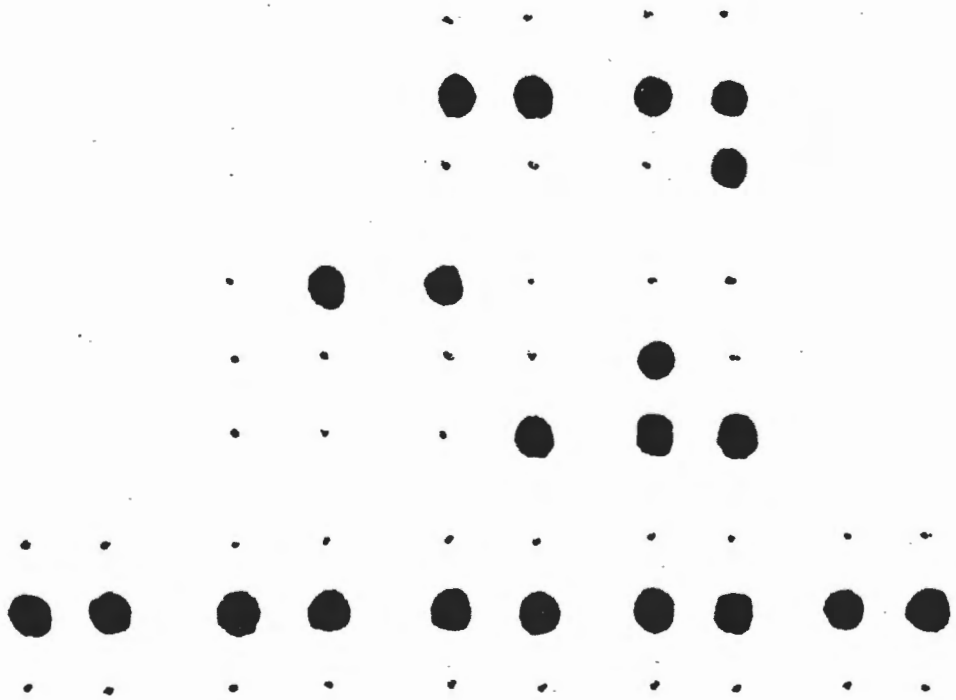
Nemeth Code

Braille Handbook



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BRAILLE HANDBOOK

FOR

NEMETH CODE OF BRAILLE MATHEMATICS AND SCIENTIFIC NOTATION

To The Student:

It is to be understood that this handbook of instruction for braille mathematics does not replace THE NEMETH CODE OF BRAILLE MATHEMATICS AND SCIENTIFIC NOTATION, developed by Abraham Nemeth, Ph.D., published by American Printing House for the Blind, Louisville, Kentucky, 1972.

The material in this handbook is written as an introductory study guide to braille mathematics, and to give the student experience in transcribing basic arithmetic, algebra, and geometry. It is assumed that the student will secure a copy of THE NEMETH CODE OF BRAILLE MATHEMATICS AND SCIENTIFIC NOTATION for further study and reference.

With the limited number of class hours that can be devoted to the study of braille mathematics, it is impossible to master the recommended text. The information in this handbook follows the NEMETH CODE rules, and effort has been made to be accurate and concise.

This book is divided into three sections. The first section consists of exercises to be prepared in braille by the student. The second section consists of a reference chart of mathematical symbols; an alphabetized list of mathematical signs, words, and phrases; the braille symbols that correspond to the mathematical signs; the rules governing the use of the symbols; and braille examples to illustrate the rules. The third section is an alphabetized index, to be used as a cross-reference to help locate mathematical signs that have several names.

Edna Laudenslager
San Francisco State College

BRAILLE HANDBOOK

FOR

THE NEMETH CODE OF BRAILLE MATHEMATICS

AND SCIENTIFIC NOTATION

1972 EDITION

EDNA LAUDENSLAGER

SAN FRANCISCO STATE COLLEGE

1972

BRAILLE HANDBOOK

EXERCISE 1

STUDY: Format, Numerals, Numeric Indicator, Punctuation Indicator, Contractions, Mathematical Comma, Equals Sign, Omission Indicator, Plus Sign, Minus Sign, Runover to a New Line, English-Letter Indicator, Separation Line, Shape Indicator, Shapes.

1. Write numerals that mean:

   a. 3 tens, 5 ones b. 9 tens, 0 ones

   c. 7 tens, 1 one d. 4 tens, 4 ones

2. Copy each of the following and replace the question mark with the missing numeral.

   a. 286 = ? tens + 6 ones b. 225 = 22 tens + ? ones

   c. ? tens = 90 d. 7 tens + 4 ones = ?

3. Rewrite each sentence and put in the missing numeral.

   a. △ - 463 = 297 b. 134 + □ = 321 c. 28 + 285 = ___

4. Copy the examples. Add down. Check by adding upward.

a.	b.	c.	d.
23	17	86	109
3	13	45	8
+1	+8	+6	+35

5. Copy each example below, leaving out the stars. Write the missing figures.

a.	b.	c.	d.
7*	*1	2*	1*8
-32	+3*	+*2	-5*
46	89	77	118

6. Copy and complete these exercises.

   a. 19, 17, 15, ?, 11, ?, 7, ?, 3, ?

   b. 47, 42, 37, ?, 27, ?, ?, 12, ?, ?

   c. 3, 8, 13, ?, 23, ?, 33, ?, ?, ?

BRAILLE HANDBOOK

EXERCISE 2

STUDY: Roman Numerals, Grouping Symbols, Format, Division Sign, Multiplication Sign.

1. Write these Roman numerals with the numerals we use.

   a. X b. XIV c. L d. XCIV e. M

2. Write the answers in our numerals.

   a. XXIII = X + X + I + I + I = ___

   b. CXXXVIII = C + X + X + X + V + I + I + I = ___

3. Copy the following sentences. Replace each frame with the missing numeral. The parentheses tell what to do first.

   a. $(6 + 12) \div 2 = \triangle$ b. $6 + (12 \div 2) = \triangle$

   c. $(24 \div 8) - 2 = \triangle$ d. $24 \div (8 - 2) = \triangle$

4. Copy each sentence and put in the missing numerals.

   a. $2 \times 82 = (2 \times \triangle) + (3 \times \square)$ b. $7 \times 41 = (7 \times \square) + (7 \times \triangle)$

5. Copy, and write each product as one numeral.

   a. $\begin{array}{r} 68 \\ \underline{\times 7} \end{array}$ b. $\begin{array}{r} 128 \\ \underline{\times 8} \end{array}$ c. $\begin{array}{r} 834 \\ \underline{\times 7} \end{array}$ d. $\begin{array}{r} 398 \\ \underline{\times 4} \end{array}$

6. Copy and divide. The first one is started for you.

   a. $\begin{array}{r} 1?? \\ 4\overline{)512} \\ \underline{4} \\ 11 \\ \underline{?} \\ ?2 \\ \underline{??} \end{array}$ b. $3\overline{)651}$ c. $3\overline{)942}$ d. $6\overline{)798}$

7. Find the quotients. Check your work.

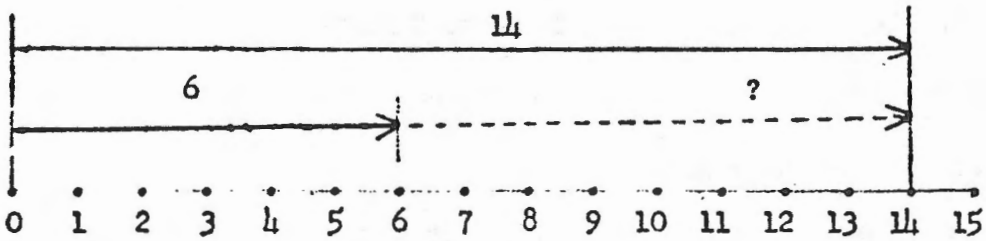
   a. $639 \div 3 = \triangle$ b. $990 \div 9 = \square$ c. $175 \div 5 = \triangle$

BRAILLE HANDBOOK

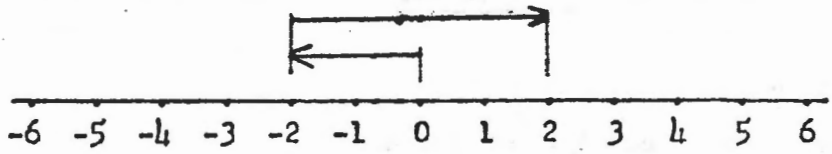
EXERCISE 3

STUDY: Drawings, Boxes, Hyphen, English-Letter Indicator, Cancellation.

1. You can use the number line to find the missing numeral in a sentence such as this one: 6 + ? = 14.



2. Does the drawing below represent this addition sentence: -2 + 4 = △ ? What is the correct replacement for the frame?



3. Write the numeral. h stands for hundreds and t stands for tens.

a. 3h, 2t, and 6 b. 6h, 0t, and 1 c. 1h, 0t, and 0

4. Subtraction: Borrowing with 2-digit numerals.

Step 1	Step 2	Step 3	Step 4
64 -26	5 14 ø ~~4~~ -2 6	5 14 ø ~~4~~ -2 6 8	5 14 ø ~~4~~ -2 6 3 8
4 - 6 = __	64 = 50 + 14	14 - 6 = 8	50 - 20 = 30

5. Cover the answers and work the problems, using the short cut.

a. 74 / -26 b. 52 / -35 c. 92 / -64 d. 83 / -27

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EXERCISE 4

STUDY: Dollar Sign, Cent Sign, Decimal Point, Abbreviations, Contractions, "To, Into, By."

1. Using the smallest whole numbers possible, express the ratio of:

   a. $5 to $40 b. $7.50 to $10.00

   c. .05 to .10 d. 8¢ to 32¢

2. Copy, and follow the signs.

   a. 3 yr. 9 mo.
      +2 yr. 6 mo.

   b. 8 hr. 35 min.
      -3 hr. 45 min.

   c. 9 T. 200 lb.
      -3 T. 800 lb.

   d. 5 lb. 6 oz.
      +14 oz.

3. Copy, follow the sign.

   a. 2 x 3 qt. 1 pt. b. 150 sq. in. ÷ 4

   c. 6 gal. 3 qt. ÷ 3 d. 5 x 5 bu. 1 pk.

4. Find the perimeter of each of the following rectangles.

   a. 165 ft. by 85 ft. b. 2.25 mi. by 4.50 mi.

5. Choose the largest measurement from each set below.

   a. 3 sq. ft.; 1 sq. yd.; 144 sq. in.

   b. 16 cups; 9 pt.; 3 qt.

   c. 1 hr.; 120 sec.; 30 min.

6. Copy and complete these sentences.

   a. .54 = 5 tenths + ? hundredths.

   b. 27.7 = ? tens + ? ones + ? tenths.

   c. 4.08 = ? ones + ? tenths + ? hundredths.

BRAILLE HANDBOOK

EXERCISE 5

STUDY: Brackets, Negation Sign, Greater Than, Less Than.

Symbols for Grouping

$7(2 + 3)$	means	$7 \times (2 + 3)$
$8(12)$	means	8×12
$5n$	means	$5 \times n$
$(2 + 1)(7 - 3)$	means	$(2 + 1) \times (7 - 3)$

Example 1:

$(15 - 6) \times (2 + 4) = n$
$9 \times 6 = n$
$54 = n$

Example 2:

$[3 + (2 \times 5)] - 8 = n$
$[3 + 10] - 8 = n$
$13 - 8 = n$
$5 = n$

Oral Which operation should be done first in each equation below?

1. $(12 + 8) \times 5 = n$
2. $8 + (2 \times 5) = n$
3. $(9 \div 3) - 2 = n$
4. $(5 + 4) + 3 = n$

Written Find n as a single numeral in each of these equations.

1. $[24 \div (8 + n)] \times 5 = n$
2. $100 \div [n(3 + 4) + 6] = 5$

Oral Read each of the following sentences correctly.

1. $12 + 2 \neq 9$
2. $16 \div 2 \neq 7$
3. $22 > 21$
4. $5 \times 7 < 38$
5. $3.2 + 6.9 \not< 8.1$
6. $24.5 \times 7.5 \not> 190$

Replace each frame with the correct numeral.

1. $7 \times (9 + 3) = (7 \times 9) + (7 \times \Delta)$
2. $84 \div 2 = (80 + \square) \div 2$
3. $3 \times 29 = 3 \times (30 - \square)$

BRAILLE HANDBOOK

EXERCISE 6

STUDY: Braces, Null Set, Ellipsis, Contractions, Union (Cup), Contained In, Contains, Less Than, Greater Than, Intersection, Tilde, Element Of.

Sets

1. $A = \{a, b, c, d, e\}$
2. $B = \{d, e, f\}$
3. $C = \{\text{Mary, Andy, Ed}\}$
4. $D = \{\text{Andy, Ed, Helen, Ruth}\}$
5. $E = \emptyset$
6. $F = \{2, 4, 6, 8, \ldots\}$

Union of Sets

1. $A \cup B = \{a, b, c, d, e, f\}$
2. $C \cup D = \{\text{Mary, Andy, Ed, Helen, Ruth}\}$

Subsets (Is Contained In); Supersets (Contains); Is Not a Subset

1. $\{6\} \subset F$
2. $\{\text{Andy, Ed}\} \subset C$
3. $\{a, b, c\} \subset A$
4. $\{5\} \not\subset F$
5. $A \cup \{f\} \supset B$
6. $D \supset \{\text{Helen, Ruth}\}$

Less Than, Not Less Than; Greater Than, Not Greater Than

1. $n(B) < n(A)$
2. $n(E) < n(F)$
3. $n(D) > n(C)$
4. $n(B) > n(A \sim \{a, b, c\})$
5. $n(E) \not> n(D)$
6. $n(A) \not< n(B) \not< n(E)$
7. $n(A \sim B) = 3$
8. $n(B \sim A) = 1$

Intersection of Sets

1. $A \cap B = \{d, e\}$
2. $C \cap D = \{\text{Andy, Ed}\}$
3. $A \cap C = \emptyset$
4. $A \cap F = \emptyset$

Element Of (Is a Member Of); Not an Element Of (Is Not a Member Of)

1. $a \in A$
2. $\text{Andy} \notin A$
3. $\emptyset \notin F$
4. $4 \in F$

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EXERCISE 7

STUDY: Fractions, Mixed Numbers, Shapes, Prime Sign, Format.

Fractions and Mixed Numbers, Written Practice

A. Copy and add. Replace each frame with a fraction.

1. $\frac{2}{5} + \frac{1}{5} = \Delta$ 2. $\frac{1}{12} + \frac{4}{12} = \Delta$ 3. $\frac{5}{8} + \frac{2}{8} = \Delta$

B. Copy each sentence and subtract.

1. $\frac{7}{8} - \frac{5}{8} = \frac{\Delta}{\square}$ 2. $\frac{9}{10} - \frac{7}{10} = \frac{\Delta}{\square}$ 3. $\frac{2}{3} - \frac{1}{3} = \frac{\Delta}{\square}$

C. Copy these sentences and replace the frames.

1. $1\frac{1}{3} = \frac{\Delta}{3}$ 2. $1\frac{1}{5} = \frac{\Delta}{5}$ 3. $1\frac{1}{4} = \frac{\Delta}{4}$

D. Solve each of the following equations.

	a	b	c
1.	$\frac{3}{5} \times \frac{2}{7} = n$	$\frac{5}{9} \times \frac{1}{5} = n$	$\frac{3}{8} \div \frac{1}{2} = n$

E. Copy. Find each sum or difference.

1. $\begin{array}{r} 19\frac{3}{8} \\ +27\frac{5}{12} \\ \hline \end{array}$ 2. $\begin{array}{r} 347\frac{5}{18} \\ +156\frac{7}{12} \\ \hline \end{array}$ 3. $\begin{array}{r} 47\frac{7}{9} \\ -39\frac{5}{6} \\ \hline \end{array}$ 4. $\begin{array}{r} 813\frac{4}{5} \\ -677\frac{9}{14} \\ \hline \end{array}$

F. Copy. Write each sum.

1. $2\frac{5}{12}$ ft., $4\frac{3}{12}$ ft. 2. $5\frac{1}{4}$" and $6\frac{1}{8}$"

3. $5\frac{1}{6}$ yd., $2\frac{2}{3}$ yd. 4. $2\frac{1}{2}$' and $6\frac{1}{4}$'

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EXERCISE 8

STUDY: Complex Fractions, Percent, Diagonal Fraction Line.

Find the missing numerals.

1. $(\frac{7}{9} + 1) - \frac{8}{9} = \square$ 2. $\square - 3\frac{3}{5} = 1\frac{1}{5}$

Tell which of the following are true and which are false.

1. $\frac{5}{6} + \frac{6}{6} > 3 - 1\frac{5}{6}$ 2. $\frac{5}{2} + \frac{1}{2} + \frac{7}{2} < \frac{16}{2}$

Write the simplest fractional numeral for each of the following.

1. $\dfrac{\frac{2}{3}}{\frac{4}{3}}$ 2. $\dfrac{\frac{3}{4}}{\frac{1}{2}} \times \frac{7}{10}$ 3. $\dfrac{\frac{9}{14}}{\frac{3}{7}} \times \dfrac{\frac{2}{5}}{\frac{3}{10}}$

4. $\dfrac{2\frac{1}{2} \times 3\frac{1}{4}}{5\frac{1}{2} \times 1\frac{3}{4}}$ 5. $\dfrac{\frac{7}{6} \div \frac{2}{3}}{\frac{3}{5} \times 1\frac{1}{4}}$ 6. $\dfrac{2\frac{1}{2} + 1\frac{3}{4}}{6\frac{1}{4} - 5\frac{1}{2}}$

Write decimal numerals for each of the following.

1. $\dfrac{15 \times 200}{\frac{1}{2}}$ 2. $\dfrac{4\% \times 21}{7\% \times 24}$ 3. $\dfrac{.82 \times .14}{.7 \times .20}$

4. $\frac{3}{15} + \frac{2}{11} + \frac{9}{16} + \frac{1}{3} + \frac{3}{4}$ 5. $\left(\frac{3}{5} \cdot \frac{2}{5}\right) - \left(\frac{1}{3} \cdot \frac{3}{5}\right)$

Perform the indicated operations.

1. $\frac{a}{xy} - \frac{b}{xy}$ 2. $\frac{a}{x+y} + \frac{b}{x+y}$ 3. $\frac{5a}{3z} - \frac{15b}{12y}$

4. 80 ft./sec. x 4 sec. 5. 30 mi./hr. x 2 hr.

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EXERCISE 9

STUDY: Superscripts, Base Line Indicator, Subscripts, Radicals, Index-of-radical Indicator, Termination Indicator.

Replace N with a single numeral that will make the sentence true.

1. $3^2 \times 10^2 = N$
2. $N = (4 \times 10^4) + (2 \times 10^2)$
3. $6^3 - 2^3 = N$
4. $5 \times (4^3 + 3^2) = N$

Find the indicated products or quotients.

1. $6y^2(4t^2 + 2t + 1)$
2. $(7x^2y + 14xy^2 + 21xyz) \div 7xy$
3. $2(x^2 + y^2)(x^3 - y^3)$
4. $(c^3 + c^2) \div c$

Find the decimal-number equivalents of the following:

1. $1023_4 + 10_4$
2. $2310_5 - 423_5$
3. $E46T_{12} - 2_{12}$

Find the sums in base six numerals.

1. $2_{six} + 4_{six} = \underline{?}$
2. $3_{six} + 5_{six} = \underline{?}$
3. $\begin{array}{r} 2_{six} \\ +4_{six} \\ \hline \end{array}$
4. $\begin{array}{r} 3_{six} \\ +5_{six} \\ \hline \end{array}$

Simplify each of the following radicals:

1. $\sqrt{8} \cdot \sqrt{6}$
2. $\sqrt{a^2b}$
3. $(\sqrt{9})$

Carry out the indicated operations and simplify:

1. $\sqrt{3a} \times \sqrt{8a}$
2. $\sqrt{(2 \times 3x)^2}$
3. $\sqrt{x^2/y} - x$
4. $\sqrt[3]{27} + \sqrt[3]{8}$
5. $\sqrt[6]{x^2 + y^2}$
6. $\sqrt[4]{64} \times \sqrt[3]{125}$
7. $\sqrt{\frac{14}{14}}$
8. $\frac{(\sqrt{3x} \cdot \sqrt{9x^2})}{\sqrt{3}}$

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EXERCISE 10

STUDY: Negative Numbers, Degree Sign, Minutes and Seconds, Pi, Multipurpose Indicator.

Combine according to the Rule of Signs.

1. $-6 - 7 + (-8) - 20 =$
2. $(-9) - 4(-20) =$
3. $-14.2 - (-40.2) =$
4. $(-12.3) + (-25.6) =$
5. $(-9.5) + (-6.2) =$
6. $-6 + -4 - -7 + -5 =$

Percent

1. Do you think we can express 25% as .25 or $\frac{25}{100}$ or $\frac{1}{4}$? What are three ways to express 10%?
2. Find the missing numeral in each of the following:
   (a) 50 is $12\frac{1}{2}$% of N.
   (b) 2% of N is 20.
   (c) N is 75% of 120.

Degrees

1. On a map, find the cities located approximately at each of the following places.
   (a) 30° N., 90° W.
   (b) 40° N., 120° W.
2. Find the sum:
   (a) $100^\circ + 60^\circ + 20^\circ = \Delta^\circ$
   (b) $73^\circ 30' + 54^\circ 24' 49'' = \Delta^\circ \square' \lozenge''$

Pi

1. Is $\frac{22}{7}$ an exact or an approximate value of π?
2. Is this an exact statement? $\pi = 3.1416$.
3. Can you find the exact value of $\frac{\pi}{2}$? $\frac{\pi}{4}$? $\frac{\pi}{6}$?

