1 The equation of a line is $y = mx + b$ where m represents the *slope*.



Reminder: Line 1 "y": The English letter indicator is not used when a "single letter" immediately precedes a sign of comparison. Line 2 "m": A freestanding letter may be brailled in UEB.

5.1.1 Abbreviation or Variable? The letter chosen to represent a variable is often based on the subject matter. In the next example, $2l + 2w$, the variables l and w represent unknown measurements for *length* and *width*. The letters l and w are chosen to aid in recognition of the parts of the formula, they are not abbreviations for the words length and width. Keep in mind that a variable represents a numerical value. A value will be "plugged into" the formula in place of the variable to come up with a solution. In contrast, an abbreviation represents a word—it has no numerical value. You can often answer the question "abbreviation or variable?" by noticing the typeform. In a formal publication, a variable will be printed in italics; an abbreviation will be in normal typeface.

Example 5.1-2 The perimeter formula for a rectangle is $2l + 2w$. How many meters of fencing is needed if $l = 4$ m and $w = 2$ m?



l and w are variables; m *is the abbreviation for "meters".*

PRACTICE 5A

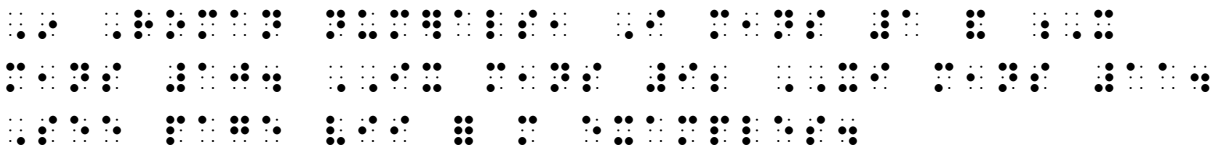
1. Express y in terms of x if $2x - 3y = 12$.
2. If $A = l \times l$, what is the length (l) of a side in inches if the area (A) of a square is 7.3 sq.ft.?
3. It is much easier to remember $A = lw$ (Area = length × width) than it is to remember $B = jt$ when trying to figure out how much carpet to buy for the living room.
4. What is the area A of trapezoid T with upper base $a = 3$ m, lower base $b = 6$ m, and height $h = 13$ m?

Roman Numerals

The BANA Mathematics Committee is discussing details regarding the treatment of isolated Roman numerals in narrative context. Correct transcriptions of the examples in this section will be confirmed after decisions are made. For now, follow these provisional guidelines.

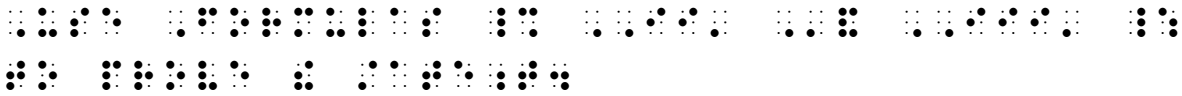
5.2 Letter or Numeral? Roman numerals are notated as certain capitalized and uncapitalized letters. Roman numerals can be brailled in UEB or in Nemeth Code, using context cues to decide whether or not to switch, just as you do with Arabic numerals. The first example below does not require code switching.

Example 5.2-1 In Roman numerals, I means 1 and X means 10. IX means 9; XI means 11. See page vii for more examples.



5.3 Transcribing Roman Numerals in Mathematical Context: When Roman numerals are part of a mathematical expression, or when a mathematical symbol is associated with a Roman numeral, a switch to Nemeth Code is required.

Example 5.3-1 Use Formulas II' and III' to prove the statement.



The presence of a prime sign requires a switch to Nemeth Code. See 4.1.1 regarding words labeling a mathematical item.

5.3.1 Roman Numerals Consisting of Lowercase Letters: In Nemeth Code, an English letter indicator (ELI) is used before *any lowercase* Roman numeral if the Roman numeral in braille is preceded by a space or by one or more punctuation marks <u>and</u> followed by a space or by one or more punctuation marks.

English Letter Indicator	⠰

⫸ i ii iii iv v

Use of the ELI with a lowercase Roman numeral follows the same rules that apply to the use of the ELI for any single English letter. In this regard, a lower-case Roman numeral is treated as "one letter" even when it consists of more than one letter. Application of these rules will be noted in the examples throughout this section.

5.3.2 Roman Numerals Consisting of One Capital Letter: In Nemeth Code, an English letter indicator (ELI) and a single capitalization indicator is used before a Roman numeral consisting of a *single capitalized* letter if the Roman numeral in braille is preceded by a space or by one or more punctuation marks <u>and</u> followed by a space or by one or more punctuation marks.

English Letter Indicator	⠰
Single Capitalization Indicator	⠠

⫸ I V X L C D M

The ELI is or is not used with single-letter uppercase Roman numerals according to the same rules that apply to the use/nonuse of the ELI for any single English letter. Application of these rules will be noted in the examples throughout this section.

5.3.3 Roman Numerals Consisting of Two or More Capital Letters: The double capitalization indicator of the Nemeth Code is used before a Roman numeral consisting of two or more unspaced capitalized letters.

Double Capitalization Indicator	⠠⠠

⫸ IV DC MMXVII

In mathematical context, an ELI is not used for Roman numerals consisting of two or more capital letters, even if the letter combination is the same as a shortform.

⫸ CD DCV

5.3.4 Punctuation with Roman Numerals: A Roman numeral is punctuated mathematically if the punctuation falls inside the switches. The presence of punctuation does not change the rules regarding use of the ELI.

⫸ "I, IV, V, MMXVI"

⫸ "i", "ii", "iii".

Example 5.3-2 In Roman numerals, “C” = 100, “L” = 50, and “ix” = 9.

An ELI is required for a single-letter Roman numeral and for a lowercase Roman numeral when preceded and followed by a punctuation mark.

Example 5.3-3 In Roman numerals, "CD" = 400 and "DCV" = 605.

Reminder: A multi-letter capitalized Roman numeral in Nemeth Code does not use an ELI even when the letter combination is the same as a shortform.

5.3.5 Nonuse of the English Letter Indicator with Roman Numerals: In Nemeth Code, the ELI is <u>not</u> used with a Roman numeral if the numeral ...

i. ... consists of two or more unspaced capitalized letters in regular type;

⫸ II III VIII XV

ii. ... immediately precedes or follows a sign of comparison;

⫸ X = 10

⫸ 1000 = M

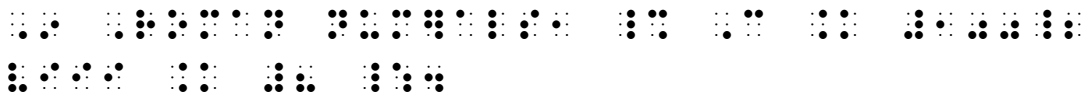
iii. ... is in an expression consisting of a sequence of unspaced mathematical symbols.

⫸ ix − v = iv

iv. ... is entirely enclosed between grouping signs.

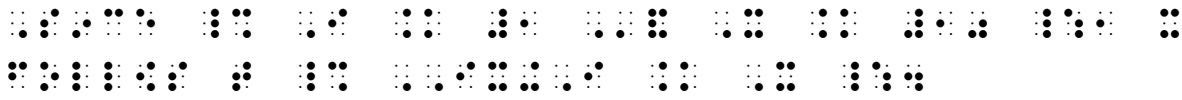
⫸ (ii)

Example 5.3-4 In Roman numerals, C = 100; viii = 8.



No ELIs: The Roman numerals immediately precede a sign of comparison (Reason ii).