BRAILLE HANDBOOK

EXERCISE 11

STUDY: Division Format, Cancellation, Recurring Decimal, Absolute Value, Enlarged Parentheses, Less Than or Equal To, Equal To or Less Than.

Copy the examples and complete them.

1.
```
      ??R?
12)134 |
   120 | = 10 x ?
   ---------------
    14 |
    ?? | = ? x ?
   ---------------
     ? |
```

2.
```
      ??R??
21)222 |
   210 | = 10 x ?
   ---------------
    ?? |
```

A Useful Short Cut in Multiplication

1. We think about factors before we multiply.

a. $\frac{\overset{1}{\cancel{2}}}{3} \times \frac{5}{\underset{8}{\cancel{16}}} = \frac{1 \times 5}{3 \times 8}$

b. $\frac{\overset{5}{\cancel{15}}}{\underset{1}{\cancel{4}}} \times \frac{\overset{1}{\cancel{4}}}{\underset{3}{\cancel{9}}} = \frac{5 \times 1}{1 \times 3}$

Recurring Decimals

1. $\frac{1}{6} = .1\dot{6}$ 2. $\frac{2}{3} = .\dot{6}$ 3. $.0\dot{7}6\dot{9}2\dot{3} = \frac{1}{13}$

Absolute Value

1. $|+3| = |-3| = 3$ 2. $|3| = 3$

Simultaneous Equations

1. $\begin{Bmatrix} 2x + y = 5 \\ x - y = 10 \end{Bmatrix}$ 2. $\begin{Bmatrix} x - 2y - 1 = 0 \\ 3x + 2y = 7 \end{Bmatrix}$

Plot the solution set on the real number axis:

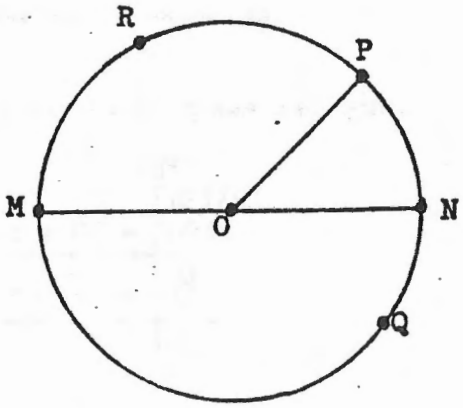
1. $-5 \leq y + 4$ 2. $|x| \leq 3$

3. $y \not\geq 4$ 4. $y^2 \leq 5$

5. $n \geq -2$ 6. $a^2 - 16 \neq 0$

EXERCISE 12

STUDY: Drawings, Modified Expressions, Shapes, Arrows.



1. Shown here is a circle with center point O and two line segments that are related to the circle. $\overline{OP}$ is a line segment called a radius.

a. Imagine a line segment $\overline{OQ}$. Is $\overline{OQ}$ a radius?

b. Imagine another segment, $\overline{OR}$. Does $\overline{OR} = \overline{OP}$?

2. $\overline{MN}$ is a diameter of the circle. Can you imagine other diameters?

3. To show that a line goes on and on in both directions, we draw arrowheads, as in the picture at the right. Two points on the line have been named. In writing we can indicate this line as $\overleftrightarrow{CD}$. We read this as "line CD."

a. We can call the part of the line from C to D a line segment or a segment. We can name it "segment CD" and write it without the arrowheads, $\overline{CD}$.

b. Does $\overline{CD}$ go on and on?

4. This picture shows a part of a line through R. We call such a figure a ray. A ray has one end point. What does the arrowhead indicate?

5. This picture shows a point, R, on a line. Two other points on the line have been given names. This helps to name a ray. We can name the ray consisting of R and all the points on the Y side of R as "ray RY," and it is written $\overrightarrow{RY}$. Notice that the end point is named first.

a. Make a drawing of $\overrightarrow{RX}$.

b. What is the name for $\overleftrightarrow{XY}$?

BRAILLE HANDBOOK

EXERCISE 13

STUDY: Drawings, Shapes (angle, triangle, perpendicular, parallel), Modified Expressions.

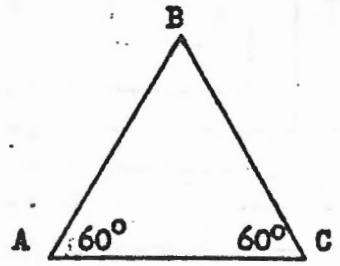
1. The picture at the right shows

$\triangle ABC$.

$\angle A = 60^\circ$

$\angle C = 60^\circ$

Find the measure of $\angle B$.



2. This picture shows $\triangle MNO$.

$\overline{MN} \perp \overline{NO}$

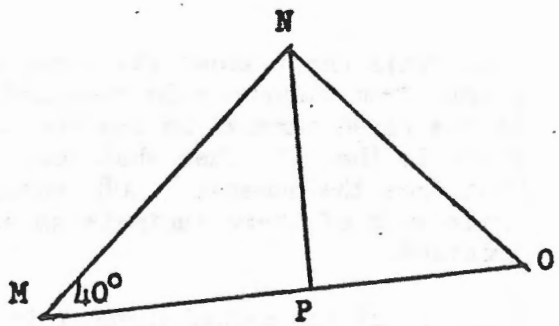
$\overline{NP} \perp \overline{MO}$

$\angle M = 40^\circ$

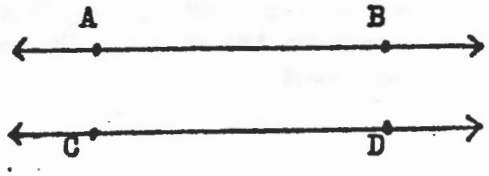
Find the measure of $\angle MNP$

$\angle PNO$

$\angle NOP$

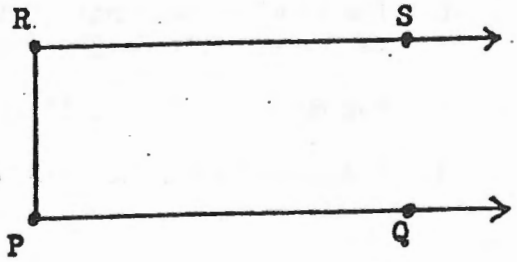


3. In this picture, two parallel lines, $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$, are shown. We can write $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$.



4. In the diagram at the right, $\overrightarrow{PQ} \parallel \overrightarrow{RS}$, $\overline{PR} \perp \overrightarrow{PQ}$. What is the measurement of $\angle PRS$?

$\angle RPQ$?



EXERCISE 14

UNDERSTANDING NUMBERS

1.a. Read this numeral: 2, 8 9 7, 3 6 4. Copy and complete this chart to show what each digit in the numeral represents.

2, 8 9 7, 3 6 4

4	is in ones'	place and represents	4
6	is in ?	place and represents	60
3	is in ?	place and represents	?
7	is in ?	place and represents	?
9	is in ?	place and represents	?
8	is in ?	place and represents	?
2	is in ?	place and represents	?

b. We can also think of the 7 in thousands' place as 70 hundreds, or ? tens. Similarly, we can think of the 8 in hundred-thousands' place as ? ten-thousands.

2.a. This chart shows the names of the places from thousands to thousandths. Look at the first numeral in the chart. In what place is the 1? Then what does .001 mean? What does the numeral .008 mean? .006? Write each of these decimals as a common fraction.

b. Look at the second numeral in the chart. Does it mean $\frac{14}{1000}$?

c. Read the third numeral in the chart. Write it as a common fraction with a denominator of 1000. Read the last numeral in the chart. Write it as a mixed fraction.

thousands	hundreds	tens	ones	tenths	hundredths	thousandths
				.0	0	1
				.0	1	4
				.3	5	8
2	5	1	2	.2	0	6

CLOCK TIME

1. The clock shows that it is now 4:27. In how many minutes will it be 5 o'clock? 5:13? 5:37?

2. How many minutes is it from 10:15 A.M. to 12:00 N.?

3. Estimate in hours: 6:52-9:40; 2:11-7:24; 1:45-3:05.

REFERENCE CHART OF MATHEMATICAL SYMBOLS

GROUPING SYMBOLS

- { } braces
- braces, enlarged
- [ ] brackets
- brackets, enlarged
- ( ) parentheses
- parentheses, enlarged
- | vertical bar, enlarged
- || vertical bar, double, enlarged

FORMAT

- Division: curved, normal
- Division: straight, inverted
- separation line
- carrying, borrowing
- square root format

PUNCTUATION

- * asterisk, used for reference, operation sign
- , comma
- ... ellipsis
- - hyphen

TYPE-FORMS

- boldface
- italic
- script
- sanserif

MODIFIERS

- ↔ arrow, end barbs
- ← arrow, left barb
- → arrow, right barb
- → contracted form, right barb arrow
- ⟷ dotted, ends
- ⟶ dotted, right
- — bar, horizontal
- | bar, vertical

SHAPES

- ∠ angle
- ○ circle
- × intersecting lines
- ∥ parallel to
- ⊥ perpendicular to
- □ square
- △ triangle
- ▽ inverted triangle

MISCELLANEOUS

- ¢ cent
- . decimal
- ° degrees (use superscript)
- $ dollars
- / negation line
- ∅ empty, or null set
- % percent
- ' prime

REFERENCE CHART OF MATHEMATICAL SYMBOLS

INDICATORS

- English-Letter
- base-line; multipurpose
- cancellation
- directly over
- directly under
- numeric
- omission
- punctuation
- radical
- radical index
- shape
- shape: filled-in
- shape: interior modification
- shape: shaded; structural modif.
- subscript
- superscript
- termination

SIGNS OF OPERATION

- ÷ division
- ∩ intersection
- ∧ logical product, meets
- ∨ logical sum, join
- − minus
- × multiplication cross
- · multiplication dot
- + plus
- ± plus a minus
- ∓ plus or minus
- ∪ union

SIGNS OF COMPARISON

- ⊂ contained in
- ⊃ contains
- ∋ contains the element
- ∈ is an element of
- = equals
- > greater than
- < less than
- :: proportion
- : ratio
- ∼ tilde, simple
- ∼ tilde, extended

FRACTIONS AND MIXED NUMBERS

- Simple fraction: opening indicator, fraction line, closing indicator
- Complex fraction: indicator, line, indicator
- Fractional part of a mixed number: indicator, line, indicator
- / Diagonal fraction line, slash line
- / Diagonal complex fraction line

BRAILLE HANDBOOK

FOR

NEMETH CODE OF BRAILLE MATHEMATICS AND SCIENTIFIC NOTATION

ABBREVIATIONS

a. Abbreviations in mathematical texts include all words and phrases that are shortened in print, except abbreviated function names, model or serial numbers, or letters that do not represent a word or phrase. Doubtful constructions are not treated as abbreviations.

b. Use abbreviations as they are shown in print for position, capitalization, spacing, and punctuation. Punctuation follows literary rules.

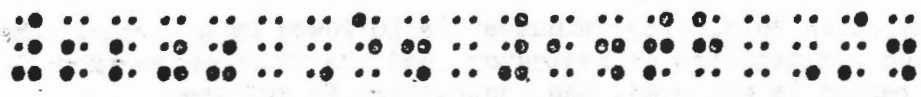
3 gal., 2 qt., 1 pt.

LCD (least common denominator)

2 P.M.

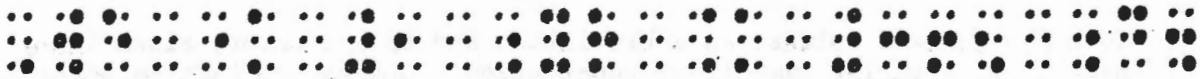
Chap. IV, pp. 40-48.

2200 E. 14th St.



c. Use letter indicators before single letters or short-form words used as abbreviations when no period follows the abbreviation. If a period ends a sentence but does not apply to the abbreviation, use the letter indicator.

We know 1 yr = 365 d. (Period ends sentence.)



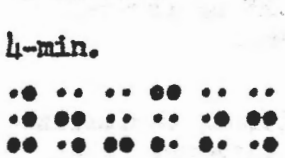
When will 1 yr. = 366 d.?

10 g + 10 g = 20 g

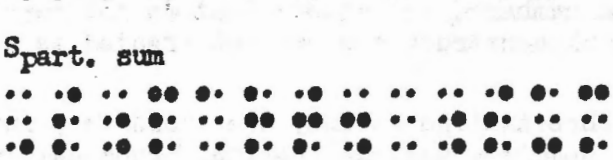
d. Contractions may be used in abbreviations that do not touch mathematical signs or symbols except those of grouping. This rule includes comparison signs although they are always spaced. If a hyphen or dash separates the abbreviation from the sign or symbol, the contraction may be used.

{Ariz., Ark., Conn.}

4-min.



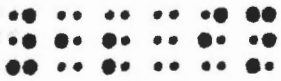
$S_{part.\ sum}$



e. The contraction "in" is never used for "inches." "St." is used for "street" or "saint," but not for an abbreviation such as "st" for "straight." The contractions "st" and "th" are not used for ordinal endings.

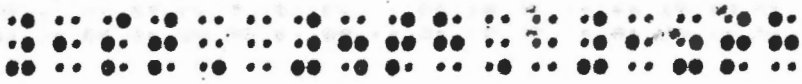
12 in.

12 in



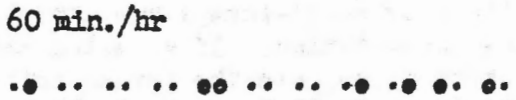
4-inch

1st, 4th, 10th

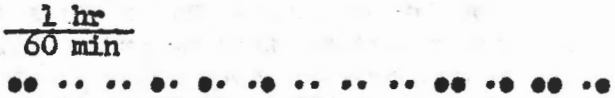


f. When the abbreviation "min." for "minutes" is followed by a period, the period may touch a slash line or indicator, and the "in" contraction is used. If the period is not used, the contraction is not used.

60 min./hr



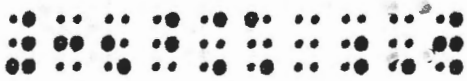
$\frac{1\ hr}{60\ min}$



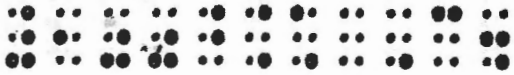
g. No space is left between an abbreviation and an indicator, slash line, fraction line, grouping symbol, or punctuation. Spaces are left in other cases.

$(3\ yd)^2 = 9\ yd^2$

35° W



100° C.

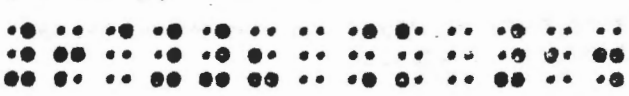


ASTERISK, MATHEMATICAL *

a. The asterisk may be used as a mathematical sign or as a reference sign. The literary asterisk must not be used in either case.

b. If an asterisk is used as a sign of operation between two numbers, the numeric indicator is repeated before the second number. No space is left before or after the asterisk.

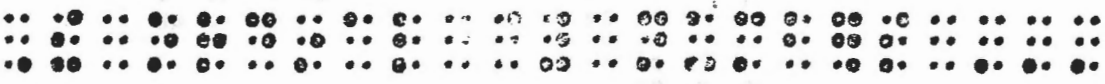
6 * 8 = 14



a * b = ab

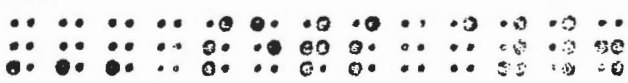
c. The superscript position is ignored when an asterisk is used as a reference sign. When an asterisk follows a word or punctuation, a space is left between them; when an asterisk is followed by literary punctuation, the punctuation indicator is needed.

The ordinal* numbers ...



... sets.*

... sets*.



BOXES

a. If a mathematical text shows study material in "boxes" made of lines, they should be made with braille lines, or drawn with a stylus or other drawing tool on the back of the braille paper. Use a ruler or straight edge to make the lines of the box. (See DRAWINGS)

b. Place a drawing pad or magazine under the paper to make clear, sharp lines.

c. Draw boxes large enough to avoid crowding the braille. The boxes are drawn after the braille has been completed unless braille lines are used.

d. Related boxes, showing the steps of a mathematical operation, should not be divided between pages.

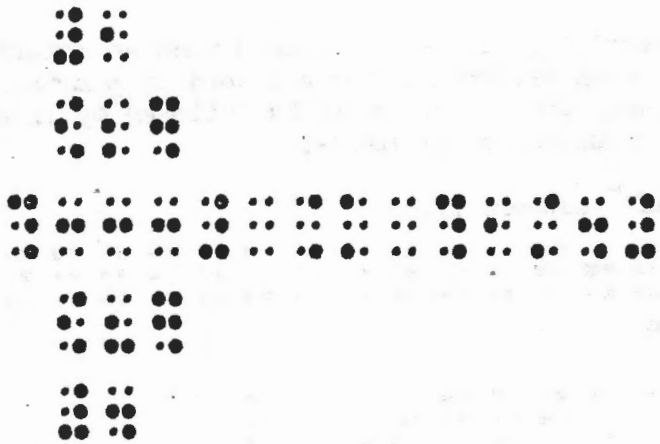
CANCELLATION INDICATORS Opening ⠘ Closing ⠸

a. Cancellation indicators are used to surround a mathematical expression which is being canceled. Cancellation indicators for each item are used if the items are individually canceled in print.

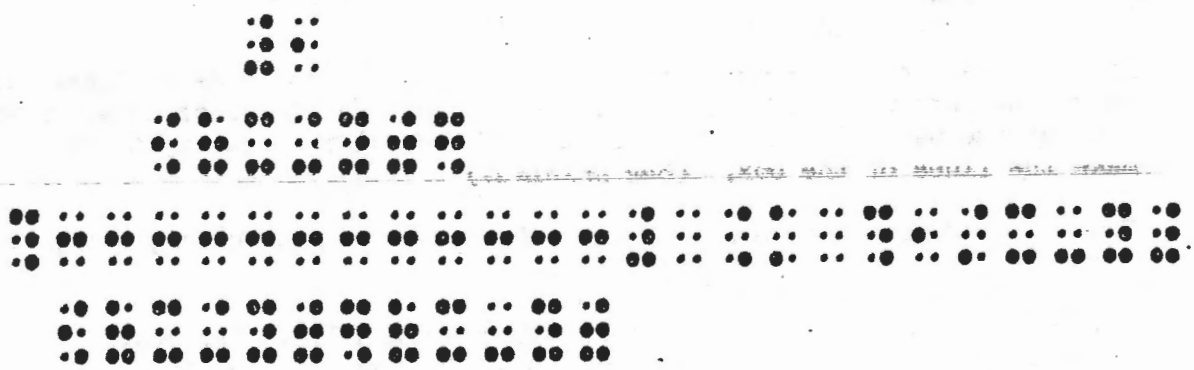
b. A spatial arrangement must be used to show cancellation, but related parts of a problem may be linear. A line is skipped above and below a problem arranged spatially.

c. Reducing fractions is not considered work arranged for computation, so numeric indicators must be used for open numerals.

$$\frac{\overset{1}{\cancel{2}}}{\underset{4}{\cancel{8}}} = \frac{1}{4}$$



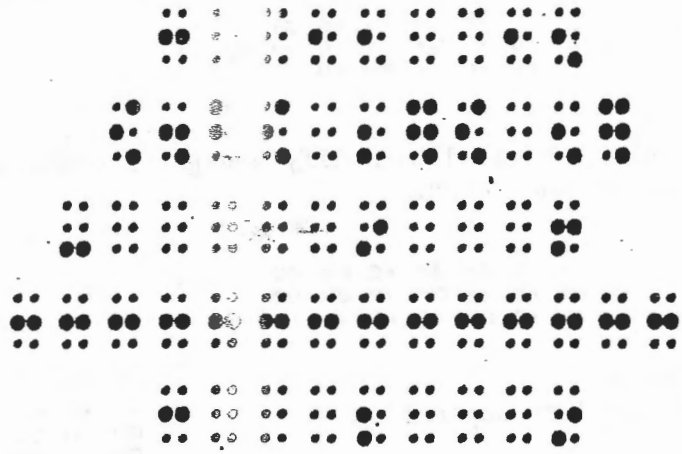
$$\frac{\overset{1}{\cancel{(x+y)}}}{\cancel{(x+y)}(x-y)} = \frac{1}{x-y}$$



CANCELLATION INDICATORS, continued

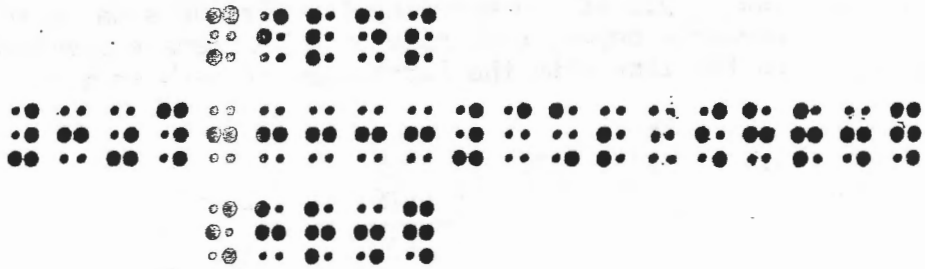
d. Cancellation indicators are used ubtraction to show borrowing; the "borrowed" number is written abo s canceled number. Numeric indicators are not needed because th k is arranged for computation. Study the spacing in the example w.

$$\begin{array}{r} 3\ 11\ 15 \\ \cancel{4}\ \cancel{2}\ \cancel{5} \\ -\ \ 9\ \ 6 \\ \hline 3\ \ 2\ \ 9 \end{array}$$



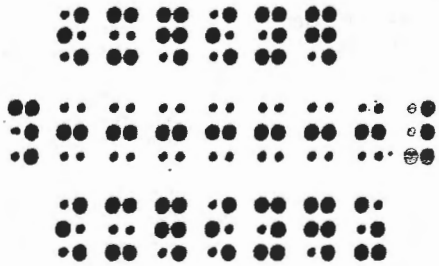
e. Words or abbreviations of measurement may be canceled. No contractions are used, and a spatial arrangement must be followed.