Example 5.3-5 Since I = 1 and X = 10, it follows that IX + I = X.



In $IX + I$, notice that "I" has its own capitalization indicator. Also note that IX and I are unspaced from the plus sign, following the same spacing rules for numerals and a sign of operation. No ELIs: Four of the Roman numerals immediately precede or immediately follow a sign of comparison (Reason ii); "IX" is in an expression consisting of a sequence of unspaced mathematical symbols (Reason iii).

5.3.6 Possessive Endings: When a Roman numeral has a possessive ending, the ELI is used or is not used as though the ending was not present.

- v's
- X's
- xix's and XIX's

The BANA Mathematics Committee is discussing details regarding plural and ordinal endings with Roman numerals. This section will be completed after decisions are made.

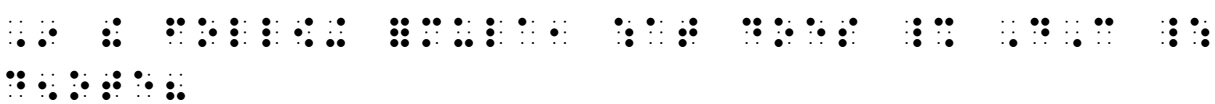
5.3.7 Large Roman Numerals: Roman numerals starting with 5,000 include a line over the numeral in print. This notation will be discussed in a later lesson.

5.4 Roman Numerals Used as Identifiers: Identifiers are transcribed according to the rules for the code in use. Compare these isolated examples of Roman numeral identifiers, noting the use of indicators and the construction of the punctuation or grouping symbols.

	UEB	Nemeth Braille
i.		
ii.		
(i)		
(ii)		

5.5 Mathematical Letter Combinations Similar to Roman Numerals: When it is unclear whether a mathematical letter combination is a Roman numeral, the combination is treated as if it were not a Roman numeral. In such cases, the letters are treated individually, and the ELI is used or is not used in accordance with the rules for English letters.

Example 5.5-1 In the following formula, what does DC denote?



Example 5.5-2 div has special meaning.

PRACTICE 5B

i. Triangle ABC in Quadrant IV is reflected in Quadrant III as Triangle A'B'C'.

ii. $\mathrm{iv} + \mathrm{vi} = \mathrm{x}$

iii. $\mathrm{X} = 10$, $\mathrm{L} = 50$, $\mathrm{C} = 100$, and $\mathrm{D} = 500$.

iv. Review items v and vi.

v. Explain why $\mathrm{MC} = 1100$, but $\mathrm{CM} = 900$.

vi. Read items $\mathrm{i}, \mathrm{i}', \mathrm{ii}$, and ii'.

Non-Decimal Bases

5.6 Letters Used to Represent Numerals in Non-Decimal Bases: When a system of numeration is to a base larger than 10, additional digits are devised to represent digits beyond the ten Arabic numerals. A common technique for providing additional digits is to use letters. For example, in base 12 "t" or "T" may represent ten and "e" or "E" may represent eleven. These letters do not function as letters – they are digits and are indicated as such by use of the numeric indicator. Only uncapitalized letters are used in braille, even when capital letters are used to represent non-decimal numerals in print.

- t or T ⠼⠞
- e or E ⠼⠑

The rules regarding the use (or nonuse) of the numeric indicator for non-decimal digits are the same as the rules for the ten Arabic numerals 0 through 9. Numerals in non-decimal bases are mathematical symbols and are punctuated accordingly.

Example 5.6-1 Counting in base twelve: 0 1 2 3 4 5 6 7 8 9 T E. 13T8 and T1E5 are base 12 numerals.

⠉⠕⠥⠝⠞⠊⠝⠛ ⠊⠝ ⠃⠁⠎⠑ ⠞⠺⠑⠇⠧⠑⠲ ⠼⠁⠉ ⠼⠁⠞ ⠼⠁⠃ ⠼⠁⠙ ⠼⠁⠑ ⠼⠁⠋
⠼⠁⠛ ⠼⠁⠓ ⠼⠁⠊ ⠼⠁⠚ ⠼⠁⠅ ⠼⠁⠇ ⠼⠁⠍ ⠼⠁⠝ ⠼⠁⠕ ⠼⠁⠏
⠼⠁⠞⠼⠓⠼⠁⠓ ⠼⠁⠞ ⠼⠁ ⠼⠁⠞⠼⠁ ⠼⠁⠞⠼⠑ ⠼⠁⠞⠼⠑⠼⠑⠼⠑⠼⠑⠼⠑

5.6.1 Transcriber's Note Required: If the print copy uses capital letters, a transcriber's note is required to inform the reader of a change in capitalization in the braille transcription. Transcriber's notes are written outside of the Nemeth Code switch indicators, following UEB rules. The note itself can contain mathematical material, in which case code switching occurs within the note, but Nemeth Code must be terminated before the closing transcriber's note indicator is brailled.

Example 5.6-2 Digits t and e are represented by capital letters T and E in print.

⠠⠠⠙⠊⠛⠊⠞⠎ ⠞ ⠁⠝⠙ ⠑ ⠁⠗⠑ ⠁⠗⠑ ⠉⠁⠏⠊⠞⠁⠇ ⠇⠑⠞⠞⠑⠗⠎
⠠⠠⠏⠗⠊⠝⠞⠲⠲⠲ ⠞ ⠁⠝⠙ ⠑ ⠁⠗⠑ ⠁⠗⠑ ⠉⠁⠏⠊⠞⠁⠇ ⠇⠑⠞⠞⠑⠗⠎
⠠ ⠠⠠⠏⠗⠊⠝⠞⠲⠲⠲

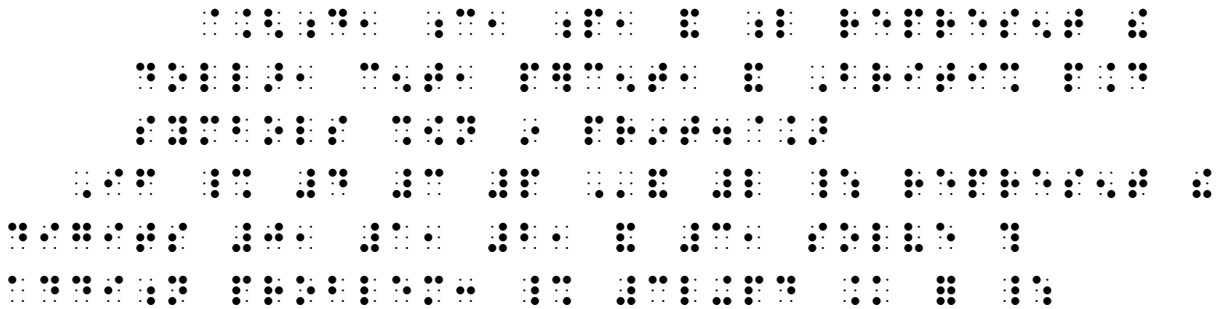
Or simply ...

Example 5.6-3 t and e are capitalized in print.