$30\ \frac{\text{miles}}{\cancel{\text{hr.}}} \times 2\ \cancel{\text{hr.}}$

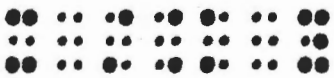


f. A cancellation stroke must not be mistaken for a negation line. Cancellation applies to mathematical expressions which contain numerals or letters; negation applies to signs of comparison.

$\frac{\cancel{x}}{\cancel{x}z}$



$x \neq y$



CARET (Circumflex) ∧

```
·o o·
·o o·
·o ·o
```

a. The caret is used to show a new location of a decimal point.

.10∧25

```
·o ·o ·· ·· ·o o· ·· ··
·o ·· o· ·o ·o o· o· o·
oo ·o ·· oo ·o ·o o· ·o
```

b. The caret may be used to modify a sign of comparison. Use the correct modification indicator.

≙

```
·· ·o o· o· ·o o· oo
·o ·· ·· o· ·o o· oo
·· ·o o· ·o ·o ·o ·o
```

CARRYING (Secondary separation line)

```
·· ·· ··
oo oo oo
oo oo oo
```

a. The secondary separation line is used between the problem and the "carried" numeral, even if not shown in print.

b. The length of the carrying line is the same as the separation line (extends one cell beyond each side of the numerals involved). A problem number is on the line with the first term of each problem.

1.

```
  ⁸
  29
 X 4
 ---
 116
```

2.

```
  ··
  254
 +176
 ----
  430
```

```
·o ·· ·o ··
·o o· ·o oo
oo ·· ·o ·o
```

```
·· ··
oo
··
```

```
·· ·· ·· ·· ··
oo oo oo oo oo
oo oo oo oo oo
```

```
·· ··
o· ·o
o· o·
```

```
·o ·· ·o ··
·o o· ·o oo
oo o· ·o ·o
```

```
·· ··
o· o·
·· ··
```

```
·· ·· ·· ·· ··
oo oo oo oo oo
oo oo oo oo oo
```

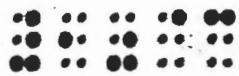
```
·· ·· ··
o· o· oo
o· ·o ·o
```

```
·o ·· ·· ··
·· o· oo oo
oo ·· oo o·
```

```
·· ·· ·· ·· ··
oo oo oo oo oo
·· ·· ·· ·· ··
```

```
·· ·· ··
oo oo ·o
·o ·· oo
```

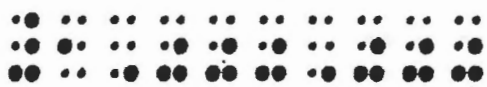
CENT SIGN ¢

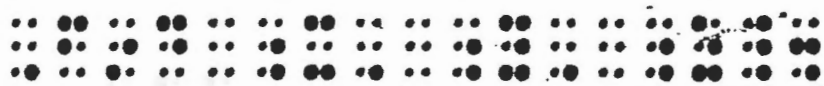
10¢  ¢10 (Follow print)

CHECK MARK √ (Must have a space on either side.)

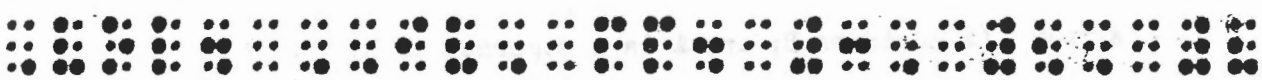
COMMA, MATHEMATICAL ,

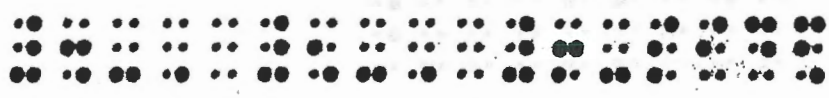
a. The mathematical comma is used with mathematical expressions, in long numbers, after letters, Roman numerals, plurals of numerals, and in computation.

1,000,000 

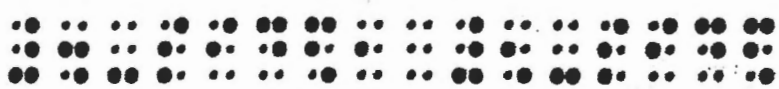
Find x, y, z. 

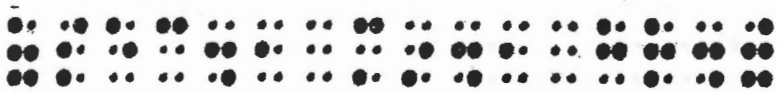
Vol. IV, pp. 3, 5, 8

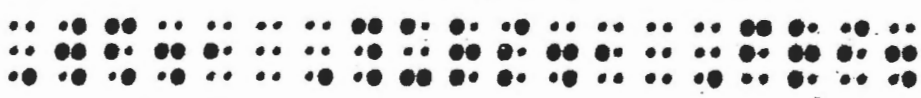


4-, 5-, 6-sided 

b. The literary comma is used after words or abbreviations.

4-sided, 5-sided 

(sec., min., hr.) 

Wed., Thurs., Fri. 

CONGRUENT TO. (Tilde over Equals) $\cong$

$\triangle ABC \cong \triangle DEF$

CONTAINED IN. (Is a subset of) $\subset$

$A \subset B$ (A is contained in B; or, A is a subset of B)

CONTAINS. (Is a superset of) $\supset$

$A \supset B$ (A contains B; or, A is a superset of B)

CONTAINS THE ELEMENT. (Reverse membership) $\ni$ or $\}$

$A \ni x$ (A contains the element x)

CONTRACTIONS AND SHORT-FORM WORDS

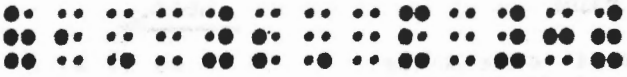
a. Contractions are used in words that are not in direct contact with mathematical signs, but there are exceptions to this rule. Punctuation is literary; contractions may be used in words that touch punctuation, and no punctuation indicator is needed. Grouping signs are both literary and mathematical; words within grouping signs may be contracted unless other mathematical signs are involved. When a hyphen joins a literary word and mathematical term, contractions may be used in the word.

5n means 5 X n.

69 = 6 tens, 9 ones.

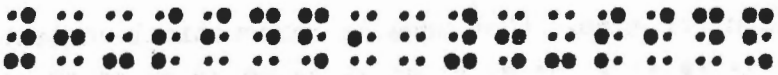
(2-inch)

(1, 2, and 3)



3-, 4-, and 5-sided

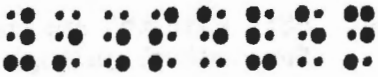
3-sided, 4-sided



b. Contractions are <u>not</u> used when words touch indicators, the general omission symbol, or any sign of operation or comparison (although comparison signs are separated by spaces from other signs).

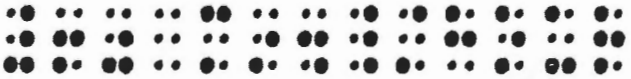
ten ? one = ten

^{9}seven (nine, base seven)

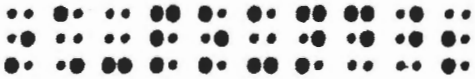


1 hour = 60 minutes

60 min./hour



inch-pound^{2}



CONTRACTIONS AND SHORT-FORM WORDS, continued

distance ÷ time = ____

(rate) X (time) = (distance)

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

c. Not used when touching radicals, modifiers, or in function names or abbreviations used in a mathematical context (follow print for spacing).

$\sqrt{\text{nine}}$

heat →

sine x + sine y

2 arcsin x

Sin is the abbreviation for sine. (Not used in mathematical context.)

a arc sin x + b arc tan y (Spaces shown in print.)

d. "St" and "th" are used as abbreviations for "street" or "saint," but not for ordinal endings of numerals or letters. A one-letter ordinal ending is used without a letter indicator.

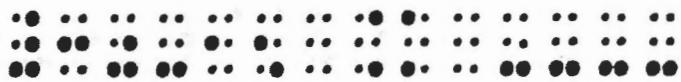
1st and 2d, 4th and 5th.

DASH, SHORT —

a. The dash is a literary punctuation sign and does not require a punctuation indicator. The long dash replaces a short dash that is shown as a mathematical omission symbol.

b. The numeric indicator is required when a numeral is preceded by a dash.

30 - 15 = __



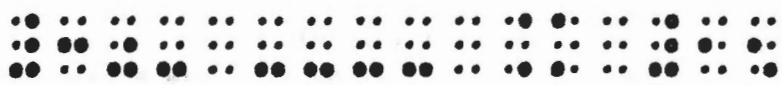
16 ounces--1 pound

DASH, LONG ____

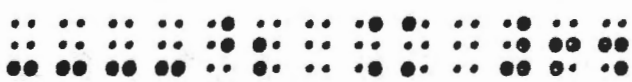
a. When a dash is used as a mathematical omission sign in print, a punctuation indicator is needed. If there is doubt about the context, the indicator is used. The hyphen is the only punctuation mark that is separated from the long dash by a space.

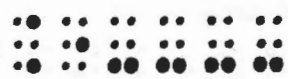
b. The long dash must be preceded and followed by a space except when used with indicators, grouping signs, symbols for dollars, cents, percent, and primes. The decimal point must have a multipurpose indicator between it and a long dash, but no space is needed.

30 - ____ = 15

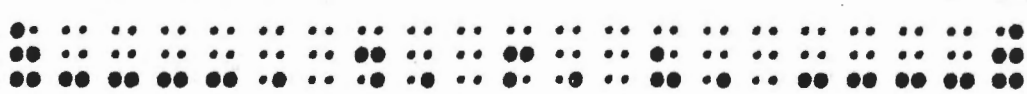


____2 = 64 .____ (decimal, dash)

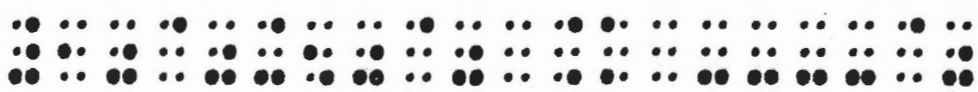




(____, 4, 6, 8, ____)



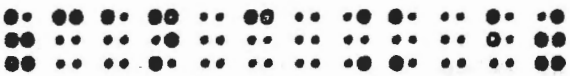
10% + 50% = ____%



CONTRACTIONS AND SHORT-FORM WORDS, continued

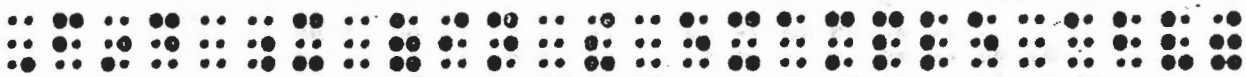
e. The whole-word alphabet contractions but, can, do, ..., you, as, the whole-word lower-cell contractions be, was, were, his, in, enough, and the whole- or part-word contractions and, of, the, for, with are never used when in direct contact with grouping symbols. No other contractions may be used in these words, and no intervening capital, italics, or punctuation affects this rule.

(can c = b)



(that is)

Find x (in the example above)



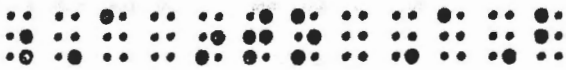
(formal proof)

(often for information)

f. To, into, and by follow the rules for the use of contractions; in of into is contracted when into is not used. These words are not contracted before any word in which contractions may not be used. In addition, they are not used before mathematical letters, single letter or short-form word abbreviations, Roman numerals, dash or ellipsis, any math symbol, or function names.

From a to z

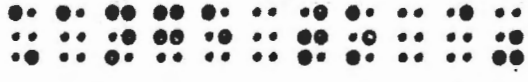
A into AB



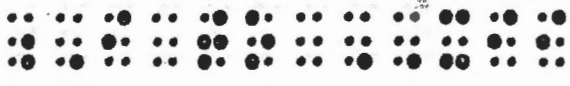
days to yrs.

open to p. 7

change to %



I to XII



g. Contractions are not used if they would be read as mathematical terms.

Can C = 100?

DECIMAL POINT .

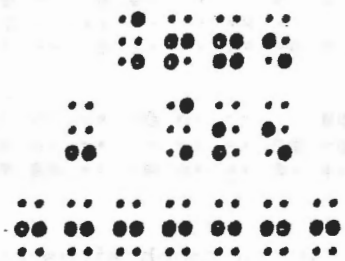
a. A numeric indicator is required before the decimal point if the decimal is preceded by a space.

.50

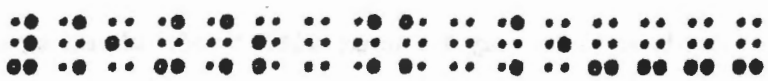
.50 + 1.50

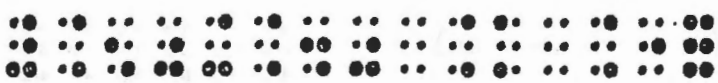
b. The numeric indicator is not required with a decimal point for material arranged for computation.

$$\begin{array}{r} .675 \\ -\ .25 \\ \hline \end{array}$$



c. When a decimal point is followed by a general omission symbol or a long dash, the multipurpose indicator (dot 5) is required between the two signs.

.1 + .2 = .____ 

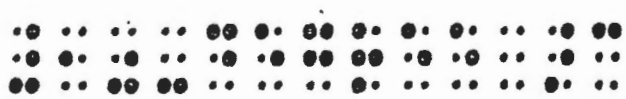
.50 + .40 = .? 

DEGREE SIGN o

a. The degree sign requires the superscript indicator, and the base line indicator is needed after the degree sign, unless it is followed by a space, comma, punctuation indicator, or another level indicator.

$60^{\circ} + 30^{\circ}$

b. If the word "degree" is used, follow the print.

10-degree arc 

DITTO MARKS "

a. Ditto marks are centered below the material which they duplicate.

b. A space is left on each side of a ditto mark.

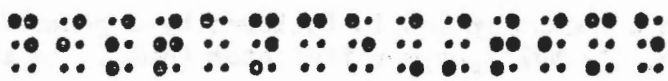
DIVISION SIGN (Divided by) ÷

a. The division sign is a sign of operation; no spaces are required with numerals, letters, or symbols of shape.

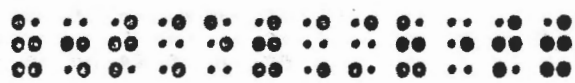
264 ÷ 4 = △

△ ÷ □ = 6

b. Contractions are not used in words which touch signs of operation.

distance ÷ time 

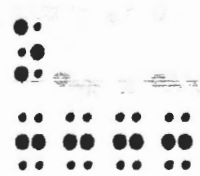
c. Contractions may be used with words which are enclosed in grouping symbols.

(distance)÷(time) 

DIVISION SIGN, FORMAT SYMBOLS

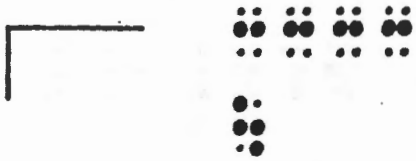
Normal with curved side

Inverted with curved side

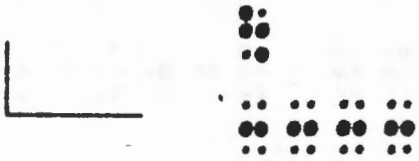


DIVISION SIGN, FORMAT SYMBOLS, continued

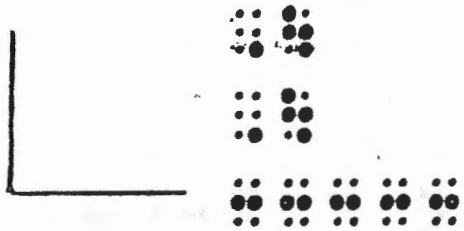
Normal with straight side



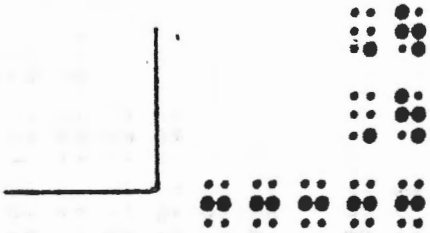
Inverted with straight side



Normal synthetic division



Reverse synthetic division



a. Two braille lines are necessary for these division signs (three for synthetic division); all separation lines must extend one cell beyond any numerals in any line when the quotient or partial products are shown.

b. No separation line is used for problems to be worked by the student. This is not considered a spatial arrangement; a numeric indicator must be used for the open numeral. No lines are skipped above or below such problems.

c. If a remainder is shown in print, separate it from the answer by a space, and follow the print copy for capital or small letter. The "r" of the remainder must be followed by the multipurpose indicator (dot 5) to show that the remainder is not a subscript. (See Subscripts)

d. A vertical line in print may be indicated by dots 4, 5, 6, or it may be drawn with a stylus. Follow print if separation lines extend to the right.

e. When a comma or decimal is shown in the dividend, a column of blank cells is left throughout the problem except in separation lines. If a caret is shown, a blank column of two cells is left. If both caret and decimal are shown, a column of one cell is left below the decimal, and a column of two cells is left below the caret.

f. Square root follows division format, but no divisor is used. Follow print as closely as possible.

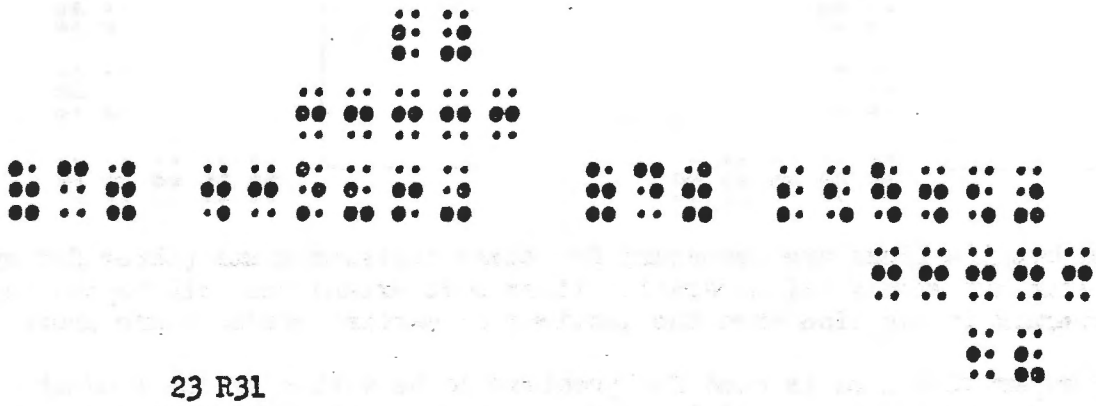
g. In synthetic division, numerals are aligned by place value; signs of operation are aligned; and a line of empty cells is left between adjacent columns.

h. The problem number is placed on the line which contains the dividend in all division problems. (See examples.)

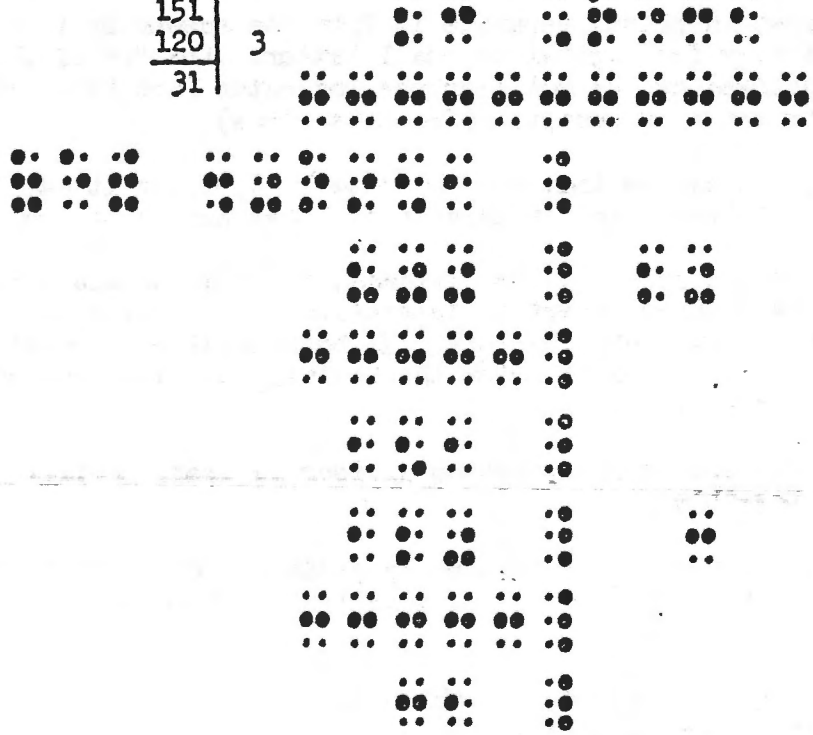
DIVISION SIGN, FORMAT SYMBOLS, continued

(a) 62)185 (b) 28)161

(c) 43)860 (d) 25|450
18



(e) 23 R31
40)951
800 | 20
151
120 | 3
31



DOLLAR SIGN $ ⠈⠎

a. Follow print for position of the dollar sign--to the left or right of numeral.

b. The numeric indicator is not used when a dollar sign precedes a numeral.

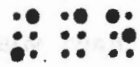
$8.25 ⠈⠼⠓⠂⠢⠑ ____$ ⠼⠈⠎

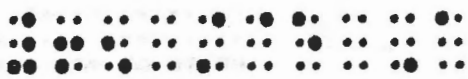
DRAWINGS, RAISED LINE

a. Since drawings are used for all levels of mathematics, it is important to have some basic drawing equipment. A compass, tracing wheel (for dotted lines), ruler, protractor, stylus or drawing pen, slate, and drawing pad are minimum requirements. A magazine, cardboard, heavy rubber, or plastic can be used for a drawing pad.
b. Drawings should duplicate the print copy, but should be large enough to accommodate numerals, letters, degrees, etc., that are shown in print. Use two or three inches for the side of a triangle.
c. Elaborate drawings for children should be avoided; brailled letters or words, or simple designs should be used instead. (Item from workbook: "Find the one that is different," drawings of six rabbits, one duck.)
d. Use numeric indicator, numeral; use a letter indicator for uncapitalized letters. No indicator required for capital letters.
e. If several drawings are to be made on one page, be sure they are not crowded. If drawings almost touch, they are difficult to read.
f. Third dimensional drawings are difficult for a blind student to understand. It is better to use a solid figure (cardboard and masking tape), or draw several views of the same figure, each a single plane.
g. If a pattern of solid basic lines and dotted secondary lines is established, the student learns to depend on this pattern, and looks for it.
h. Before using ruler and drawing tool, sketch the drawing on the right side of the braille paper, with a sheet of carbon paper face up under the braille sheet. Then turn the braille page over and make the final drawing from the carbon lines which show the drawing in reverse.
i. Braille preliminary information, make the drawing, reinsert the paper in the brailler (or use slate and stylus) to add information on the drawing.
j. Number line drawings may require solid lines and dotted lines. Brailled dots may be used; enlarged dots may be made for number points. Arrows may be made with brailler or drawing tool. If necessary, omit numeric indicator, use fold-in sheet, or number line may be drawn vertically with the numbers written horizontally.
k. A "permanent" number line can be made of wood or cardboard (ruler or yardstick) with numbers and number marks brailled on "glue on" plastic.
l. Basic shapes can be cut of cardboard and used as patterns for drawings.
m. Avoid altering the arrangement of drawings. Let the student and classroom teacher be able to depend on accuracy in transcription.

ELEMENT OF, IS AN (Is a member of) $\in$ or $\in$

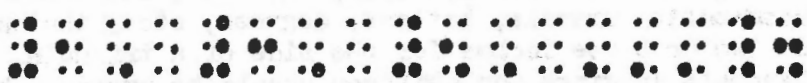
64 $\in$ A (Set A consists of all even numbers; 64 is an element of Set A)

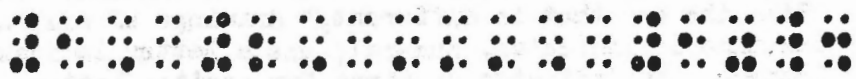
ELEMENT OF, IS NOT AN $\notin$ or $\notin$ 

65 $\notin$ A  (Set A consists of all even numbers; therefore 65 is not an element of Set A)

ELLIPSIS ...

a. An ellipsis may be used as a mathematical or as a literary sign. It represents an omission of term, entry, or line, and requires a punctuation indicator when followed by literary punctuation. If used in a literary sense, no punctuation indicator is needed.

1, 3, 5, ... 

1, 2, ..., 10. 

ones, tens, ...

b. A space is left between an ellipsis and a sign of operation or comparison, but no space is needed with indicators, grouping signs, symbols for decimal, dollars, cents, percent, and primes, or punctuation except the hyphen.

20 + ... = 24

(..., -1, 0, ...)

9¢ + 7¢ = ...¢

ENGLISH-LETTER INDICATOR

a. A "single letter" is an unmodified, regular type letter from the English alphabet, is not an abbreviation, and is preceded and followed by a space or punctuation. Grouping signs are not punctuation marks.

b. The letter indicator is used before a single letter or an uncapitalized letter group which corresponds to a short-form word. Not used when the letters are preceded or followed by a sign of comparison (or operation).

Find x.

"x"

$x^2 + y$

X-, Y-, and Z-axes.

Exercises A-F; p. 7 ("p." is an abbreviation)

C. stands for Centigrade. (abbreviation with period)

32° F = 0° C. (abbreviations without periods)

ab is parallel to cd (short-form word letters)

ab = cd (comparison sign used)

c. Used before letters with plural, possessive, or ordinal endings, if the indicator would be needed with the ending removed. The ending does not require an English-letter indicator.

x's

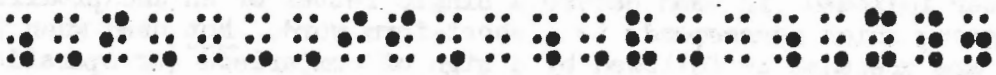
xs

nth

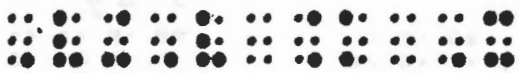
ENGLISH-LETTER INDICATOR, continued

d. Used before single capitalized Roman numerals, and before uncapitalized Roman numerals. The letter indicator is repeated before a second numeral when two are joined by a hyphen. No indicator is needed when grouping signs enclose a Roman numeral, or signs of operation or comparison are used.

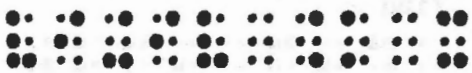
I, II, V, X.



V + V = X



vi + iv = x



i, ix, xi-xiv, I-X

i = 1, v = 5.

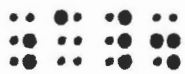
(I) (ii) (III) (iv-x)

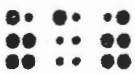
e. Used before letters of problem subdivisions unless the letter is enclosed in grouping signs.

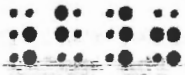
1.
  a.
  b.

1.
  (a)
  (b)

1.
  a)
  b)







f. Used in drawings or diagrams with an uncapitalized letter; not used with capital letters.

g. Used in tables for headings or entries according to position and use in the table. Follow rules for English-letter indicator.

ENGLISH-LETTER INDICATOR, continued

h. When the numerator and denominator of a fraction written spatially are single letters or short-form word letters, each letter or letter group is preceded by a letter indicator.

$\frac{x}{y}$ $\frac{a}{ab}$ $\frac{x + y}{x - y}$

i. Each capitalized or uncapitalized letter of a type-form that is not standard (boldface, italics, script), and that has mathematical significance, has a letter indicator following the type-form indicator.

AB (boldface type) *ab* (italics) *ab* (script)

j. Not used for letters of an "enclosed list." If the material is not actually an enclosed list, the letters involved require letter indicators just as they would if the parentheses, braces, or brackets were removed.

(An "enclosed list" consists of at least two items surrounded by grouping signs; items must be separated by commas, contain no literary term (word, abbreviation, plural ending, ordinal ending), or other punctuation. An omission sign or ellipsis may be used in the list as an omission symbol.)

(a, b, c, d, ...) (an enclosed list)

(p and q) (not an enclosed list)

(x, x + 1, ?) (an enclosed list)

(a, b; m, n) (not an enclosed list)

ENGLISH-LETTER INDICATOR, continued

k. Not used for a letter that follows a sign of shape, unless the sign of shape has a possessive or plural ending (the mathematical sequence has been interrupted by a literary letter).

∠a

∠s a, b, c

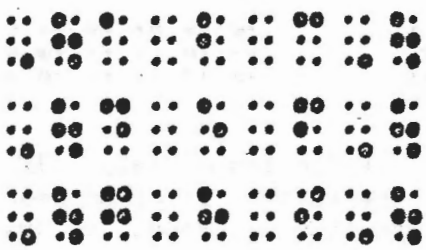
l. Not used with function names or their abbreviations.

Arc Sine x

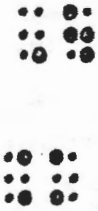
sin x

m. Not used before any entry in a determinant or matrix.

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$$

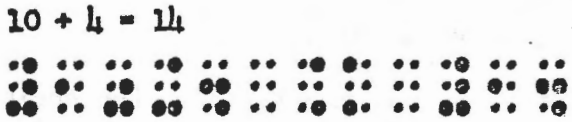


EQUALS SIGN =

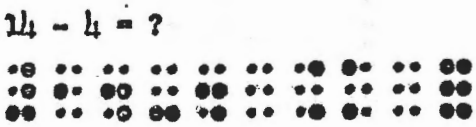


a. The equals sign is a comparison sign; space before and after.

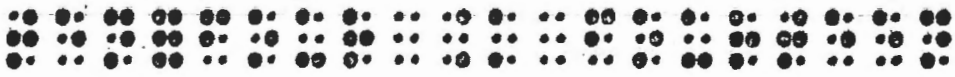
10 + 4 = 14



14 - 4 = ?



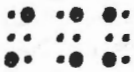
ten ? four = fourteen



='s added to ='s are =

b. The equals sign is made to read "is not equal to" by using the negation sign directly before the equals sign. Although various angle directions of the negation line may be used in print, only one is used in braille.

A ≠ B

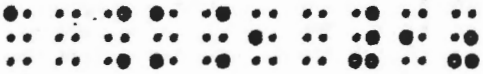
+ ≠ 

c. A boldface equals sign is shown by writing the boldface type indicator before the equals sign.

EQUAL TO OR GREATER THAN ⩾ ⩾ or ≥

a. Follow print for sign used. Some texts use a single line, or horizontal bar, as an equals sign when combined with another comparison sign.

a ⩾ 10



a ⩾ 10

b. The negation line will make this sign read "is not equal to or greater than."

4 ⩾̸ 5

EQUAL TO OR LESS THAN ⩽ ⩽ or ≤

A ≤ B

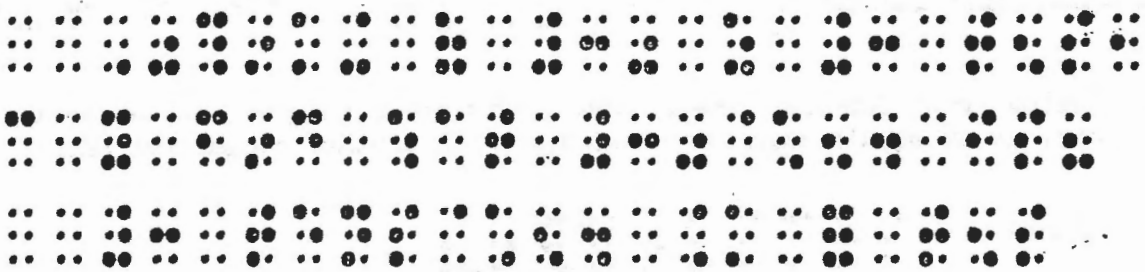
FORMAT

a. Narrative Material

Paragraphs that are not numbered or lettered begin in cell 3, with runovers beginning in cell 1. An embedded expression is written within the paragraph with no changes in spacing. A displayed expression begins in cell 3 of a new line, with any runover beginning in cell 5. The anchor of a linked expression begins in cell 3 of a new line, runover in cell 7. Each link begins in cell 5 of a new line, runover in cell 7.

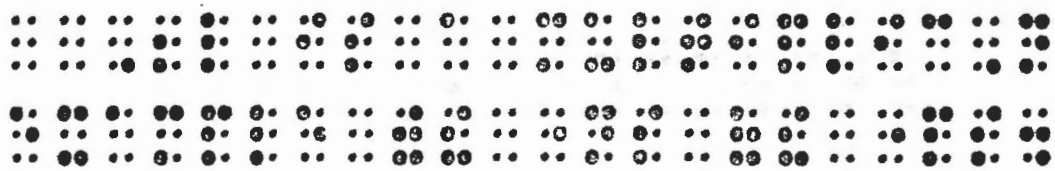
(Illustration 1) By thinking of 30 as 3 tens, can you find what 30 X 54 is?

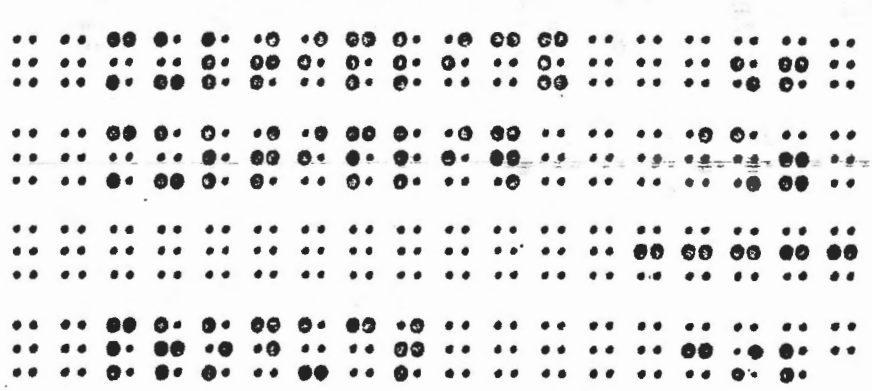
3 tens X 54 = ? tens



(Illustration 2) Below is a multiplication example with the names of the parts.

multiplicand ⟶ 56
multiplier ⟶ X 7
product ⟶ 392



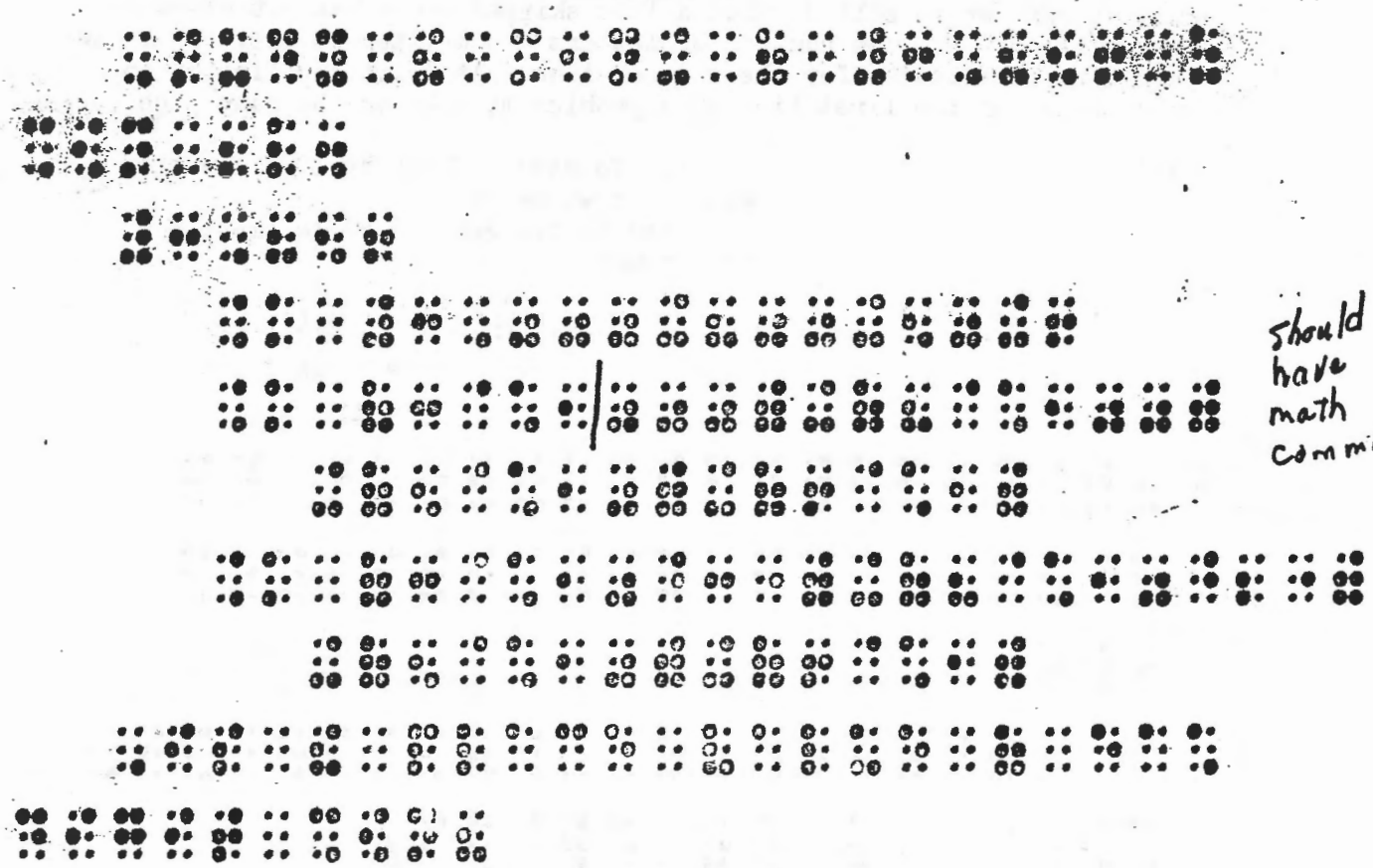


FORMAT; Narrative Material, continued

(Illustration 3) Study the meaning of 3,856 as shown below.

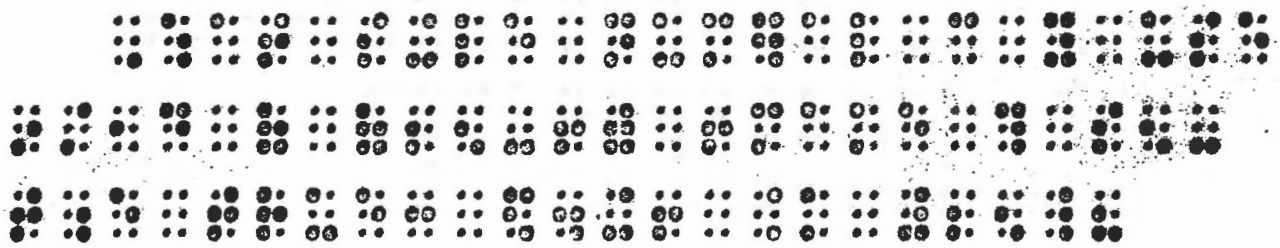
$$3{,}856 = 3{,}000 + 800 + 50 + 6$$
$$= (3 \times 1{,}000) + (8 \times 100) + (5 \times 10) + (6 \times 1)$$
$$= (3 \times 10^3) + (8 \times 10^2) + (5 \times 10) + (6 \times 1)$$

Is the place value of each digit shown?



should have math commo

(Illustration 4) What single numeral can you use instead of (25 - 6) to make this sentence true: □ + 6 = 25?



FORMAT, continued

b. Itemized Material with Main Divisions only

Itemized materials are numbered or lettered exercises or outlines. Main divisions begin in cell 1, runovers in cell 3. Sub-paragraphs (without number or letter) begin in cell 5, runovers in cell 3. A displayed expression begins in cell 5, runover in cell 7. The anchor of a linked expression begins in cell 5, runover in cell 9. Each link begins in cell 7, runover in cell 9. Instructions for a group of problems begin in cell 5, runover in cell 3, with a line skipped above but not below the instructions. Problem numbers or letters are written in cell 1. A new-page line substitutes for the skipped line. At least one line of instructions and the first line of a problem must be on the same page.

(Illustration 1)

1. To divide 736.4 by 100, use the method shown below.

What is the correct replacement for the frame?

$$736.4 \div 100 = 736.4 \times \frac{1}{100}$$
$$= 736.4 \times .01$$
$$= \square$$

FORMAT; Itemized Material with Main Divisions only, continued

(Illustration 2)

Divide each of these numbers by 10; by 100; by 1,000.

1. 168.53 2. .915 3. 937.54

(Illustration 3)

Copy, divide, and check.

1. 15) $144.15 58) 37,199 55) 3,371

2. 39) 2,900 44) 42,271 63) 3,881

FORMAT, continued

c. Itemized Material with Main Divisions and Subdivisions

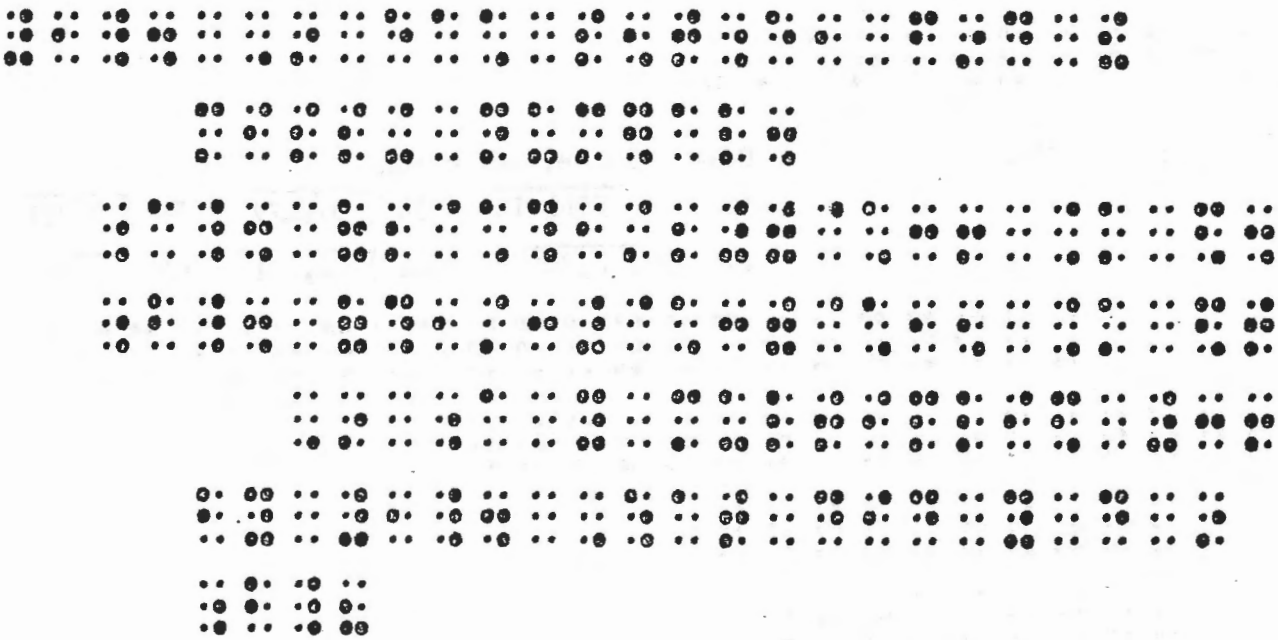
When itemized material has main divisions and subdivisions, main divisions begin in cell 1, runovers begin in cell 5. Subdivision numbers or letters begin in cell 3, runovers in cell 5. Sub-paragraphs begin in cell 7, runovers in cell 5. Displayed expressions begin in cell 7, runovers in cell 9. The anchor of a linked expression begins in cell 7, runover in cell 11. Each link begins in cell 9, runover in cell 11. Instructions for a group of problems begin in cell 5, runover in cell 3, and a line is skipped above but not below the instructions. Problem numbers are written in cell 1. A new page-line substitutes for the skipped line. The last line of instructions and the first line of a problem must be on the same page. Subdivisions may be written on a single line if there is no runover.