⠠⠠⠞ ⠁⠝⠙ ⠑ ⠁⠗⠑ ⠁⠗⠑ ⠠⠠⠉⠁⠏⠊⠞⠁⠇⠊⠵⠑⠙ ⠊⠝ ⠠⠠⠏⠗⠊⠝⠞⠲⠲⠲

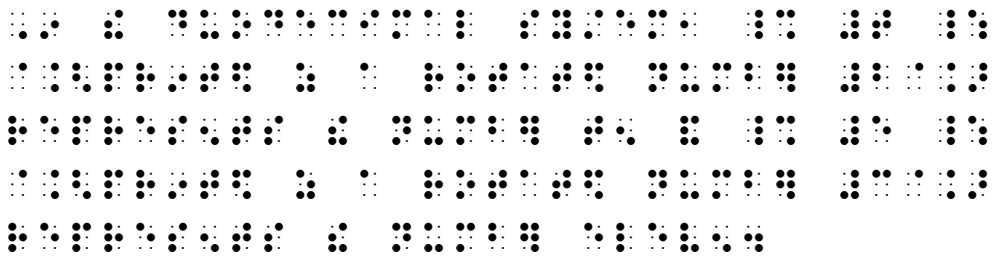
5.7 Non-Alphabetic Symbols Used to Represent Numerals: If symbols other than letters represent digits, the transcriber should choose one-cell symbols to represent the special signs. The preferred method is to select letters of the English alphabet in a similar manner as described above. A transcriber's note must specify the meanings assigned to these letters.

Example 5.7-1 If $ ¢ % and £ represent the digits 0, 1, 2, and 3, solve this addition problem: ¢£ + %$ = ?



If the print sign lacks a symbol in the Code, the transcriber's note should include a drawing or a description in order to identify it.

Example 5.7-2 In the duodecimal system, Ƨ represents the number ten and Ɛ represents the number eleven.



The two print symbols are described in embedded transcriber's notes:"printed as a rotated number 2 " and "printed as a rotated number 3 ".

PRACTICE 5C

I. In the hexadecimal system (base 16), the number "one thousand" is written as 3e8.
II. Convert hex 7a1 to decimal numeration.

OTHER ALPHABETS

5.8 Alphabetic Indicators: The language of mathematics uses letters from more than just the English (Roman) alphabet. Specific provision is made in the Nemeth Code for the transcription of the letters of the German, Greek, Hebrew, and Russian (Cyrillic) alphabets. Each alphabet has a unique alphabetic indicator.

5.8.1 Code Switching and Use of Letter Indicators: The English letter indicator was introduced in Lesson 4. Recall that switching to Nemeth Code to braille an English letter is not always required, and that the Nemeth Code English letter indicator may be omitted in certain circumstances. *In contrast, an alphabetic indicator is always required to identify a letter from the German, Greek, Hebrew, or Russian alphabets and a switch to Nemeth Code is always required for such letters even if UEB has a symbol for the letter.*

5.8.2 Capitalization and Punctuation: When a letter from any alphabet is capitalized in Nemeth Code, the capitalization indicator (dot 6) is placed between the alphabetic indicator and the letter. Letters are individually capitalized—the effect of the capitalization indicator extends only to the letter which follows it. In a technical transcription, letters from the German, Greek, Hebrew, and Russian alphabets are mathematical symbols and so are punctuated mathematically when the punctuation falls within the Nemeth Code switch.

Certain letters have unique mathematical applications. If you are unsure of a letter, find an expert who can identify it. Do not guess.

The Greek Alphabet

5.9 Greek Alphabet: Many letters from the Greek alphabet are used in mathematics and science. The following indicator identifies a letter as being from the Greek alphabet.

Greek Letter Indicator (standard form)	⠨

This symbol is read as the Greek letter indicator only when immediately followed by a letter or by the capitalization indicator and a letter. The Nemeth Code table of Greek letters is reproduced on the next page.

GREEK ALPHABET TABLE

Name of letter	Regular uncapitalized	Regular capitalized	Alternative form
alpha	α	Α	∝
beta	β	Β	ϐ
gamma	γ	Γ	
delta	δ	Δ	
epsilon	ϵ	Ε	
zeta	ζ	Ζ	
eta	η	Η	
theta	θ	Θ	ϑ
iota	ι	Ι	
kappa	κ	Κ	
lambda	λ	Λ	
mu	μ	Μ	
nu	ν	Ν	
xi	ξ	Ξ	
omicron	ο	Ο	
pi	π	Π	
rho	ρ	Ρ	
sigma	σ	Σ	ς
tau	τ	Τ	
upsilon	υ	Υ	
phi	ϕ	Φ	φ
chi	χ	Χ	
psi	ψ	Ψ	
omega	ω	Ω	
sampi	ϡ		
stigma	ϛ		
vau	Ϝ		
koph (qoph)	Ϙ		

5.9.1 Code Switching with Greek Letters: Even though the uncapitalized form of the Greek letters in Nemeth Code is identical to the uncapitalized form in UEB, you must switch to Nemeth Code when a Greek letter appears in a technical transcription, even in narrative context. Greek letters used in the following examples are listed in the box below. Notice the placement of the capitalization indicator in the two capitalized letters. As stated in **5.8.2**, the capitalization indicator is placed *between* the alphabetic indicator and the letter.

Delta	Δ	⠨⠠⠙
pi	π	⠨⠏
Sigma	Σ	⠨⠠⠎
theta	θ	⠨⠹

Example 5.9-1 The Greek letter θ (theta) represents a plane angle in geometry.

⠠⠮ ⠠⠛⠗⠑⠑⠅ ⠇⠗ ⠹⠩ ⠨⠹ ⠹⠲ ⠐⠣⠮⠛⠁⠐⠜
⠗⠑⠏⠗⠑⠎⠢⠛⠎ ⠁ ⠏⠇⠁⠝⠑ ⠁⠝⠛⠇⠑ ⠔ ⠛⠑⠕⠍⠑⠞⠗⠽⠲

Example 5.9-2 $\pi < 0 < 2\pi$

⠹⠩ ⠨⠏ ⠐⠅ ⠼⠴ ⠐⠅ ⠼⠆⠨⠏ ⠹⠲

Example 5.9-3 Find the button marked "π" on your calculator.

⠠⠋⠔⠙ ⠮ ⠳⠥⠞⠞⠕⠝ ⠍⠜⠅⠫ ⠹⠩ ⠧⠨⠏⠹⠴ ⠹⠲ ⠕⠝ ⠽⠗
⠉⠁⠇⠉⠥⠇⠁⠞⠕⠗⠲

Greek letters are mathematical symbols and so are punctuated mathematically.

5.9.2 Alternate Form of Greek Letters: The Greek alphabet table shows an alternate uncapitalized print form for five of the Greek letters. The following indicator is used to identify the alternate forms.

Greek Letter Indicator (alternate form)	⠨⠈

The alternative form is used in braille <u>only when both forms</u>—standard and alternative—appear in the same print text. If a Greek letter is represented by its alternative form *instead of* its standard form throughout the print text—that is, only one form of the letter is used throughout—the symbol for the standard form is used in braille. Include a transcriber's note at the beginning of the text to inform the reader of the change in braille usage. For example,

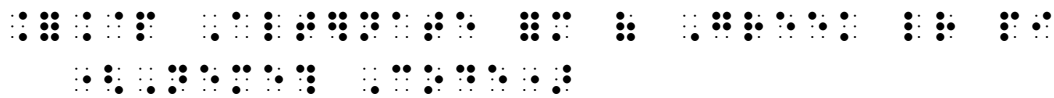
Example 5.9-4 *(Suggested wording for the Transcriber's Notes page is shown below.)*

The alternate form of the Greek letter theta is used exclusively in print.
In braille, the standard form is used.

If a text shows an alternate form of a Greek letter that does not appear in the table, follow the guidelines above to determine if you should substitute the regular form or if you should use the alternate Greek letter indicator. If the alternate form is used, list those symbols on the Special Symbols page since they do not appear in the Nemeth Code. For example, here are four alternate forms that do not appear in the braille table:

epsilon ε kappa $\varkappa$ pi ϖ rho ϱ

Example 5.9-5 (Special Symbols page)



If the letter's identity is not clear from context, consult an expert in the field in order to determine its designation.

PRACTICE 5D

Δx means "the change in x" and Δy means "the change in y". When x increases by Δx, y increases by Δy as expressed in the equation $y = \Delta y = f(x + \Delta x)$.

Although the handwritten form of phi (φ) may be found in source materials, only the standard form (ϕ) is used in this book.

The German Alphabet

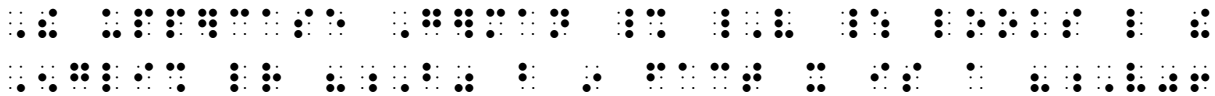
5.10 German Alphabet: German letters used as mathematical symbols must be brailled in Nemeth Code. The following indicator is used to identify a letter as being from the German alphabet.

German Letter Indicator	⠰

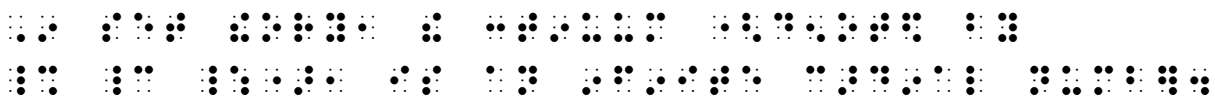
German letters are most commonly encountered in specialized fields of mathematics and science. Refer to the table of German letters in *The Nemeth Code for Mathematics and Science Notation* to determine the identity of the letter and see its braille equivalent. Three examples are shown below.

tseh	$\mathfrak{c}$	⠰⠉	**gheh**	$\mathfrak{g}$	⠰⠛	**Veh**	$\mathfrak{V}$	⠰⠧⠲

Example 5.10-1 The uppercase German $\mathfrak{V}$ looks like the English letter "B" but in fact it is a "V"!



Example 5.10-2 In set theory, the continuum (denoted by $\mathfrak{c}$), is an infinite cardinal number.



German letters may be encountered in the study of set theory.

The German letter is sometimes associated with the same letter from the Roman (English) alphabet, which may help you identify it.

Example 5.10-3 $\mathfrak{g} = \mathrm{Lie}(G)$

German letters may be encountered in the study of Lie algebra.

The Hebrew Alphabet

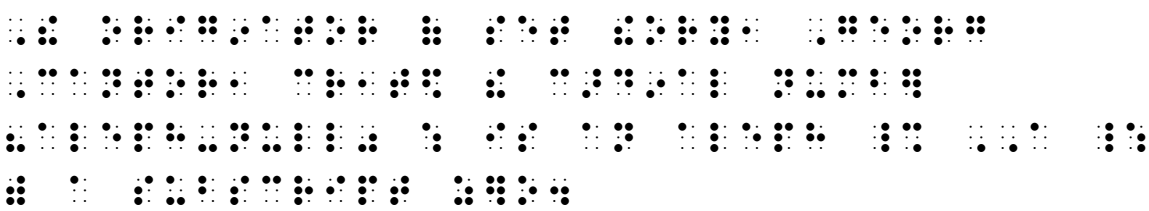
5.11 Hebrew Alphabet: Hebrew letters used as mathematical symbols must be brailled in Nemeth Code. The following indicator is used to identify a letter as being from the Hebrew alphabet.

Hebrew Letter Indicator	⠨⠨

The Hebrew alphabet has no capitalized form. The letter most commonly-encountered in technical material is the aleph: $\aleph$ The aleph is usually written with a subscript, and so will be further discussed in the lesson on level indicators. For a complete list of the Hebrew letters and their braille equivalents, see *The Nemeth Code for Mathematics and Science Notation*.

aleph	$\aleph$	⠨⠨⠁

Example 5.11-1 The originator of set theory, Georg Cantor, created the cardinal number "aleph-null" which is an aleph $\aleph$ with a subscript zero.



The Russian Alphabet

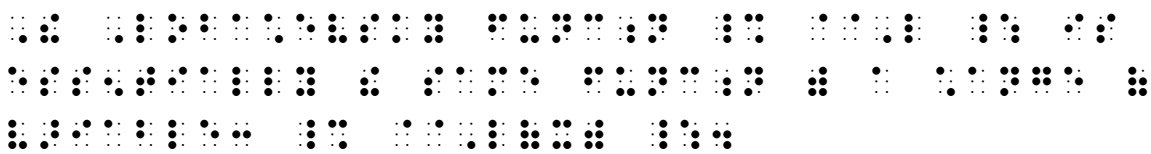
5.12 Russian Alphabet: Russian (Cyrillic) letters used as mathematical symbols must be brailled in Nemeth Code. The following indicator is used to identify a letter as being from the Russian alphabet.

Russian (Cyrillic) Letter Indicator	⠨⠨

Two Cyrillic letters in common usage are Sha which is used in number theory and Ell (also the lowercase ell) which is used in hyperbolic geometry. The Sha usually keeps company with bold and double-struck letters, and so will be further discussed in Lesson 7. For a complete list of the Cyrillic letters and their braille equivalents, see *The Nemeth Code for Mathematics and Science Notation.*

ell	л	⠨⠨⠇
Ell	Л	⠨⠨⠠⠇
Sha	Ш	⠨⠨⠠⠱

Example 5.12-1 The Lobachevsky function Л is essentially the same function with a change of variable: Л(x).



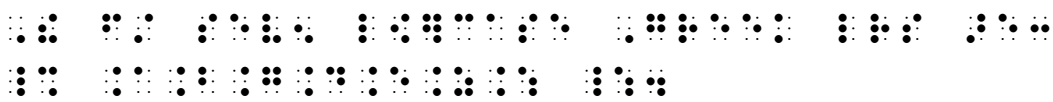
Use the Russian alphabet table in your Nemeth Braille codebook to determine how to braille the Cyrillic letters in sentence 2.

PRACTICE 5E

1) Be sure to differentiate between the Cyrillic letters "ell" л and "Ell" Л and the Greek letters "pi" π and "Pi" П.
2) The first ten uncapitalized Cyrillic letters are: ah а, beh б, veh в, gheh г, deh д, yeh е, zheh ж, zeh з, ee и, and kah к.

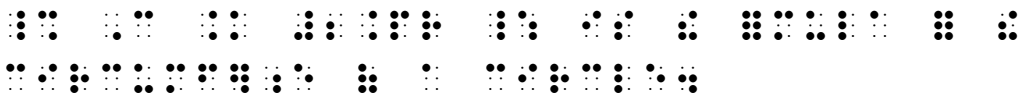
5.13 A Sequence of Unspaced Letters: The effect of an alphabetic indicator extends only to the letter which follows it. Thus, in a sequence of unspaced letters from non-Roman alphabets, the appropriate alphabetic indicator is used before each letter.

Example 5.13-1 The first seven lowercase Greek letters are: $\alpha\beta\gamma\delta\varepsilon\zeta\eta$.

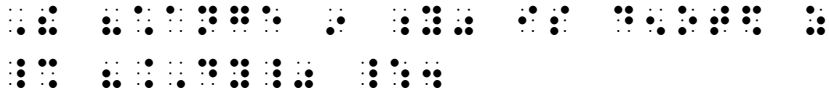


An English letter in regular type which appears in an unspaced sequence of terms does not require a letter indicator.