(Illustration 1)

1. In each sentence, find the missing numeral.

a. $(2 \times \frac{1}{2}) \times 36 = \square$ b. $(\frac{1}{3} \times 3) \times 15 = \triangle$

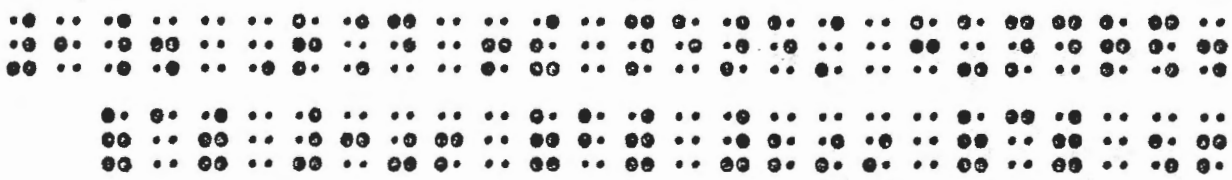
In a you multiplied 36 by 1. What did you do in b?



(Illustration 2)

1. Round to the nearest hundred.

(a) 306 (b) 299 (c) 56



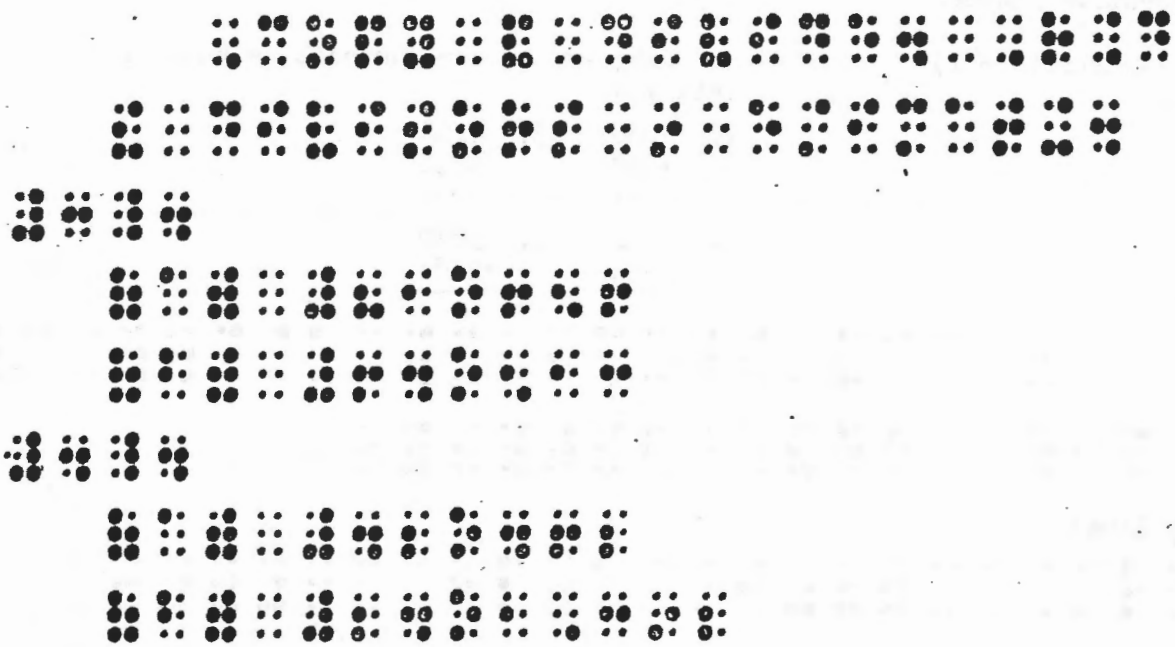
FORMAT; Itemized Material with Main Divisions and Subdivisions, continued

(Illustration 3)

Copy and divide. Round the divisors in estimating.

3. (a) $81\overline{)656}$ (b) $64\overline{)513}$

4. (a) $42\overline{)462}$ (b) $24\overline{)1,392}$



d. Spatial Arrangements

1) A line must be skipped before and after spatial arrangements. Directions which precede the problems, but which have no number or letter, begin in cell 5, runovers begin in cell 3. A line is skipped after the directions.

2) Problem numbers or letters are written on the same line as the top numerals of addition, subtraction, or multiplication problems. Carried numbers, carrying line, or cancellation numbers are on lines above the problem numbers.

3) Problem numbers or letters are written on the line with the dividend of division problems, and the radicand of square root.

4) Fractions written spatially have the problem number on the line which shows the fraction line. The top line of continued fractions and the problem numbers are on the same line. Problem numbers are written with the top line of determinants, matrices, and unified expressions.

5) No numeric or letter indicators are used for spatially arranged addition, subtraction, multiplication, or division.

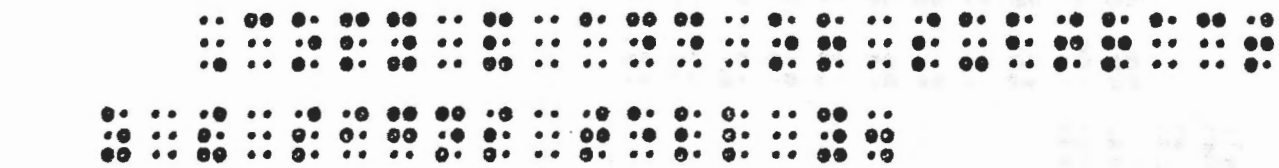
FORMAT; Spatial Arrangements, continued

6) When spatial arrangements consist of main divisions only, the number or letter of the first problem begins in cell 1. An empty cell forms a column between the end of the problem number and the first cell of the longest line of the problem--usually the separation line. Another empty cell column separates the last cells of the problem from the second problem number. Problems follow in numerical order across the page, regardless of print order. A second row of problems begins in cell 1 with the next consecutive number.

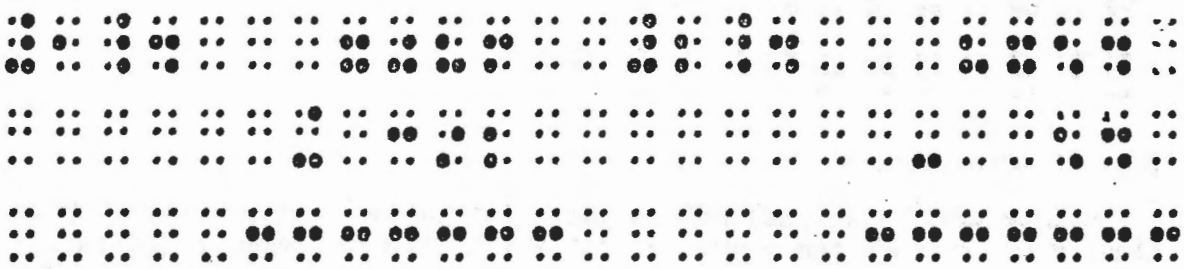
(Illustration 1)

Copy and add or subtract as the signs tell you.

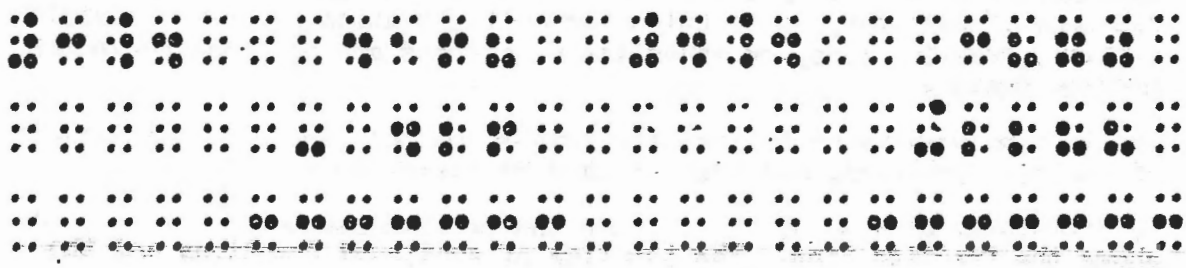
1.	7086 +392	3.	4168 -426
2.	8754 -54	4.	3870 +2288



(skip line)



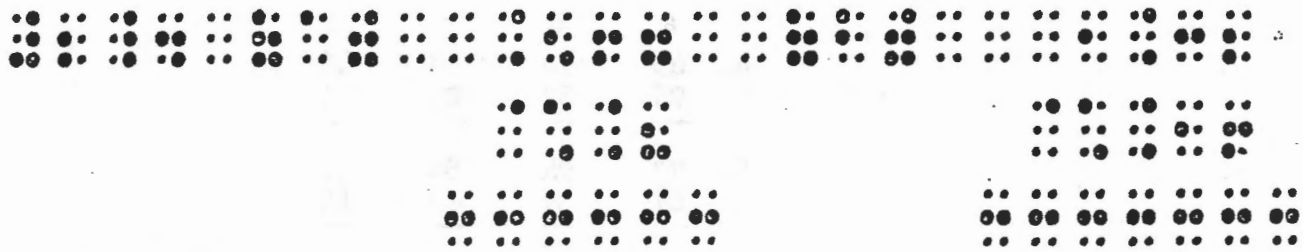
(skip line)



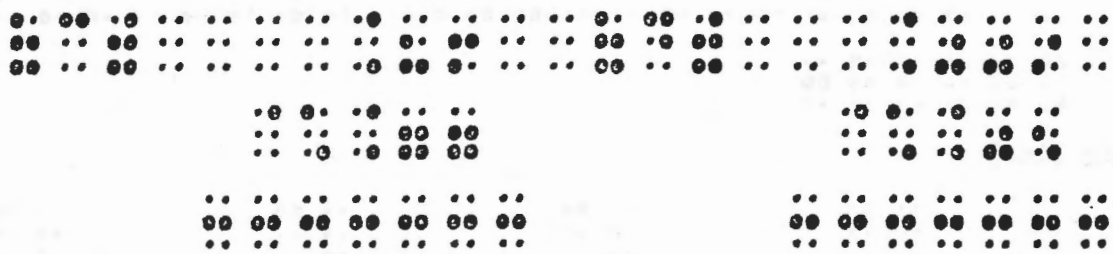
FORMAT; Spatial Arrangements, continued

7) Main divisions which are followed by subdivisions begin in cell 1. The first subdivision number or letter may be written on the same braille line with the problem following, or the format of itemized material may be used (see Illustration 3). Other problems are written in numerical order across the row; a second row begins in cell 3 with the next subdivision number.

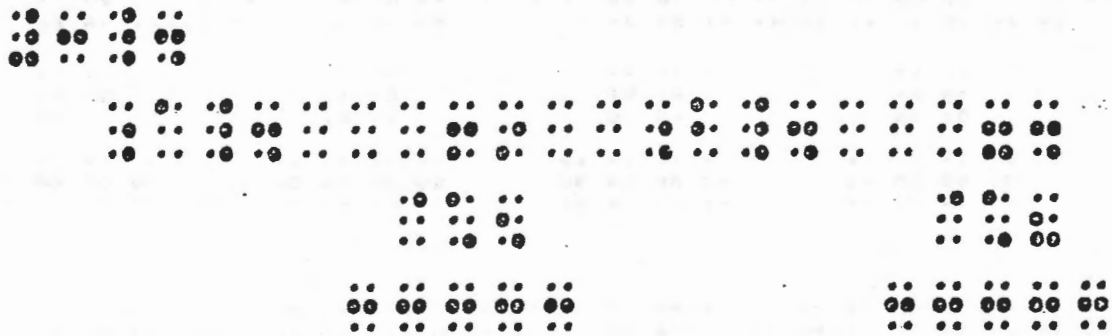
(Illustration 2) 2. (a) .567 X .8 (b) 1.32 X .16 (c) .86 X .77 (d) .009 X .05



(skip line)



(Illustration 3) 3. a. 69 X 5 b. 74 X 8 c. 42 X 7



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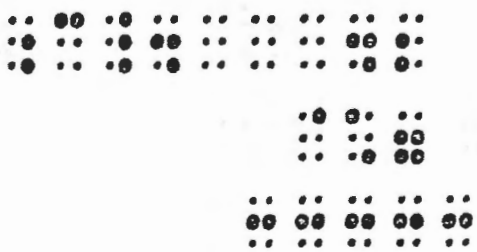
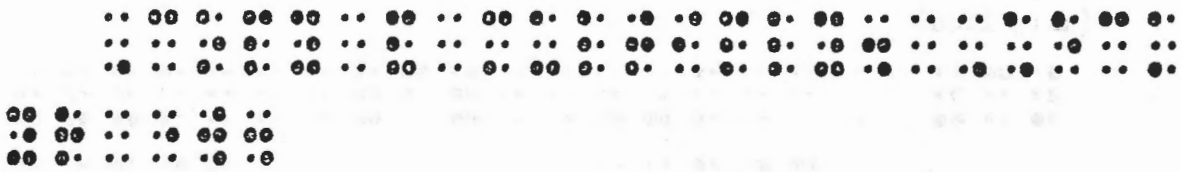


FORM; Spatial Arrangements, continued

8) Itemized material arranged in tabular form with numbered rows and lettered columns (or the reverse) have column letters beginning in the same cell as the column material, a line skipped above and below the letter heading, and row numbers beginning in cell 1. Two cells are skipped between columns. If all the items cannot be completed in one row with this method, each number should be considered a main division, and each column letter a subdivision (see d7 above).

(Illustration 4) Copy and multiply. Check your work.

	a	b	c	d
4.	43	96	58	46
	95	57	29	53
5.	73	94	86	57
	67	39	62	84



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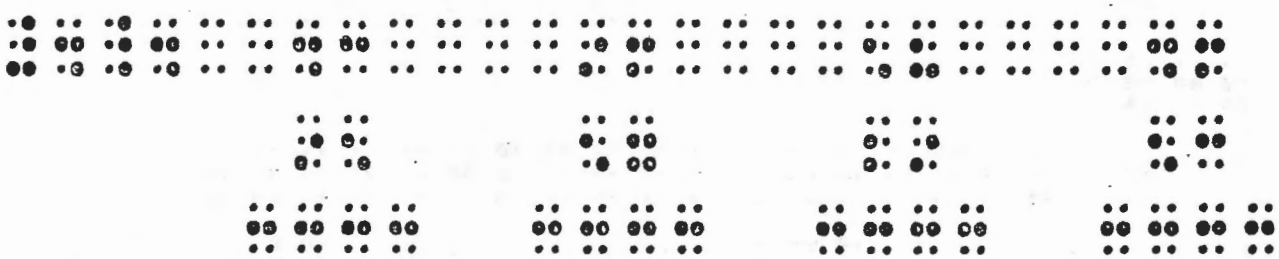

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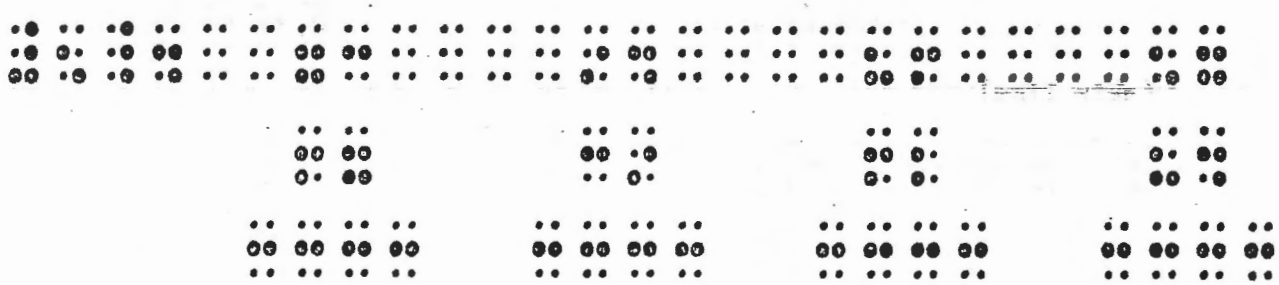
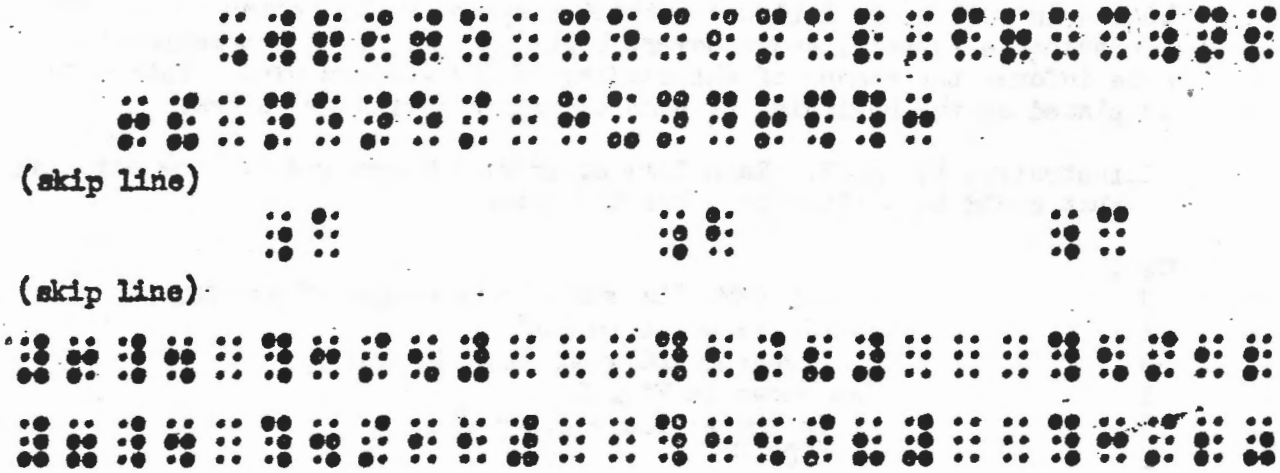


FORMAT; Spatial Arrangements, continued

(Illustration 5)

Write decimal fractions to the nearest hundredth:

	a	b	c
6.	$\frac{3}{5}$	$\frac{1}{8}$	$\frac{5}{12}$
7.	$\frac{4}{11}$	$\frac{15}{8}$	$\frac{3}{20}$



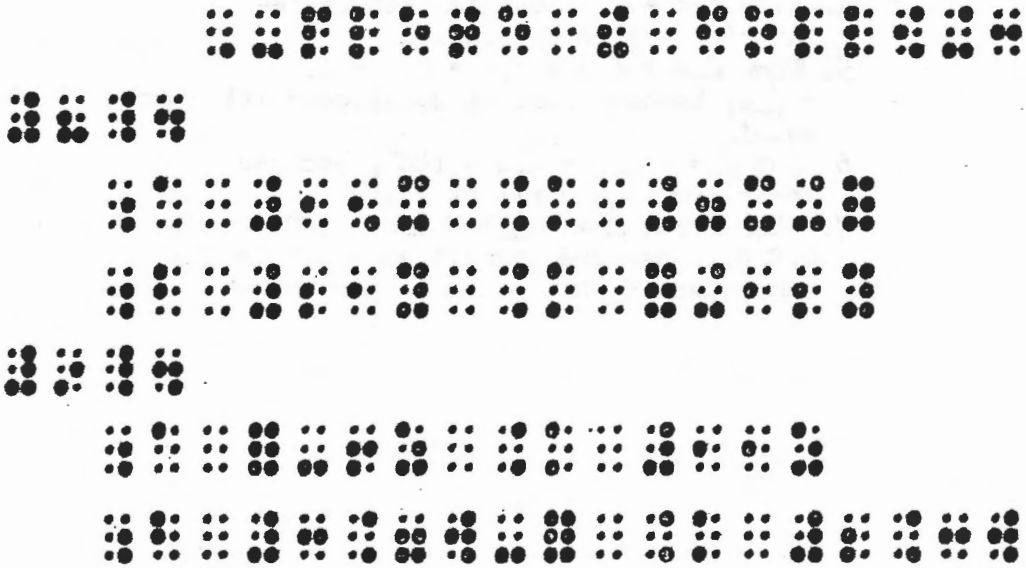
(skip line)

(skip line)

(Illustration 6)

Complete the following:

	a	b
8.	$15x = 7x + ?$	$21y = ? + 12y$
9.	$? - 6z = 11z$	$3.7w - ? = 2.3w$



FORMAT, continued

e. Formal Proofs

1) A line is skipped before and after a formal proof. The introductory word (THEOREM, PROPOSITION, or LEMMA) is fully capitalized, begins in cell 3, and statement runover begins in cell 1. Auxiliary headings (Given, Hypothesis, Prove, or Conclusion) begin in cell 3, no line is skipped, print is followed for capitals or italics, and statement runovers begin in cell 1.

2) When work of a formal proof is shown by step number in two columns with word headings (Statement, Reason, or other term), each step number begins in cell 1, is followed without a space by the letter "S" or "R" (or suitable letter), and runovers begin in cell 3. A transcriber's note informs the reader of the meaning of the letters used. This note is placed at the beginning of each appropriate braille volume.

(Illustration 1) NOTE: Each line of print is arranged to show material that could be written on a braille line.

Cell	
3	THEOREM: The sum of the angles of any tri-
1	angle is equal to 180°.
3	Given: $\triangle$ABC with $\angle$s a, b, and c,
1	as shown in Fig. 21.
3	To prove: $\angle a + \angle b + \angle c$
1	= 180°.
3	PROOF:
Skip	
1	1. Let BD be the line through B parallel
3	to AC, by the parallel postulate.
1	2. Then $\angle a = \angle d$, since corre-
3	sponding angles are equal.
1	3. And $\angle b = \angle b$ is an identity.
1	4. Also $\angle c = \angle e$, because alternate-
3	interior angles are equal.
1	5. Then $\angle a + \angle b + \angle c = \angle d + \angle b$
3	$+ \angle e$, because sums of equal quantities are
3	equal.
1	6. But $\angle d + \angle b + \angle e = 180°$, because
3	their sum is a straight angle.
1	7. Therefore, $\angle a + \angle b + \angle c = 180°$,
3	Q.E.D., because quantities equal to the
3	same quantity are equal to each other.

FORM ; Formal Proofs, continued

(Illustration 2) The same formal proof as it would be written in two columns in print. Below, the same proof as it would be written in braille; each line of print equals the cells of a braille line.

...

To prove: $\angle a + \angle b + \angle c = 180^\circ$.

Proof:

Statement	Reason
1. Let BD be a line through B parallel to AC.	1. Parallel postulate.
2. $\angle a = \angle d$.	2. Corresponding angles are equal.
3. $\angle b = \angle b$.	3. Identity.
4. $\angle c = \angle e$.	4. Alternate-interior angles are equal.
5. $\angle a + \angle b + \angle c = \angle d + \angle b + \angle e$.	5. Sums of equal quantities are equal.
6. $\angle d + \angle b + \angle c = 180^\circ$.	6. A straight angle equals 180°.
7. $\therefore \angle a + \angle b + \angle c = 180^\circ$.	7. Quantities equal to the same quantity are equal to each other.

(Braille format)

1S. Let BD be a line through B parallel to AC.
1R. Parallel postulate.
2S. $\angle a = \angle d$.
2R. Corresponding angles are equal.
3S. $\angle b = \angle b$.
3R. Identity.
4S. $\angle c = \angle e$.
4R. Alternate-interior angles are equal.
5S. $\angle a + \angle b + \angle c = \angle d + \angle b + \angle e$.
5R. Sums of equal quantities are equal.
6S. $\angle d + \angle b + \angle c = 180^\circ$.
6R. A straight angle equals 180°.
7S. $\therefore \angle a + \angle b + \angle c = 180^\circ$.
7R. Quantities equal to the same quantity are equal to each other.

FRAC ONS AND MIXED NUMBERS

Simple Fractions

Indicators: Opening Closing

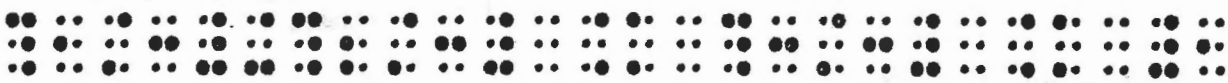
Horizontal fraction line: Diagonal fraction line:

a. A linear arrangement is preferred for writing fractions, but spatial arrangements may be used when fractions are first introduced to children. The numerator and denominator of a simple fraction contain no fractions. Fraction indicators surround the fractions, and a fraction line is placed between the numerator and denominator. No numeric indicator or letter indicator is needed, and there are no spaces between the parts.

$\frac{1}{2}$

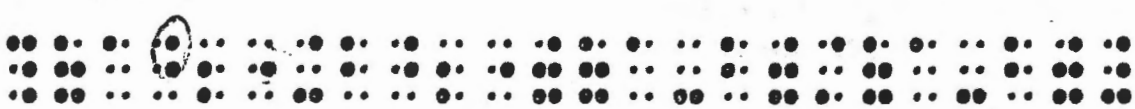
$\frac{x + y}{x - y}$

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



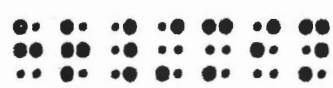
b. Simple fractions may have superscripts, subscripts, grouping symbols, signs of operation, radicals, or any combination of these, and they are still simple fractions.

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



c. The diagonal fraction is frequently used with the meaning "per." Words or abbreviations may be used, without spaces, in a linear arrangement.

6 cu. ft./min. hr/min

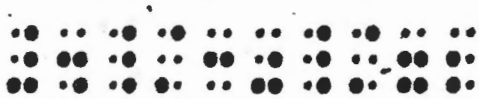


FRACTIONS AND MIXED NUMBI imple Fractions, continued

d. When a diagonal fract line is shown in print, with the numerals on the same level and of the size as the surrounding material, the fraction indicators are not This leaves an open numeral; a numeric indicator is needed.

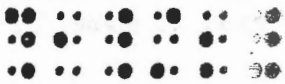
1/2

4/30/72



e. If numerals are on dif ent levels, or are of a different size type, fraction indicators ar used with the diagonal fraction line.

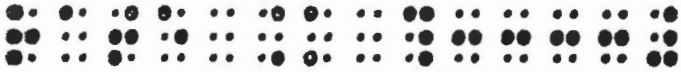
1/2



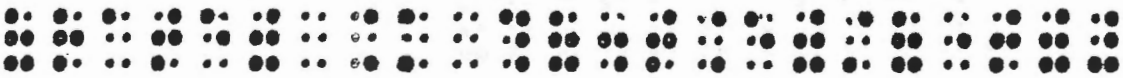
e. When a word, or abbreviation without a period, touches a fraction indicator or line, no contractions are used in the word. If a fraction is written spatially, the words do not touch indicators or line, and contractions may be used. Fraction words within grouping symbols do not touch fraction indicators or line, and contractions may be used.

rate = distance / time

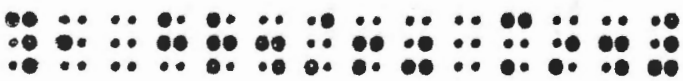
rate = distance / time



(rate) = (distance) / (time)



1 hr. / 60 min.



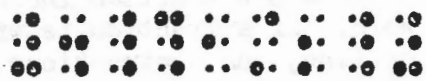
FRACTIONS AND MIXED NUMBERS, continued

Mixed Numbers

Indicators for the fractional part of a mixed number:

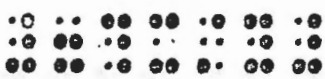
Opening Closing Fraction line

a. A mixed number is a whole number with a fractional part-number. It is considered a unit in itself, not a number and separate fraction, and there are no spaces in the group. A numeric indicator is needed for an "open" numeral. The diagonal fraction line is used if shown in print.

$4\frac{1}{2}$ 

$4^3/_8$

b. There are no letters in a mixed number. In the example below, the 7 is multiplied by the fraction "x over y."

$7\frac{x}{y}$ 

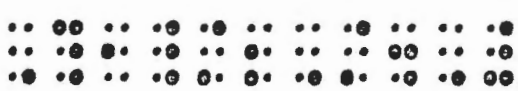
Complex Fractions

Indicators: Opening Closing

Horizontal fraction line: Diagonal fraction line:

a. To be a complex fraction, the numerator and/or the denominator must be a simple fraction or a mixed number.

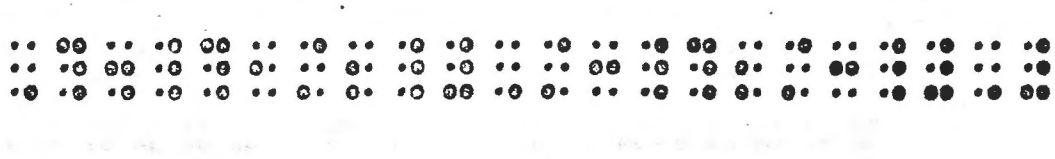
$\frac{\frac{1}{2}}{4}$

$\frac{1/2}{4}$ 

FRACTIONS AND MIXED NUMBERS; Complex Fractions, continued

b. A mixed number divided by a mixed number, written in fraction form, is a complex fraction, and complex fraction indicators must be used at beginning and end. A complex fraction line is used for the main fraction line.

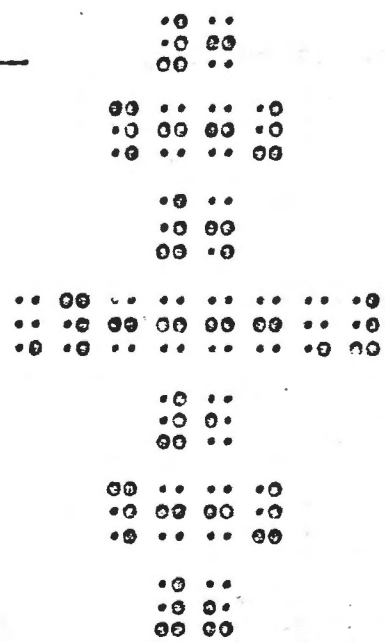
$$\frac{4\frac{1}{2}}{3\frac{2}{3}}$$



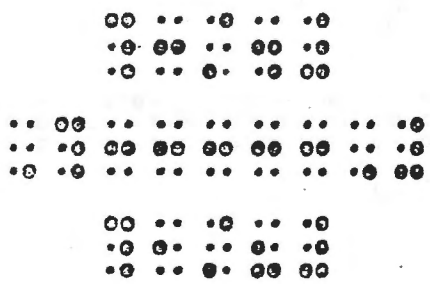
c. When fractions are written spatially, the appropriate fraction indicators are placed at the beginning and end of the separation line which is as long as the material above or below it. The numeric indicator is used for open numerals; the letter indicator is used for single letters or letter groups which correspond to short-form words. In fractions written semi-spatially, the numerator and denominator are written in a linear manner, and the spatial fraction line (separation line) is between them. If any runover is necessary for either numerator or denominator, the two required lines are centered with the runover below the first line used.

Spatial arrangement:

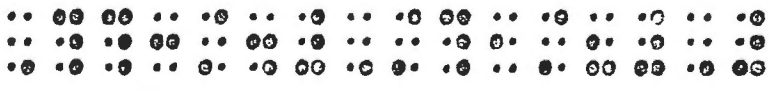
$$\frac{\frac{3}{4}}{\frac{1}{8}}$$



Semi-spatial arrangement:



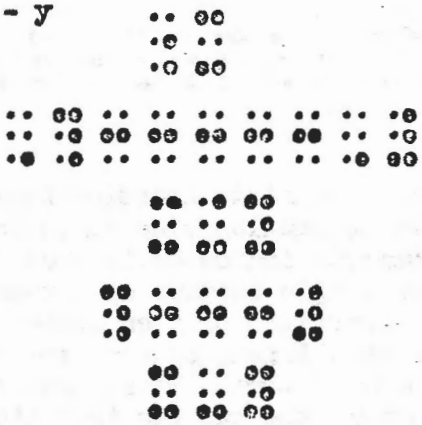
Linear arrangement:



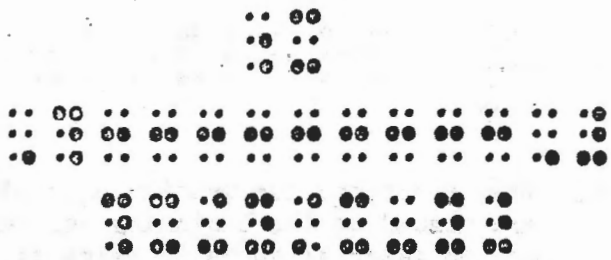
FRACTIONS AND MIXED NUMBERS; Complex Fractions, continued

Spatial arrangement:

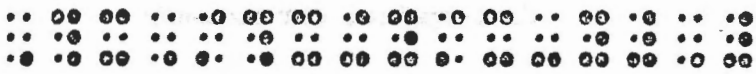
$$\frac{x}{\frac{x+y}{x-y}}$$



Semi-spatial arrangement:

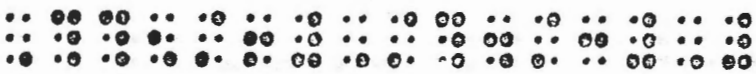


Linear arrangement:

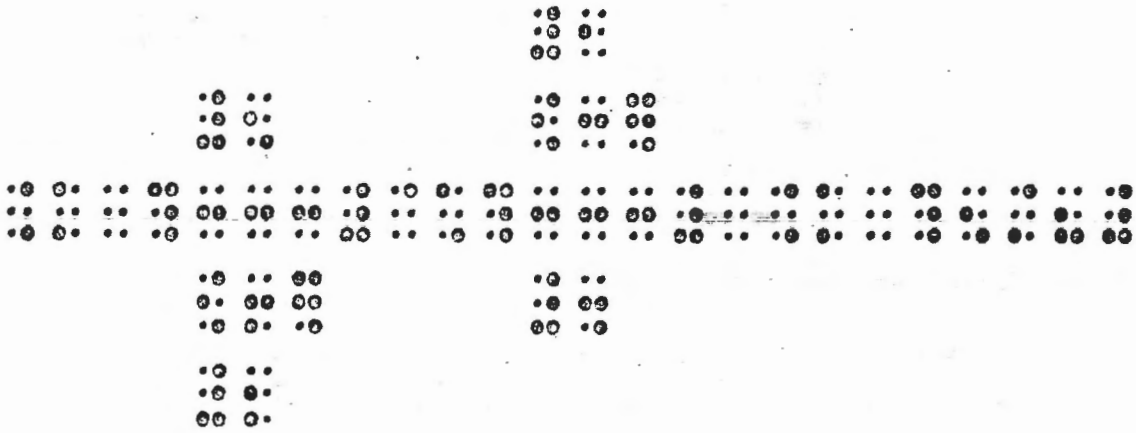


d. Fractions showing cancellation must be written spatially.

$$\frac{\frac{5}{6}}{\frac{4}{3}} = \frac{5}{\cancel{6}_{2}} \times \frac{\cancel{3}^{1}}{4} = \frac{5}{8}$$



(skip line)



FRACTIONS AND MIXED NUMBERS, continued

Hypercomplex Fractions

Indicators: Opening

```
•• •• ••
•• •• ••
•• •• ••
```

Closing

```
•• •• ••
•• •• ••
•• •• ••
```

Horizontal fraction line

```
•• •• ••
•• •• ••
•• •• ••
```

a. To be a hypercomplex fraction, the numerator and/or denominator must contain a complex fraction. A semi-spatial arrangement is best for hypercomplex fractions, but they may be completely spatial for instructional purposes.

b. Hypercomplex fractions are not in common use for arithmetic, algebra, or geometry. Print texts show a complex fraction, a division sign, another fraction.

GREATER THAN

```
>  •• ••
   •• ••
   •• ••
```

a. "Greater than" is a sign of comparison; space before and after.

9>5

```
•• •• •• •• •• •• •• ••
•• •• •• •• •• •• •• ••
•• •• •• •• •• •• •• ••
```

b. A negation line makes this sign read "is not greater than."

9≯10

```
•• •• •• •• •• •• •• •• •• ••
•• •• •• •• •• •• •• •• •• ••
•• •• •• •• •• •• •• •• •• ••
```

GREATER THAN OR EQUAL TO

≧

```
•• •• •• ••
•• •• •• ••
•• •• •• ••
```

≥ or ≥

```
•• •• ••
•• •• ••
•• •• ••
```

a. "Greater than or equal to" is a sign of comparison; space before and after. Follow print for equal sign or single line horizontal bar.

b. The horizontal bar is not treated as a modifier when used with a sign of comparison; it becomes a component of the sign.

a≥b

```
•• •• •• •• •• •• ••
•• •• •• •• •• •• ••
•• •• •• •• •• •• ••
```

GROUPING SYMBOLS

Parentheses ( ) Enlarged ( )

Braces { } Enlarged { }

Brackets [ ] Enlarged [ ]

Half Brackets

Upper left ⌈ Enlarged ⌈

Upper right ⌉ Enlarged ⌉

Lower left ⌊ Enlarged ⌊

Lower right ⌋ Enlarged ⌋

Transcriber's Grouping Symbols

Left Enlarged

Right Enlarged

a. Mathematical grouping symbols enclose both literary and mathematical material; literary grouping signs are used <u>only</u> on title pages of a book.

(Chap. V, pp. 62-74.)

(1-to-1)

$(x + 4)(x^2)$

{Mary, Sally, Jean}

[π = 3.1416]

GROUPING SYMBOLS, continued

b. An enclosed list requires no numeric or letter indicators for any item in regular type, including items of a runover.

ENCLOSED LIST:

An enclosed list consists of at least two items surrounded by grouping signs (need not be the same sign at beginning and end); items must be spaced and separated by commas, contain no literary term (word, abbreviation, ordinal or plural ending), comparison sign, or punctuation. An omission sign or ellipsis may be an item in the list. A function name or shape symbol and the signs which follow them are considered a single item, and may be part of an enclosed list, and the beginning item needs no indicator.

(1, 2, ..., 10]

(1,2,3,4,5)

$(6 + 2^2, 2 + 2^3)$

$(4\frac{1}{2}, 5, x)$

(a, ab, b, c, cd)

c. A list that is not enclosed requires numeric and letter indicators as they would be used if there were no grouping symbols involved. If the first numeral touches a grouping symbol, it is not an open numeral, and needs no indicator.

(1 2 3)

(a-z)

(-1, 1; -2, 2)

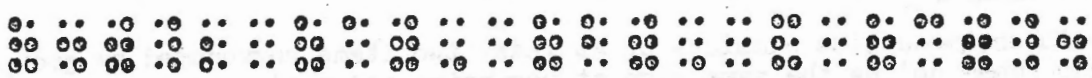
(u, v; x, y)

(a = 1, b = 2)

GROUPING SYMBOLS, continued

d. Single letters or numerals enclosed in grouping symbols require no indicators, provided they are English and in regular type.

(4); (a), (b), and (c).



e. The use of grouping symbols does not prevent the contraction of words or part-words except when the words listed below are in direct contact with a grouping symbol. If any words touch mathematical indicators, modifiers, operation signs, comparison signs, or a radical, contractions are not used.

EXCEPTIONS (when in direct contact with grouping symbols):

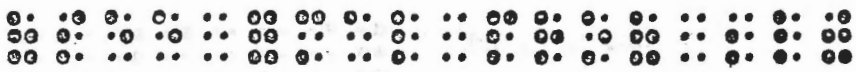
1) Whole word alphabet contractions but, can, do, ..., you, as.

2) Whole word lower-cell contractions be, was, were, his, in, enough.

3) Whole or part-word contractions and, of, the, for, with. (No other contractions may be used when these contractions are not used.

(distance) ÷ (time) = ?

(see formal proof below)

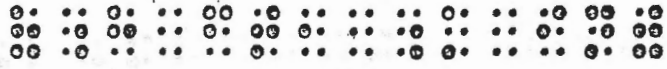


(Formal Proof)

(Proof Formal)

(3 tens and 7 ones)

(h ft, k in)



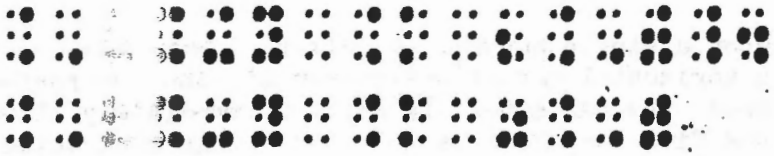
f. When grouping signs are used horizontally, it is recommended that raised line drawings be made. Horizontal signs are modifiers, and if brailled, must be transcribed according to the Five-Step Rule.

$\underbrace{x + y}$ $\quad$ $\underbrace{x + y}$ $\quad$ $(\underbrace{x + a)\overline{(x} + b)}$

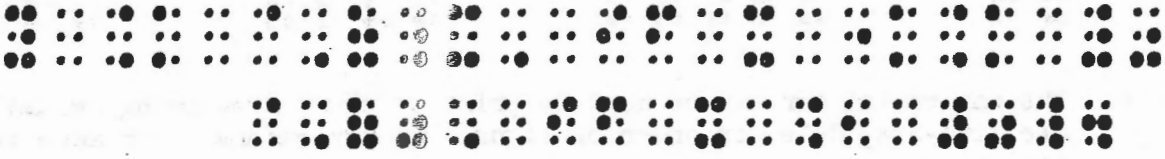
GROUPING SYMBOLS, continued

g. Enlarged grouping symbo[illegible]e used when mathematical expressions are ar-
ranged on two or more l[illegible] and a print grouping sign is shown. The print
may show an enlarged si[illegible] one side only, and this is followed in the
braille transcription. [illegible]rgement signs may be raised line drawings to
save space, if this is [illegible]sary.

$$\left\{\begin{matrix} x + y = 2 \\ x - y = 0 \end{matrix}\right\}.$$



$$y = \begin{cases} x, \text{ if } x \leqq 0 \\ 0, \text{ if } x > 0. \end{cases}$$



h. Enlarged grouping symbols are <u>not</u> used when print grouping symbols are made larger to cover a fraction or other material that requires more space, but is not a mathematical enlargement.

$$\left(\frac{x}{y}\right)$$

$$\left(\frac{P}{Q}\right)^2$$

i. Transcriber's grouping symbols are used to enclose a transcriber's note which has been inserted in the text. The enlarged symbol is used to show the explanation of a print arrangement of lines for which there is no suitable grouping symbol.