Example 5.13-2 $C = 2\pi r$ is the formula for the circumference of a circle.



Example 5.13-3 The "change in y" is denoted as "Δy".



5.13.1 Derivatives: The English letter combinations "dx", "dy", etc. often used in differential notation are usually spaced away from surrounding characters in print in order to enhance recognition. The space is omitted in braille unless another Nemeth Code rule requires a space. Print may show the letter d in italics or in regular type; either way, the letter is not italicized in braille.

Example 5.13-4 $(x + y)\,\mathrm{d}x\,\mathrm{d}y =$ ___

In print there is a space before each "d".

5.14 Mathematical Constant: A mathematical constant is a special number whose value is non-varying ("constant") and is represented by a certain alphabetic character. Two common examples are the Greek lower-case pi π and the English letter *i*. Constants are usually printed in italics uniformly throughout a technical document. In both UEB and Nemeth braille, constants are brailled as regular type unless other circumstances require the typeface to be maintained. (Typeforms are presented in a later lesson.)

Example 5.14-1 $i(a + bi) = -b + ai$

Example 5.14-2 $C = 2\pi r + \pi\Delta r$

Revisiting Code-Switching Considerations: Placement of code switches is the challenge in this practice. Apply normal (3-1) paragraphing margins to each sentence in the practice. Judicious placement of code switches will result in clarity for the reader. After brailling each sentence, write down your reasons for switching where you did. Then compare your decisions to the answer key and commentary at the end of the lesson.

PRACTICE 5F

Variables a and b are inversely related.

There exists a constant N such that no bit of Ω after the Nth can be proven to be 1 or 0.

Randall replied, "$12-n, 11-n, 10-n$ ... which is correct?"

"$12-n, 11-n, 10-n, \ldots$"

Which is correct: "$4x+3y$," "$3x+4y$," or "$4x+4y$"?

What is the remainder when 101 is divided by 3 ($101 \div 3$)?

The result is $(ax+by)(cx+dy)$, where all components are real.

($4x+3y$ is the denominator.)

ENCLOSED LISTS

5.15 SPECIAL CASE—Definition of "Enclosed List" Special provision is made for the transcription of a sequence of mathematical items enclosed within grouping signs. All of the following must be true in order to apply this rule.

i. The sequence must begin and end with a sign of grouping. The grouping signs do not have to be of the same kind.

ii. The list must have at least two items and the items must be separated by commas.

iii. An item of the list may be any sign used for omission – for example, an ellipsis or a long dash.

iv. The list cannot contain any punctuation mark other than the separating commas. (The omission ellipsis or long dash are not considered to be punctuation.)

v. The list cannot contain any words, abbreviations, ordinal endings, or plural endings.

vi. The list cannot contain a sign of comparison.

An enclosed list must be brailled in Nemeth Code, within the code switches, even if the items in the list are simple numerals or letters. The enclosure symbols are part of the mathematical notation, using the appropriate Nemeth Code grouping symbols.

5.15.1 Nonuse of the Numeric Indicator in an "Enclosed List": A numeric indicator is not used before a numeral or before a decimal point and a numeral in an "enclosed list".

Example 5.15-1 $\{2, 4, 6, 8\}$

Example 5.15-2 $(-3.1, -2, -.9, 0, .9, 2, 3.1)$

Example 5.15-3 Consider the set $\{5 + 5, 10 + 10\}$.

Example 5.15-4 $(5, 12]$ means do **not** include 5, but **do** include 12.

The next two examples do not satisfy the definition of an "enclosed list". A numeric indicator is brailled where required.

Example 5.15-5 Create two different sets from these numbers: [3, 4, 5; .3, .4, .5]

This is not an "enclosed list" because a semicolon is used. A numeric indicator is required before all but the first numeral.

Example 5.15-6 To show the probability of spinning a 3 and a 7, calculate P(3 and 7).

This is not an "enclosed list" because there are no commas and because it contains a word. A numeric indicator is required before the numeral 7. The word "and" has mathematical significance and so is brailled in Nemeth Code without contractions.

5.15.2 Nonuse of the English Letter Indicator in an "Enclosed List": In an "enclosed list", the English letter indicator is not used with any English letter or combination of letters in regular type.

Example 5.15-7 $(\mathrm{a}, 2\mathrm{x}, \ldots, \mathrm{b}, ab)$

Example 5.15-8 Write the coordinates of the points as ordered pairs (x, y).

The ELI is not used with a Roman numeral in regular type.

Example 5.15-9 (i, ii, iii, iv)

⠷⠊⠂ ⠊⠊⠂ ⠊⠊⠊⠂ ⠊⠧⠷

A letter from another alphabet must retain the appropriate alphabetic indicator in an "enclosed list".

Example 5.15-10 (α, a, β, b)

⠷⠨⠁⠂ ⠁⠂ ⠨⠃⠂ ⠁⠷

The Greek letters alpha and beta are in this enclosed list.

Note: There are situations where a numeric indicator or an English letter indicator is required in an enclosed list. More information will be in the lessons on functions and shapes.

FORMAT

5.15.3 Keep Together: Items in an enclosed list must not be divided between braille lines if the entire list will fit on a single braille line.

Example 5.15-11 Fill in the missing numerals: $(1, 3, ?, ?, 9)$

⠠⠋⠊⠇⠇ ⠊⠝ ⠞⠓⠑ ⠍⠊⠎⠎⠊⠝⠛ ⠝⠥⠍⠑⠗⠁⠇⠎⠲
⠷⠁⠂ ⠉⠂ ⠢⠂ ⠔⠂ ⠔⠂ ⠊⠷

Example 5.15-12 The replacement set is $\{m, n, o, p, q, r, s, t, u, v\}$.

⠠⠞ ⠗⠑⠏⠇⠁⠉⠑⠍⠑⠝⠞ ⠎⠑⠞ ⠊⠎ ⠷
⠍⠂ ⠝⠂ ⠕⠂ ⠏⠂ ⠟⠂ ⠗⠂ ⠎⠂ ⠞⠂ ⠥⠂ ⠧⠷⠲

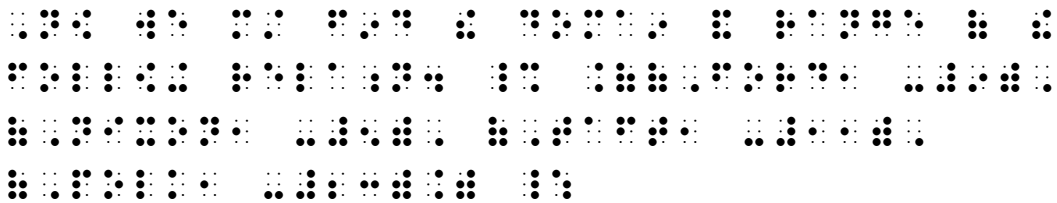
5.15.3.a Division Between Lines: If the enclosed list will not fit on a single braille line, use as much of the current line as possible and begin a runover line after a comma. When the items in an enclosed list must be divided between braille lines, neither the numeric indicator nor the English letter indicator is used before the runover on the new line.

Example 5.15-13 Does $\{\ldots, -4, -3, -2, -1, 0, 1, 2, 3, 4, \ldots\}$ represent a set of integers?