In x^2, the ^{2} is the exponent.

HORIZONTAL BAR — ⠸

a. The horizontal bar over letters indicates an open interval or line segment in geometry. See Modified Expressions, Five-Step Rule.

$\overline{AB}$ ⠈⠈⠐⠈⠐⠠⠐⠐
⠠⠈⠈⠈⠐⠠⠠⠠
⠈⠠⠈⠠⠈⠠⠠⠠

b. When a single numeral or letter (lower-case or capitalized) is shown with a horizontal bar directly over it, the contracted form of modification is used: the bar symbol is written immediately after the numeral or letter; the Five-Step Rule is not used. This contracted form may be used with the Five-Step Rule without causing confusion.

$\overline{x}$ ⠠⠸
⠈⠠
⠠⠠

$\overline{x} + \overline{y}$ ⠠⠸⠠⠸⠸
⠈⠠⠠⠠⠠
⠠⠠⠠⠠⠠

$\overline{xyz}$ ⠠⠠⠸⠸
⠈⠠⠠⠠
⠠⠠⠠⠠

$\overline{x}^2$ ⠠⠸⠠⠈
⠈⠠⠠⠈
⠠⠠⠈⠠

c. The horizontal bar may be used in print to show a recurring decimal. See Five-Step Rule for order of signs when bar extends over more than one numeral.

$.\overline{3}$ ⠠⠠⠈⠠
⠠⠈⠠⠠
⠠⠠⠈⠠

$23.\overline{072}$ (23.072072072...) ⠠⠈⠈⠠⠈⠈⠈⠈⠠⠠⠠
⠠⠠⠠⠈⠠⠠⠠⠠⠠⠠⠠
⠠⠠⠈⠠⠈⠠⠠⠠⠠⠠⠠

d. The horizontal bar may be combined with a comparison sign, and in this case means "equals." The example below reads "A is greater than or equal to B." A double or triple bar may modify a letter or number, but it must not be mistaken for an equals sign.

$A \geqslant B$ ⠈⠈⠈⠈⠠⠠⠈⠈⠠
⠠⠈⠈⠠⠈⠠⠈⠠⠈

$\overline{\overline{x}}$ ⠈⠠⠠⠠⠠⠠
⠠⠠⠠⠠⠠⠠
⠈⠠⠠⠠⠠⠠

e. The horizontal bar over or under the tilde reads "is equal or similar to" or "is similar or equal to."

$\overline{\sim}$ ⠠⠠⠠
⠠⠠⠠
⠠⠠⠠

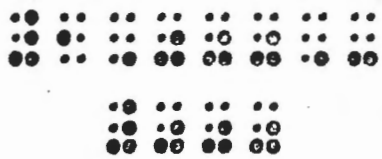
$\underline{\sim}$ ⠠⠠⠠
⠈⠠⠠
⠈⠠⠠

f. See NEMETH CODE TEXT for information on Modifiers of Higher Order, Subscripts and Superscripts with Modifiers, etc.

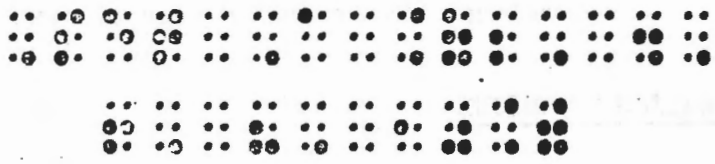
HYPHEN

a. A hyphen is either literary or mathematical; no punctuation indicator is required. The hyphen divides long numerals or words, but is not added to print to show the division of long mathematical expressions.

1,000,-
000,000



Set A {2, 4, 6, 8, 10}

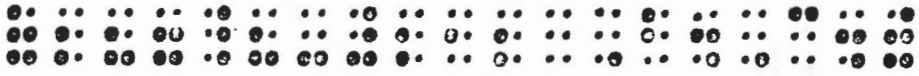


b. Hyphened terms require a numeric indicator when the hyphen follows a word, abbreviation, or mark of punctuation. The numeric indicator is not required after a hyphen which follows a numeral, letter, or other mathematical expression.

1-to-1

U-238

(287?-212 B.C.)



45-50

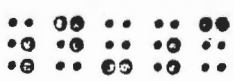
Section A-12

c. A letter indicator is needed for letters, single letter abbreviations, or short-form word letters which are used before or after a hyphen.

X-, Y-, and Z-axes.

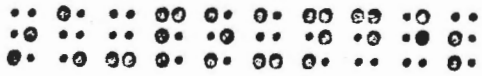
1 light-yr

d-c (direct current)



d. Contractions are used in words which touch a hyphen, if there are no other conditions to prevent the use of contractions.

inch-pound^2



INTERSECTION (Cap) $\cap$

a. "Intersection" is a sign of operation; no spaces are needed.

$B \cap C$

b. When the intersection or union sign is modified, it is no longer a sign of operation, but becomes a sign of comparison.

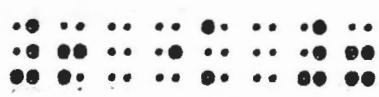
KEYING TECHNIQUE

a. When material is shown in columns, tables, etc., and space does not permit an exact transcription of the headings and entries, a numeric or alphabetic key may be made. Consecutive literary numerals preceded by numeric indicators are used in a numeric key, and no punctuation is used. An alphabetic key consists of two appropriate letters for each entry. Two identical items should have the same key. The key numerals or letters are placed in the table (figure, matrix, determinant, or columns) in the same position as the material they replace.

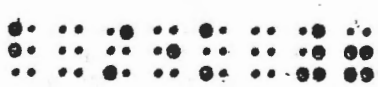
b. A list of the keys and their meanings precede the table, and are enclosed in transcriber's grouping symbols. Key items may be listed at the margin or placed in columns, and a line is skipped before and after the key.

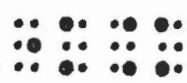
LESS THAN $<$

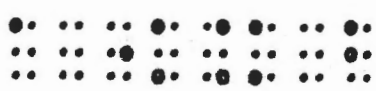
a. "Less than" is a sign of comparison; space before and after.

$6 < 7$ 

b. A negation line makes the sign read "is not less than."

$b \not< 7$ 

LESS THAN OR EQUAL TO $\leqq$  $\leq$ or $\leqslant$

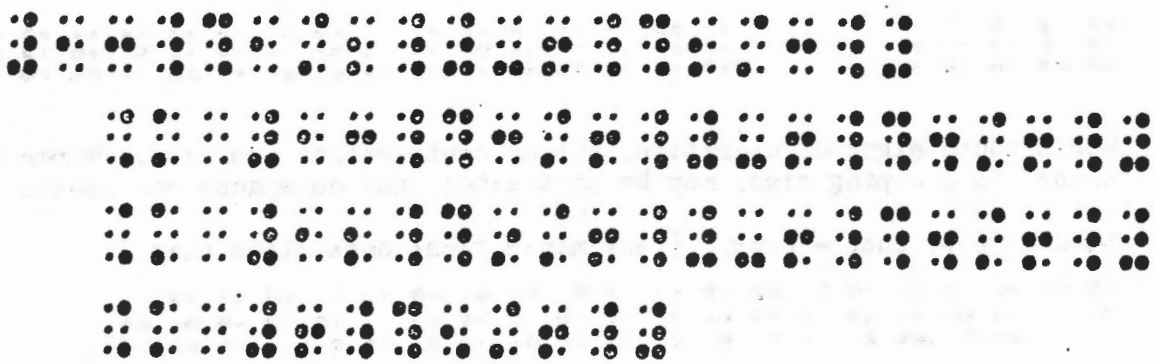
$a \leqq b$ 

LINKED EXPRESSIONS

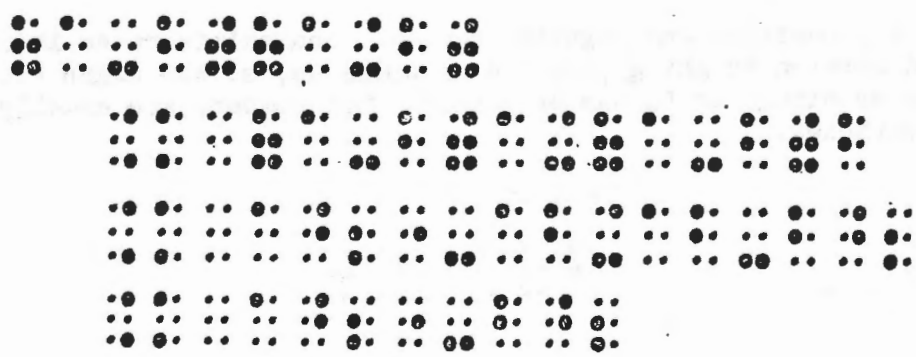
a. A linked expression contains at least one sign of comparison. The part which precedes the first sign of comparison is called the anchor. Each remaining part, beginning with a comparison sign but not including the next comparison sign, is called a link, and begins two cells to the right of the anchor. All runovers begin two cells to the right of the links. (See FORMAT for margin spacing.)

b. A linked expression is displayed (usually shown centered in print); it is not embedded within the text. Each comparison sign is vertically aligned in print, but the last few may be on one line. Only the first comparison sign is preceded by a mathematical expression.

$$13\frac{1}{2} - 6\frac{2}{3} = 13\frac{3}{6} - 6\frac{4}{6}$$
$$= 12\frac{9}{6} - 6\frac{4}{6}$$
$$= 6\frac{5}{6}$$



$$(a - b)(a + b) = (a - b)a + (a - b)b$$
$$= a^2 - ab + ab - b^2$$
$$= a^2 - b^2$$



LOGICAL PRODUCT

LOGICAL SUM

MINUS SIGN — ⠤

a. The minus sign is a sign of operation; no spaces are needed except with abbreviations.

5 - 4 a - b □ - 4 = 1

6 yd - 2 ft yds. - in.

b. The numeric indicator is needed between the minus sign and a numeral or decimal point that follows, if the minus sign is preceded by a space, punctuation mark, or if it begins a new line.

-.05 From -10 to +10.

c. Words touch signs of operation, but no contractions are used. Words enclosed in grouping signs may be contracted, and no spaces are needed.

tens - tens; ones - ones. (tens minus tens; ones minus ones.)

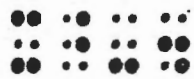
(whole number)-(fraction)

d. When working with positive and negative numbers, the multipurpose indicator must be placed between touching plus and minus signs, so the signs will not read "plus or minus" or "minus or plus." Such numbers are usually enclosed in parentheses.

-3 - +4 6 + -2

MINUS SIGN, continued

e. A minus sign may be all or part of a superscript or subscript.

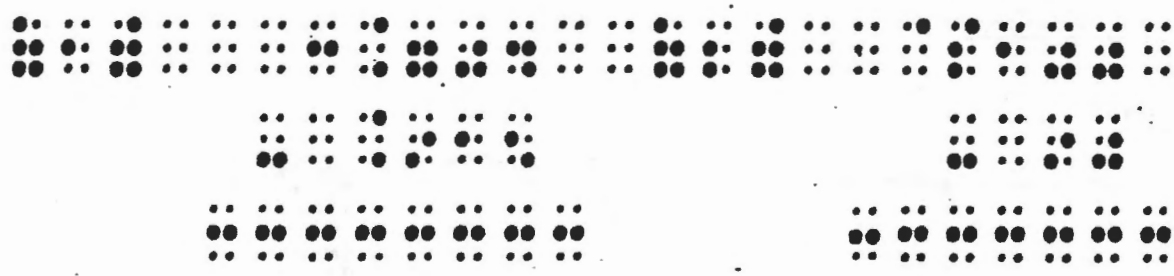
x^{-4}  ^{-}y

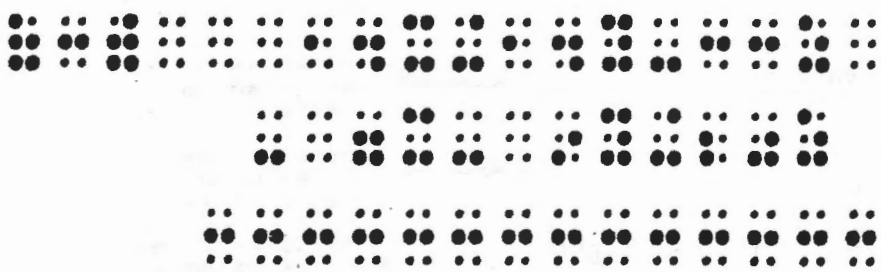
f. Function words and abbreviations follow the minus sign without a space.

sin x - sin y

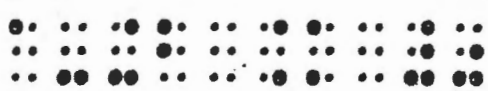
g. When problems are written spatially, the minus (or plus) sign is placed one cell to the left of any numerals shown above the separation line, and no numeric indicators are used. The print copy is followed for the position of a minus or plus sign used with a dollar sign.

(1) $\begin{array}{r} 3.704 \\ -\ .915 \\ \hline \end{array}$ (2) $\begin{array}{r} \$100 \\ -\ 90 \\ \hline \end{array}$ (3) $\begin{array}{r} 14x + 14y - 33z \\ -\ 7x - \ 9y + 20z \\ \hline \end{array}$





MINUS OR PLUS $\mp$

$a \mp b = 0$ 

MODIFICATION INDICATORS Directly over Directly under

a. The modification indicator is placed immediately after the modified expression. Use the "directly over" when the modification is over the expression, and "directly under" for modification under the expression.

b. The indicator tells the reader where the modification is placed.

MODIFIERS

a. A modifier is a mathematical symbol that is placed directly over or directly under a mathematical expression. The modifier symbol must follow the modification indicator.

b. Modifiers may be combined to produce the print sign needed, provided the sign is part of a modified expression.

c. See NEMETH CODE TEXT for Modifiers of Higher Order.

List of Modifiers:

Arc

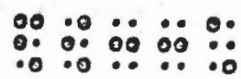
Concave upward

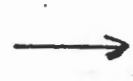
Concave downward

Arrow

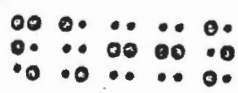
Barbed at both ends

Barbed at left

Barbed at left and dotted at right 

Barbed at right 

Barbed at right, contracted form

Barbed at right and dotted at left 

MODIFIERS; List of Modifiers, continued

Arrows, continued

Dotted at both ends

Dotted at left (no barb)

Dotted at right (no barb)

Hollow dot at both ends

Hollow dot at left (no barb)

Hollow dot at right (no barb)

Hollow dot at left, barbed at right

Bar

Horizontal

Vertical

Caret

Inverted

Left-pointing

Right-pointing

Dot

Hollow dot

Tilde, simple

Extended

MODIFIED EXPRESSIONS

a. A modified expression is a mathematical term with additional mathematical information placed directly above or directly below it, but which has no complete braille sign listed especially for it. Modifications may be shown by combining the individual signs involved, and using the correct indicators.

b. A modified expression is written without spaces between the symbols used.

c. The information is given to the reader in the following order:

FIVE-STEP RULE:

1) Multipurpose indicator (dot 5). Alerts reader to impending modification.
2) The basic mathematical expression being modified.
3) The indicator for directly over or directly under (Modification Indicators). Tells the reader where the modification is placed.
4) The symbol for the modifier. Tells the reader what the modifier is.
5) The termination indicator (dots 1-2-4-5-6). Tells the reader the modification has been completed.

d. Examples of modified expressions:

$\overleftrightarrow{AB}$ (line, or full line)

$\overrightarrow{AB}$ (half-line or ray, extending right)

$\overleftarrow{AB}$ (half-line or ray, with dot)

$\overline{AB}$ (open interval or line segment)

$\overline{AB}$ (closed interval or line segment)

$\overline{AB}$ (open interval or open segment)

$\overline{AB}$ (half open interval, closed left)

$\overline{AB}$ (interval, closed left, open right)

(NOTE: Geometry textbooks vary in the interpretation of lines. Follow the print copy, using the listed modifiers.)

MULTIPLICATION CROSS AND DOT X

a. Multiplication signs are signs of operation; no spaces are needed with numerals or letters which are not abbreviations. The cross and dot must not be interchanged; use the sign shown in the print copy.

4 · 8 · 3 4 X 8 X 3 x · y · z

b. Contractions are not used in words that touch signs of operation, but words enclosed in grouping symbols are contracted. Abbreviated words, with or without a period, must be spaced away from signs of operation. No spaces are necessary when abbreviations are enclosed in grouping signs.

Area = length X width.

(area) = (length) X (width).

c. In work arranged for ~~computation,~~ the ~~multiplication sign is placed next to the multiplier~~. All separation lines extend one cell beyond any term involved. A column of one empty cell separates a problem from the problem number, and from the number of the next problem. (See FORMAT.)

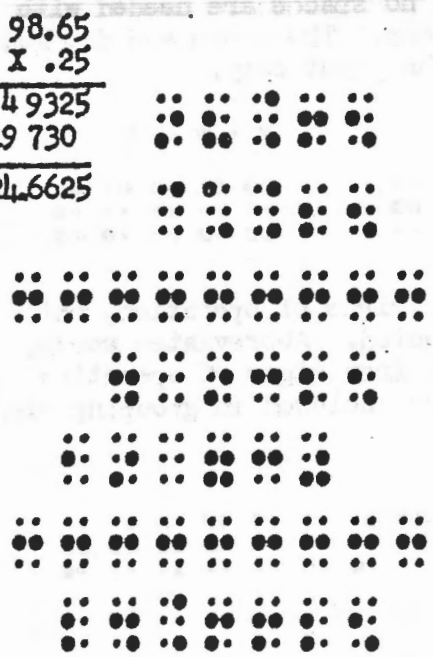
1. 57903 X 46 2. 4138 X 79

d. Problems arranged for computation ~~must not be divided~~ between pages. Start a new page with the directions pertaining to the problems. A subdivision of a group of linear problems may begin a new page, but individual problems should not be divided.

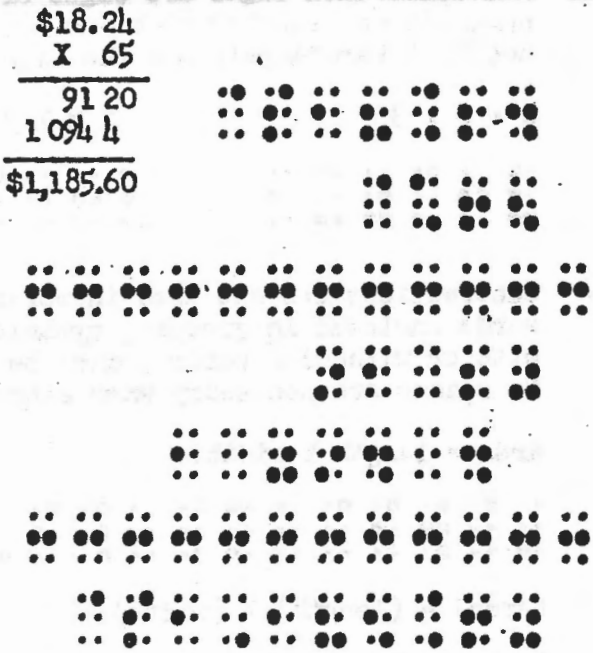
MULTIPLICATION CROSS AND DOT, continued

e. When a comma or ~~decimal~~ point is shown in print for the answer of a multiplication problem, ~~a blank column~~ of cells is left in the partial products.

```
 98.65
 X .25
 49325
19 730
24.6625
```

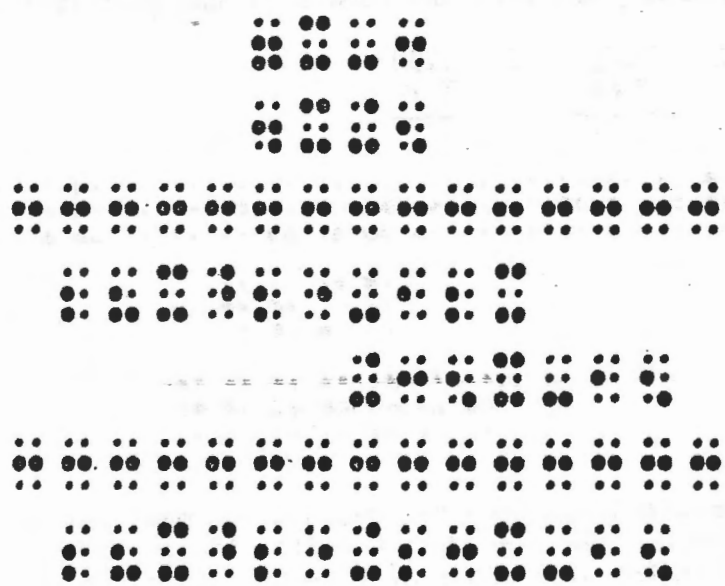


```
 $18.24
  X  65
  91 20
1 094 4
$1,185.60
```



f. In problems containing fractions, mixed numbers, or polynomials, the terms are vertically aligned.

$$\begin{array}{r} 7x - 3 \\ 4x + 5 \\ \hline 28x^2 - 12x \qquad \\ + 35x - 15 \\ \hline 28x^2 + 23x - 15 \end{array}$$



MULTIPURPOSE INDICATOR

a. The multipurpose indicator is u etween a letter and a following numeral to indicate that the nume not a subscript to the letter. (A letter with a numeral subscr es not require a subscript indicator or base line indicator. See SU PTS.)

a2

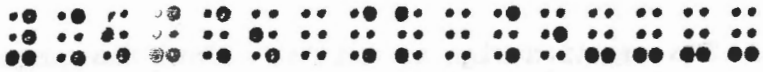
b. Used between a numeric subscrip a numeral when the numeral is on the base line.