⠠⠓⠁⠎ ⠠⠊⠞ ⠠⠓⠑⠏⠗⠑⠎⠑⠝⠞⠑⠙ ⠁ ⠎⠑⠞ ⠕⠋ ⠠⠊⠝⠞⠑⠛⠑⠗⠎⠲
⠠⠊⠞ ⠕⠂ ⠠⠊⠝⠞⠑⠛⠑⠗⠎ ⠠⠊⠞ ⠠⠓⠁⠎ ⠠⠊⠝⠞⠑⠛⠑⠗⠎ ⠠ ⠠⠊⠞ ⠠
⠠⠊⠞⠓⠑⠗⠑⠲

Although the next example is not an "enclosed list" according to the Nemeth Code (it contains words), rules regarding division between braille lines are followed.

Example 5.15-14 Now we must find the domain and range of the following relation:
{(Ford, –9), (Nixon, –5), (Taft, –11), (Polk, –23)}



Even though "(Polk," will fit on line 3, the pair enclosed in parentheses "(Polk, –23)" is kept together on one braille line.

Instructions: First determine if each item is or is not an "enclosed list". Write YES if the item is an "enclosed list" and NO if it is not. Then transcribe the entire practice using Nemeth Code throughout.

PRACTICE 5G

{a, b, c, d}

(−1, −2, −3)

(h ft, k in)

(ab, cd, ef)

1, i, −1, −i

(1, i, 2, ii)

(1st, 2nd, 3rd)

(A, A', B, B', C)

{___, .3, .5, .7, ___}

(1 + h, 2 + k, 0)

(x = 1, 2, ..., 10)

(a, b]

(1 2 3)

[0, 1]

(u, v; x, y)

{(Denver, 19), (Utah, 27), (Minnesota, 24), (San Antonio, 28)}

(a, b, ...)

(x + 1, x + 2, ?, ?, x + 5)

<−1, 0]

(2, 4, 6, ___, 10)

(0, a, 1, b, 2)

{1's, 2's, 3's}

MORE ABOUT ENGLISH LETTERS

5.16 English Letters and Grouping Symbols: In Lesson 4 you learned that the ELI is not needed when a "single letter" or a letter grouping that corresponds to a shortform is enclosed between mathematical grouping symbols.

⫸ (c) ⠷⠉⠾ *compare to* "c" ⠦⠰⠉⠸⠴

⫸ (alm) ⠷⠁⠇⠍⠾ *compare to* "alm" ⠦⠰⠁⠇⠍⠸⠴

However, when a "single letter" or a letter grouping that corresponds to a shortform is in direct contact with only its opening or only its closing grouping sign, and the letter is not an item in an "enclosed list" as defined above, rules regarding the English letter indicator are applied as though the grouping sign was not present.

Example 5.16-1 $(k = 1, 2, \ldots, n)$.

⠸⠩ ⠷⠅ ⠨⠅ ⠼⠂⠠ ⠼⠆⠠ ⠄⠄⠄⠠ ⠰⠝⠾ ⠸⠱⠲

Without the opening parenthesis, the letter k would not need an ELI because it is followed by an equals sign. Without the closing parenthesis, the letter n would need an ELI because it is preceded by a space and followed by punctuation.

Example 5.16-2 Consider the set $\{m \text{ and } n\}$.

⠠⠒⠎⠊⠙⠻ ⠮ ⠎⠑⠞ ⠸⠩ ⠨⠷⠰⠍ ⠁⠝⠙ ⠰⠝⠨⠾ ⠸⠱⠲

Without the opening brace, the letter m would need an ELI because it is preceded and followed by a space. Without the closing brace, the letter n would need an ELI because it is preceded by a space and followed by punctuation. Set notation is mathematical and so a switch to Nemeth Code is required. The word "and" is part of the math.

Example 5.16-3 If two events are mutually exclusive we write $P(A \text{ and } B) = 0$ where $P(A \text{ and } B)$ means "the probability of A and B occurring at the same time".

⠠⠊⠋ ⠞⠺⠕ ⠑⠧⠢⠞⠎ ⠜⠑ ⠍⠥⠞⠥⠁⠇⠇⠽ ⠑⠭⠉⠇⠥⠎⠊⠧⠑ ⠺⠑
⠺⠗⠊⠞⠑ ⠸⠩ ⠠⠏⠷⠠⠁ ⠁⠝⠙ ⠠⠃⠾ ⠨⠅ ⠼⠴ ⠠⠄⠐⠱
⠠⠏⠷⠠⠁ ⠁⠝⠙ ⠰⠠⠃⠾ ⠸⠱ ⠍⠂⠝⠎ ⠦⠮ ⠏⠗⠕⠃⠁⠃⠊⠇⠰⠽ ⠷
⠠⠁ ⠯ ⠰⠠⠃ ⠕⠒⠥⠗⠗⠬ ⠁⠞ ⠮ ⠎⠁⠍⠑ ⠐⠞⠴⠲

Line 2: Without the opening parenthesis, the letter A would not need an ELI because it immediately follows the letter P. Without the closing parenthesis, the letter B would not need an ELI because it is followed by a comparison sign.
Line 3: Without the opening parenthesis, the letter A would not need an ELI because it immediately follows the letter P. Without the closing parenthesis, the letter B would need an ELI because it is preceded and followed by a space.
Line 4: Letters A and B follow the rules of UEB in the narrative.

The same rule applies to a Roman numeral that is in direct contact with only an opening or closing grouping sign. The ELI is be used or is not used as though the grouping sign was absent. The following example illustrates Roman numerals used as identifiers, assuming uninterrupted mathematical context.

- i)
- iv)
- v)

If the grouping sign includes a prime or other modifying symbol, the ELI is not used with the single English letter that touches the (modified) grouping symbol.

- t]'

Example 5.16-4 t]' and v]' have unique meaning.

The same rule applies to Roman numerals – if the grouping sign carries a prime sign, the Roman numeral is now considered to be part of an unspaced mathematical expression even if the context is not mathematical.

Example 5.16-5 Read sections X) and X)′.

Switch Decision: To maintain consistency, both section numbers are brailled inside the switches.

5.17 English Letters and Endings: When a "single letter" or a letter grouping that corresponds to a shortform has a plural, possessive or ordinal ending, in mathematical context the ELI rules of the Nemeth Code are applied as though such endings were not present. The following examples illustrate proper use of the ELI, assuming mathematical context. Note that the expressions are punctuated mathematically. The presence of a plural, possessive, or ordinal ending does not change the fact that the punctuation mode is mathematical.

Plural:

- ps, qs, rs

  Think: p, q, r – ELI is required

- Xs, Ys, Zs

  Think: X, Y, Z – ELI is required

Possessive: *Reminders: A punctuation indicator is required before an apostrophe; otherwise dot 3 is read as a prime sign. The ELI is not used with the letter "s" when it is part of the apostrophe-s combination.*

- p's, q's, r's

  Think: p, q, r – ELI is required

- X's, Y's, Z's ⠠⠭⠄⠎ ⠠⠽⠄⠎ ⠠⠵⠄⠎

  Think: X, Y, Z – ELI is required

Ordinal:

- nth, 2nth ⠝⠞⠓ ⠼⠃⠝⠞⠓

  Think: n – ELI is required; 2n – ELI is <u>not</u> required

Remember: Letter combinations require a switch to Nemeth Code.

- ABs and GHs ⠁⠃⠎ ⠛⠓⠎

  Think: AB GH – Capitalize each letter individually, no ELI.

- AB's and GH's ⠁⠃⠄⠎ ⠛⠓⠄⠎

  Think: AB GH – Capitalize each letter individually, no ELI.

- ab's and gh's ⠁⠃⠄⠎ ⠛⠓⠄⠎

  Think: ab gh – "ab" requires ELI because it is the same as a shortform; "gh" does not.

- abth and jkth ⠁⠃⠞⠓ ⠚⠅⠞⠓

  Think: ab jk – Only the letter combination that is the same as a shortform requires an ELI.

Instructions: Stay in Nemeth Code to transcribe items C) and E).

PRACTICE 5H

A) Find all ABs, CDs, and EFs; draw XYZs.
B) Find all AB's, CD's, and EF's; draw XYZ's.
C) (1st, 2nd, ... nth, ... 49th)
D) Does $|a| \times |b| = |ab|$?
E) If Q, then {[Not-P] or P}.

MORE ABOUT ABBREVIATIONS

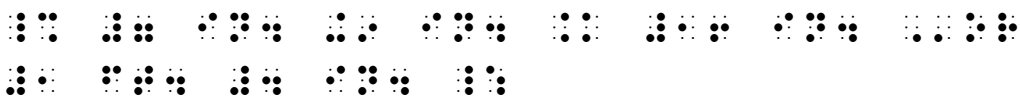
Abbreviation Reminders

- Abbreviations are not mathematical expressions although they may be part of a mathematical expression.
- A space comes between an abbreviation and its related value, even if no space is shown in print. This rule applies even in UEB context.
- An abbreviation and its related value must not be divided between braille lines. This rule applies even in UEB context.
- Between a two-word abbreviation, follow the same spacing as used in print and do not divide the abbreviation between lines.
- Abbreviations are punctuated in literary mode even in mathematical context.

5.18 More Spacing Rules

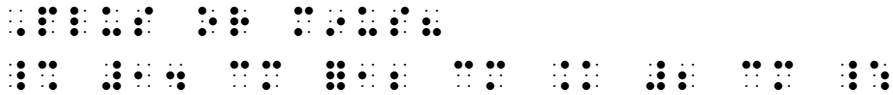
5.18.1: Spacing of Abbreviations With Operation Signs: A space is required between an abbreviation and a sign of operation.

Example 5.18-1 7 in. + 9 in. = 16 in. or 1 ft. 4 in.

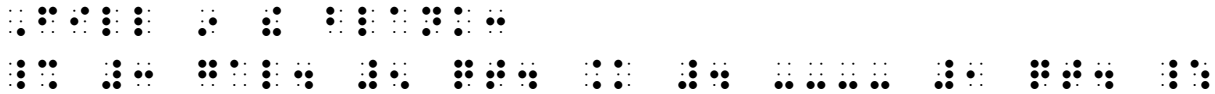


5.18.2: Spacing of Omission Symbols: If a sign of omission is used to represent an abbreviation, the omission symbol is spaced as the abbreviation which it replaces. This spacing rule is crucial to provide clarity in the braille transcription. Spacing in the print copy often does not follow this design and must be disregarded when applying spacing to the braille transcription.

Example 5.18-2 Plus or minus? 14 cm _?_ 12 cm = 2 cm

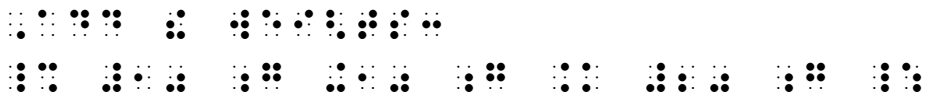


Example 5.18-3 Fill in the blank: 3gal.5qt. = 4___1qt.



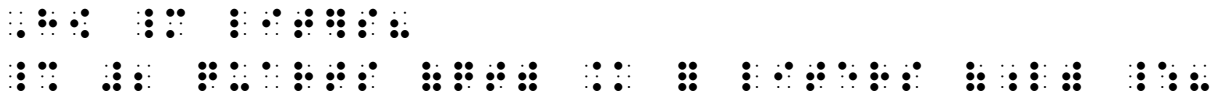
5.19 Single-Letter Abbreviations: A single-letter abbreviation from the English alphabet that does not have a related period must always begin with an English letter indicator. Rules for the nonuse of the ELI with mathematical "single letters" do not apply to abbreviations.

Example 5.19-1 Add the weights: 10 g + 10 g = 20 g



Even the "g" that is immediately followed by a comparison sign requires an ELI because "g" is a single-letter abbreviation without a related period.

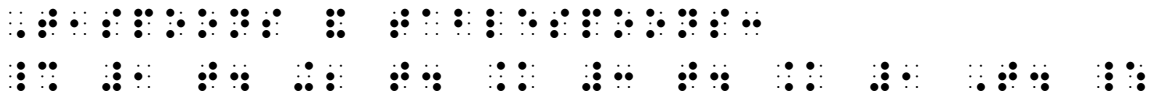
Example 5.19-2 How many liters? 2 quarts (qt) = ? liters (l)?



Even the "l" that is enclosed within parentheses requires an ELI because "l" is a single-letter abbreviation without a related period.

A single-letter abbreviation from the English alphabet that has a related period does not use an ELI.

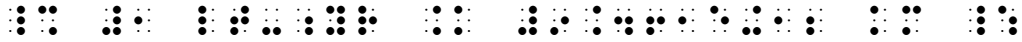
Example 5.19-3 Teaspoons and tablespoons: 1 t. + 2 t. = 3 t. = 1 T.



Reminder: Abbreviations are punctuated in literary mode even in mathematical context.

5.20 Abbreviations Whose Letters Correspond to a Shortform: When an abbreviation whose letters correspond to a shortform does not have a related period, an ELI is required. Rules for the nonuse of the ELI with mathematical letter groupings that correspond to a shortform do not apply to abbreviations.

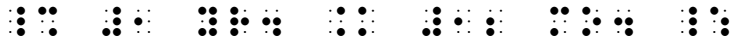
Example 5.20-1 1 lt-yr = 9.461e + 12 km



Even though "yr" is immediately followed by a comparison sign, an ELI is required because "yr" is an abbreviation whose letters corresponds to a shortform and there is no related period. The letter combinations "lt" and "km" do not correspond to a shortform so no ELI is needed. (The letter "e" is a constant and follows the rules of a "single letter".)

An ELI is not needed when an abbreviation includes a related period, even when the letters correspond to a shortform.

Example 5.20-2 1 yr. = 12 mo.



Example 5.20-3 How many days? 2 years (yr.) = ? days (da.)?

5.21 Context Clues: Look for context clues when an abbreviation ends a sentence. When in doubt about the function of a period at the end of a sentence, assume that the period applies to the abbreviation as well. Compare these three examples.

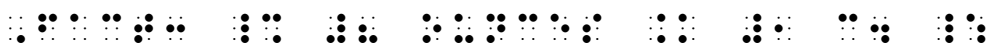
Example 5.21-1 Fact: 8 oz. = 1 c.

Because the abbreviation "oz." has a related period, treat the period after "c." in the same manner. The related period is brailled before the Nemeth Code terminator. No ELI is needed for the letter "c" because the abbreviation has a related period.

Example 5.21-2 Fact: 8 oz = 1 c.

Because the abbreviation "oz" does not have a period, treat the period after "c" as an end-of-sentence period only. The period is brailled outside of the switch. An ELI is needed for the letter "c" because the abbreviation does not have a related period.

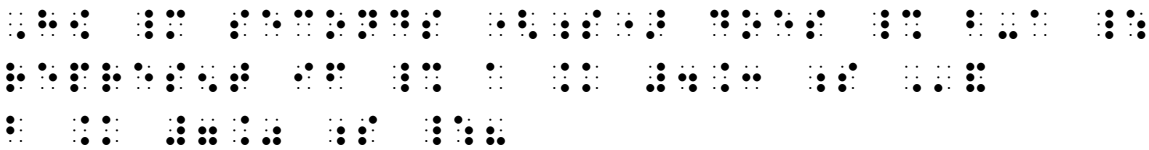
Example 5.21-3 Fact: 8 ounces = 1 c.



Within this short example, there are no context clues to determine if this period applies to the single-letter abbreviation "c". When in doubt, assume that the period <u>does</u> apply to the abbreviation. The period is brailled inside the switch. No ELI is needed.

In the next example, s is the abbreviation and *a* and *b* are the variables. The single-letter abbreviation requires an ELI; the variables do not.

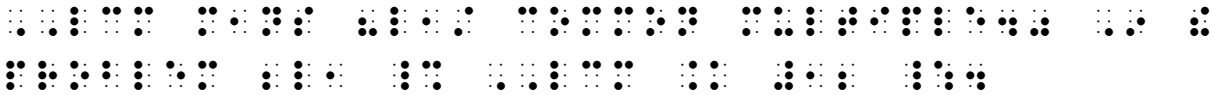
Example 5.21-4 How many seconds (s) does $b - a$ represent if $a = 4.3$ s and $b = 7.0$ s?



Reminder: A variable is usually printed in italics; an abbreviation is printed in normal typeface. Review 5.1.1 "Abbreviation or Variable?"

5.22 Fully Capitalized Acronyms: An abbreviation consisting of more than one capital letter is capitalized as a unit using the double capitalization indicator of the Nemeth Code.

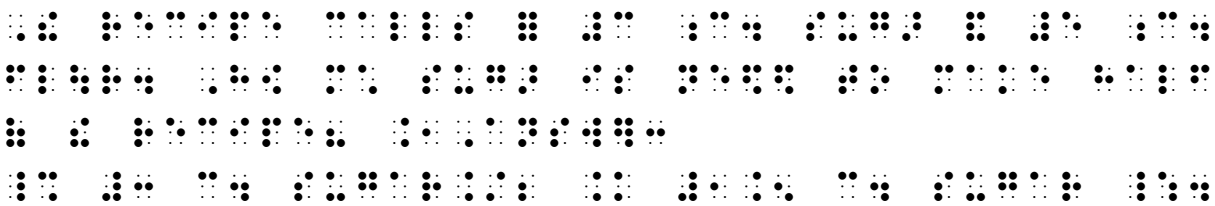
Example 5.22-1 LCM means "least common multiple." In the problem below, LCM = 12.



On line 2, the three-letter abbreviation (acronym) is part of the math.

5.23 UEB vs. Nemeth Code: Apply UEB rules in literary mode; apply Nemeth Code abbreviation rules in Nemeth mode.

Example 5.23-1 The recipe calls for 3 c. sugar and 5 c. flour. How much sugar is needed to make half of the recipe? *Answer:* 3 c. sugar ÷ 2 = 1.5 c. sugar.

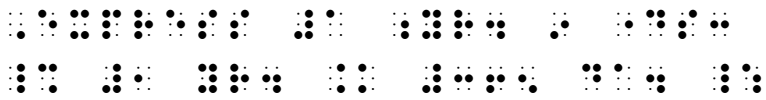


COMPARE: A UEB Grade 1 indicator is required for the abbreviation c. *in the literary portion of the example. Between the Nemeth Code switches, however, an abbreviation with its period does not need an English letter indicator.*

Take Another Look: In the equation, the word "sugar" is part of the math problem and so is brailled inside the switches, without contractions.

⩾ 3 c. sugar ÷ 2 = 1.5 c. sugar

Example 5.23-2 Express 1 yr. in days: 1 yr. = 365 da.



COMPARE: A UEB Grade 1 indicator is required for the abbreviation yr. in the literary portion of the example. Between the Nemeth Code switches, however, an abbreviation with its period does not need an English letter indicator.

5.24 Placement of Switch Indicator Before Itemized Material: When an itemized set of problems begins in Nemeth Code, the opening switch indicator can be placed alone on the line above the first item. This placement is useful following a heading or at a page turn. A switch indicator alone on a line does not replace a necessary blank line. The Nemeth Code terminator is placed on the same line with the text where Nemeth Code ends, if space permits. Otherwise it is placed in the runover position of that line.

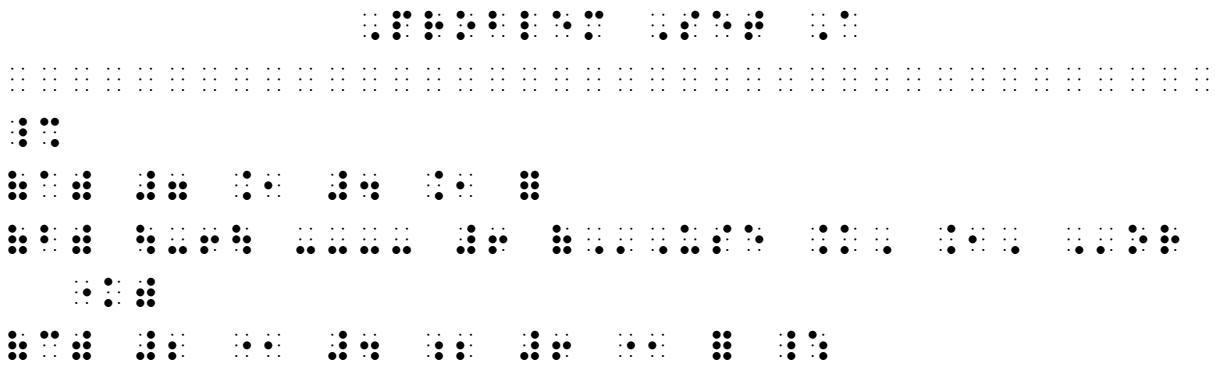
Example 5.24-1

Problem Set A

(a) $7 > 4 >$ -?-

(b) $|-6|$ __ 6 (Use $=$, $>$, or $<$)

(c) $2 : 4 :: 6 : ?$



Instructions: Use the optional placement suggestion for the opening switch indicator by placing it on line 3 in cell 1. Begin item A. on line 4 in cell 1. Review the "keep together" format rule for abbreviations and a preceding or following numeral to which it applies, presented in Lesson 4.

PRACTICE 5I

A. 1 m = 100 cm

B. 3 yrs = 365 × 3 days

C. Draw three triangles using the given side lengths: (i) 1.5 cm, 5 cm, and 4.5 cm (ii) 4.5 cm, 5 cm, and 7.5 cm (iii) 1.5 cm, 4.5 cm, and 7 cm.

D. 1 square mile converted to acres: 1 sq mi = 640 ac

E. 5 in + 25 in = 30 in

F. Fill in the missing information in the Lifetime Value Formula using SAC (Subscriber Acquisition Costs): LTV = ___–SAC

ANSWERS TO PRACTICE MATERIAL

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The function of the parentheses is to group the factors, specifying multiplication. Enclosure symbols that are part of the mathematical expression must be brailled as Nemeth braille symbols.

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The opening parenthesis is transcribed in UEB. Not only is the mathematical portion easily isolated, but balance is achieved when the paired grouping symbols are in the same code.

PRACTICE 5G

YES ⠸⠩ ⠸⠷⠁⠠ ⠃⠠ ⠉⠠ ⠙⠨⠾

YES ⠷⠤⠂⠠ ⠤⠆⠠ ⠤⠒⠾

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YES ⠷⠁⠃⠠ ⠉⠙⠠ ⠑⠋⠾

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EXERCISE 5

Exercise 5 will be available when this course is finished being written and is no longer "Provisional".

Proceed to Lesson 6.