$c_1 10 + c_2$

c. Not used with letters which repre nt numerals in bases other than 10. (Capitals are not used with such letters, regardless of print.)

$T6E4_{twelve}$

d. Used after a decimal point to indicate that the symbol which follows is not a numeral.

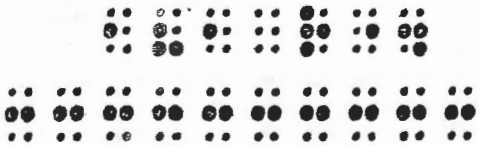
.5 + .5 = .____ 

$2.a_1 a_2 \ldots$

e. Used before a modified mathematical expression to indicate impending modification. (See Modified Expressions.)

$\overline{AB}$ (open interval)

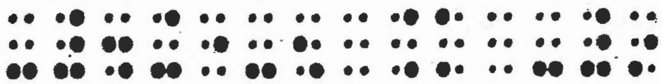
f. Used in division, between the remainder ("r" or "R") and the numeral, to indicate the remainder is not a subscript.

181 r4
25)4529 

MULTIPURPOSE INDICATOR, continued

g. Used between horizontal signs of operation; not used with vertical signs.

$-4 + -5 = -9$



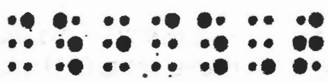
4 ± 5

h. Used between an operation symbol represented by a regular polygon and a numeral which follows.

$9 \square 14 = 23$

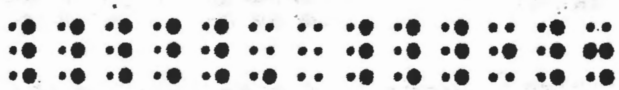
i. Used between two tilde symbols to show they are written horizontally.

$\sim \sim$ T



j. Used between a tally mark and punctuation indicator.

卌, ||| .

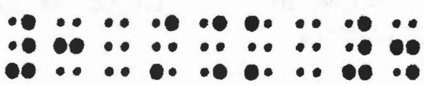


NEGATION SIGN

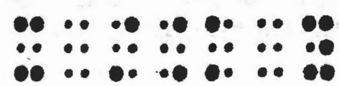
a. The negation sign is written before the comparison sign, and is not separated from the comparison sign by a runover to a new line.

b. Print may show a vertical stroke or an oblique stroke in either direction; use the negation symbol shown above for all print negation symbols.

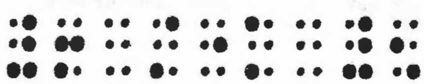
$3 \neq 4$



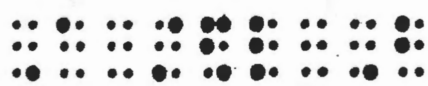
$x \nmid y$



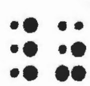
$6 \not< 5$



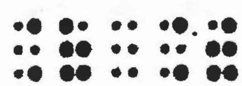
$A \nparallel B$



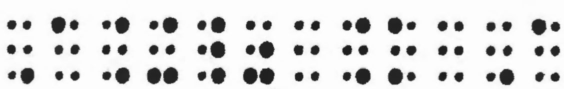
NULL SET (Empty set, Void set) $\emptyset$



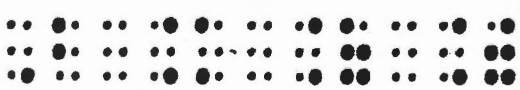
or $\{\}$



$A \cup \emptyset = A$



$B = \{\}$



NUMBER SIGN (Crosshatch) # (This is not the numeric indicator.)

a. If print shows this sign as a sign of operation, the numeral which follows must be preceded by a numeric indicator.

b. No spaces are necessary when a crosshatch is used as a sign of operation.

8 # 5 = 13

NUMERALS

a. Mathematical numerals correspond to literary numerals, but are in the lower part of the cell.

1 2 3 4 5 6 7 8 9 0

b. Used for every numeral in mathematics except page numbers at top and bottom corners of a page, and numeric information on title pages. The numerals on contents pages, forewords, introductions, page references, footnotes, indices, and bibliographies are the numerals of Nemeth Code. References to pages are written in Nemeth Code.

See Chap. 2, p. 54.

Exercise 7, problems 1-10

c. A new page line number is literary, just as the corner page numbers are literary.

New page: 23

NUMERIC INDICATOR

a. The numeric indicator is used before a numeral which is preceded by a space or an "open" numeral.

1, 10, and 100

b. Used before the runover of long numerals, except when the numerals are enclosed in parentheses or other grouping symbols.

3,000,-
000,000

(3,000,-
000,000)

c. Used before a numeral which follows a mark of punctuation, including the hyphen when the hyphen follows a word or abbreviation. The indicator is not used when a numeral, letter, or other mathematical term precedes the hyphen.

"6"

1-to-1

50-60

A-12

3:30 - 4:45

d. Used between a minus sign and a numeral when the minus sign is preceded by a space or by punctuation.

-8 + 3 = -5

e. Used before a decimal point which is preceded by a space or a minus sign.

.25 + .25 = .50

NUMERIC INDICATOR, continued

f. Used before open numerals enclosed in grouping signs, when the material is not an "enclosed list." If the first numeral is in direct contact with the left grouping sign, it is not an open numeral. Not used at the beginning of items in an "enclosed list."

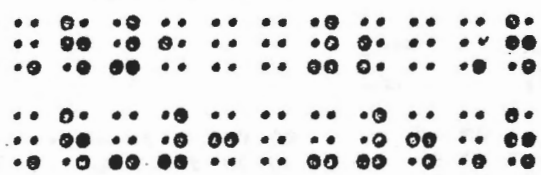
(x = 1, y = 2)

(1, 2, 3, and 4)

(-1, -2, -3)

g. Used after a left grouping symbol which introduces a determinant or matrix. A minus sign in this position is followed by a numeric indicator.

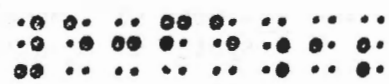
$$\begin{vmatrix} 1 & 2 \\ -3 & -4 \end{vmatrix}$$



h. Used before letters which represent numerals in a base other than 10. No capitals are used for such letters, regardless of print.

$T41E7_{12}$

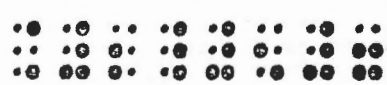
$E3FE_{12}$



i. Used between a type-form indicator and a numeral, even in an "enclosed list." The type-form indicator shows that the numerals are in italics, script, or boldface type.

25 (italics)

257 (italic 2, boldface 5, regular 7)

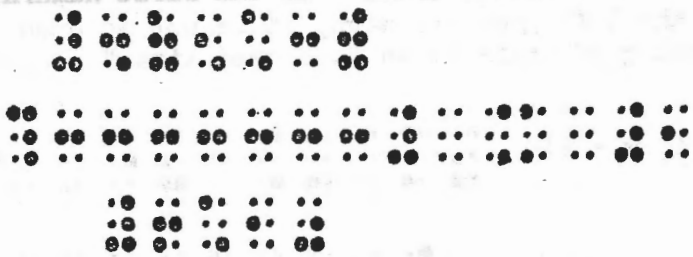


j. Used in diagrams or drawings which contain numeric labels.

NUMERIC INDICATOR, continued

k. The numeric indicator is used for numerals in a fraction that is written spatially.

$$\frac{4(5\cdot3)}{6\cdot10} = 1$$



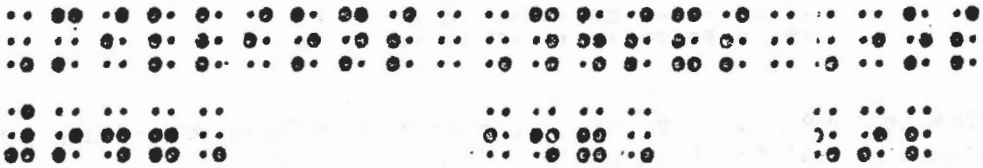
l. Used after a section mark, crosshatch, paragraph mark, or asterisk, and after the general reference indicator or any reference symbol.

4 * 6

3 # 4

m. Not used after spaces which partition a numeral into segments. The numerals are left justified, regardless of print.

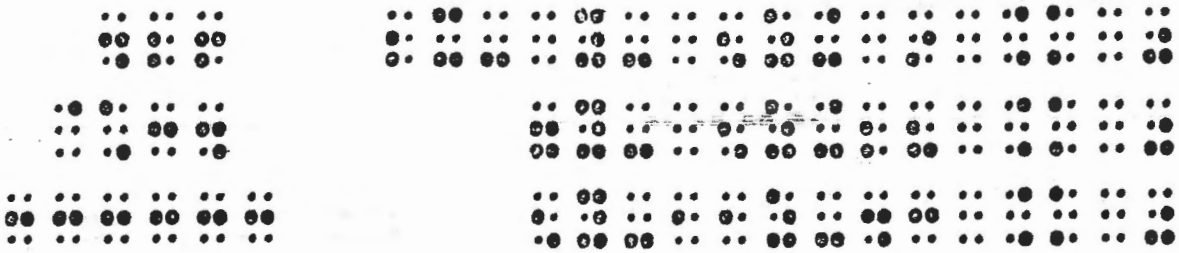
Millions	Thousands	Ones
947,	147,	592



n. Not used with numerals arranged for computation, or in the alignment of a system of equations.

$$\begin{array}{r} 426 \\ \underline{X34} \end{array}$$

$$\begin{aligned} 2x - y - 5z + 9 &= 0 \\ 7y - 5z + 28 &= 0 \\ 5y - 11z - 43 &= 0 \end{aligned}$$



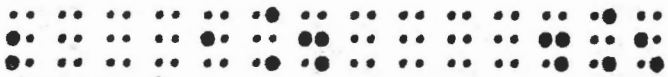
NUMERIC INDICATOR, continued

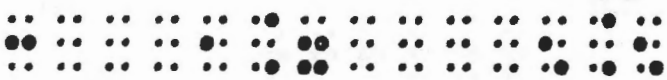
o. Not used in the columns of tables. If words or letters are included in the table, the numeric indicator must be used. The minus sign is not numeric; if it is used in the table, the numeric indicator is used throughout the table.

SQUARE ROOT TABLE

N	$\sqrt{N}$	$\sqrt{10N}$
1	1.0	3.2
2	1.4	4.5
3	1.7	5.5

etc.



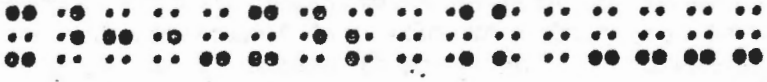


OMISSION SYMBOL

a. The omission symbol replaces a question mark, a question mark combined with hyphens or dashes, or a blank space that denotes omitted material. If a long dash or ellipsis is shown in print, the double dash or ellipsis is used in the transcription.

4 + ? = 9

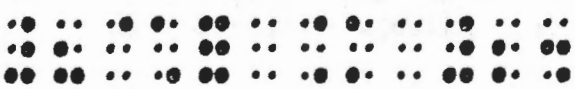
$x^3 - x^2 =$ __



0.333 ... 3 ...

b. One omission symbol replaces a blank space to show omitted material.

8 X = 24



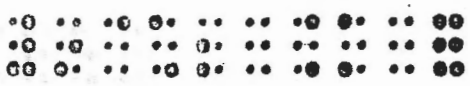
8 + 16 =

OMISSION SYMBOL, continued

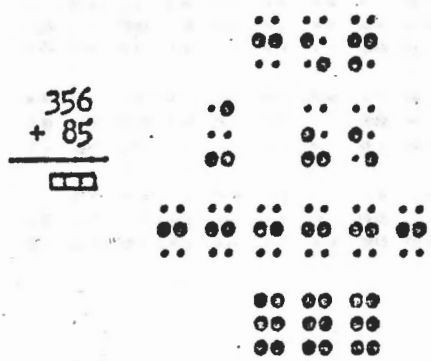
c. The number of omission symbols used is the same as is shown in print, but hyphens used with question marks are considered single signs.

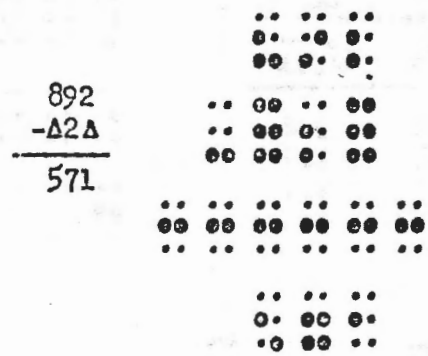
9 X 2 = ??

9 X 2 = -?-



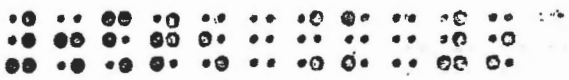
d. The regular omission symbol replaces any print sign used for omission in work arranged for computation. The number of symbols used is the same as is shown in print.



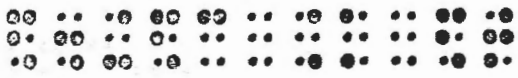


e. When a shape is used as a "space holder" in work for children, use the shape symbol as it is in print. Consult the classroom teacher if there is doubt about the use of "shape" terms.

4 Δ 5 = 9



□ + ○ = Δ



f. If a "shape" is used as an omission sign for a superscript or subscript, use the superscript or subscript indicator, the shape indicator, and the shape indicated. No space is necessary in the group, since the shape indicator may be used without a space when it is preceded by another indicator.

$7^{\square}$

g. Omission signs shown in print which have no Nemeth Code equivalent may be drawn, or the transcriber may devise a suitable braille symbol.

PERCENT SIGN. %

a. The percent sign is placed, wit space, next to the numeral.

50%

b. If the words "per cent" or "perc are used in the print, use the words in the braille copy. Use percent sign only when it is used in print.

PI. π

a. Pi is the letter "p" with the Greek alphabetic indicator preceding it.
b. Pi is used as a mathematical term, spaced and punctuated accordingly.

$c = \pi d = 2\pi r$

PLURALS OF MATHEMATICAL TERMS.

a. When an apostrophe-s is added to a mathematical term to form the plural, the punctuation indicator precedes the apostrophe-s, which then becomes part of the mathematical term, and any punctuation sign that is added requires another punctuation indicator.

1's, 2's, and 3's.

b. The plural of letters must have the punctuation indicator before the apostrophe-s, and the alphabetic indicator before the letter.

Count the x's and y's.

PLUS SIGN + ⠬

a. The plus sign is a sign of operation; no spaces are needed between the sign and numerals, letters, symbols of shape, indicators, or a function name and its related expression.

69 + 45 ⠼⠖⠔⠢ ⠼⠲⠑

x + y + z ⠭⠬⠽⠬⠵

6 + □ ⠼⠖⠬⠸⠶

△ + ○ ⠸⠣⠬⠸⠕

$x^2 + y^2$ ⠭⠘⠆⠬⠽⠘⠆

$6 + \sqrt{2}$ ⠼⠖⠬⠩⠼⠆

$\frac{1}{2} + \frac{1}{4} = ?$ ⠼⠂⠌⠼⠲⠬⠼⠂⠌⠼⠦⠶⠐⠱

sin x + sin y ⠎⠊⠝⠭⠬⠎⠊⠝⠽

b. No contractions are used in words which touch addition signs. When words are enclosed in grouping symbols, contractions are used.

4 children + 3 children

⠼⠙⠉⠓⠊⠇⠙⠗⠑⠝⠬⠼⠉⠓⠊⠇⠙⠗⠑⠝

(4 children)+(3 children) = 7 children

⠶⠼⠙⠉⠓⠊⠇⠙⠗⠑⠝⠾⠬⠶⠼⠉⠓⠊⠇⠙⠗⠑⠝⠾⠐⠱

c. A space is required between an abbreviation and a sign of operation.

16 in. + ? in. = 2 ft.

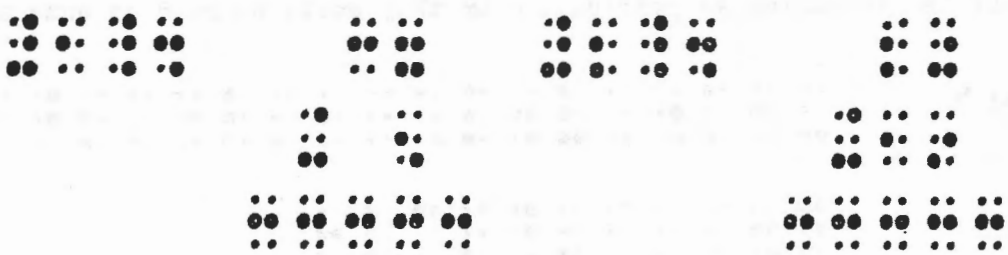
⠼⠁⠋⠲⠀⠬⠀⠦⠀⠋⠲⠀⠐⠱⠀⠼⠃⠀⠟⠞⠲

PLUS SIGN, continued

d. In addition arranged for computation, the plus sign is placed one cell to the left of all numerals or symbols except the dollar sign. No numeric indicators are used; one empty cell is left between problem numbers and the longest part of the problem. All signs must be vertically aligned, with digits under digits, commas under commas, decimal points under decimal points, fractions under fractions, abbreviations under abbreviations, and any signs of operation or comparison under like signs. Any intentional misalignment must be transcribed as it is in print.

1. 37
+ 5

2. 20
+19

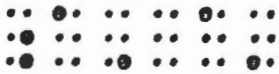


PLUS OR MINUS ±

PRIME '

a. The prime is not considered a superscript; no superscript indicator is needed. In the example below, the single letter requires a letter indicator; the a' is not a single letter. It has become a longer mathematical expression, and does not require a letter indicator.

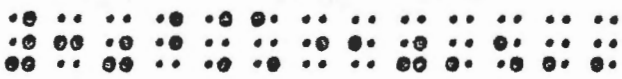
a, a'



b. The single and double prime signs are used to show feet and inches, minutes and seconds, as well as the standard prime.

2'8" + 5'6" = ?

30° 10' 5 "



PUNCTUATION INDICATOR

MATHEMATICAL EXPRESSIONS: Numerals, single letters, groups of letters with separate identities, Roman numerals, ordinal- plural- possessive-endings, grouping symbols, indicators, omission symbols (including the long dash and ellipsis when used as omission signs), radical symbol, symbols of shape, modified expressions, words or abbreviations when not on the base line, function names, and reference symbols.

a. The punctuation indicator must be used when a mathematical expression is followed by a literary punctuation mark--period, colon, semicolon, question mark, exclamation mark, quotation mark, or apostrophe. Since these punctuation marks are the same dot combinations as mathematical numerals, they must be identified as punctuation or they would be read as numerals.

3; 6; a; b.

△ ABC.

I; III; V.

1st; 5th.

$\frac{1}{2}$? Or $\frac{1}{4}$?

4 X 4 = ____.

(LCD).

13_{seven}.

" □ + ○ = △ "

PUNCTUATION INDICAT ontinued

b. The effect of t actuation indicator continues until it is terminated by a space, a n ne, or any symbol other than punctuation.

Count by 5's.

("8" and "9").

c. Not used before a mathematical comma; or a hyphen, dash, or ellipsis used as punctuation in a literary context.

(1), (2), (3).

3:30-4:45

Ones, tens, ____.

d. Not used with words or abbreviations which are on the base line.

3 quarts; 1 pint.

2 hr. 40 min.

[Wed., Thurs.]

1 ten = 10 ones.

.____ = 50%.

Chap. 4, p. 56.

RADICAL $\sqrt{}$ INDEX-OF-RADICAL INDICATOR TERMINATION INDICATOR

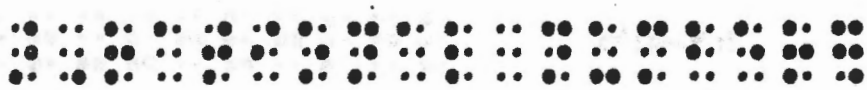
a. To write the square root of a numeral, write the radical sign, the numeral, the termination indicator. The termination indicator must always be used.

$\sqrt{625}$ $\sqrt{x^2 - y^2}$

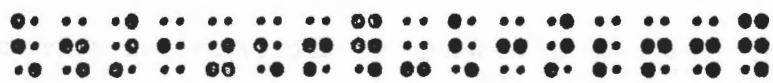
b. To show an index other than 2, this order is followed: Index-of-radical, numeral or letter index, radical sign, radicand, termination indicator.

$\sqrt[3]{125}$ $\sqrt[n]{a + b}$

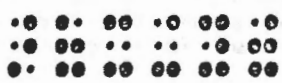
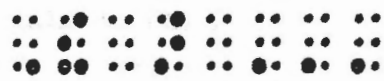
c. A word may be used as the radicand. There are no contractions used.

$\sqrt{\text{Rational number}}$ 

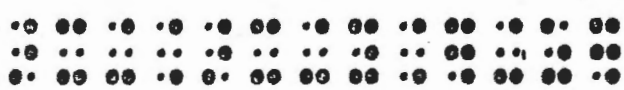
d. Radical signs may be used touching signs of operation.

$\sqrt[4]{1056} - \sqrt[3]{264}$ 

e. When a radical is shown without a radicand or without the horizontal line over numerals, the termination indicator is omitted.

$\sqrt{(x + y)}$  The $\sqrt{}$ ... 

f. When a radical is within a radical, the second radical has a depth of order 2, a third radical has a depth of order 3, etc. The order of radical indicator (dots 4-6) is written before the radical symbol and its termination for each inner radical. The first inner radical (order 2) is preceded by dots 4-6; a radical within that radical (order 3) is preceded by dots 4-6, 4-6, and this method continues for each successive inner radical.

$\sqrt{x + \sqrt{x + y} + z}$ 

RATIO; PROPORTION : ::

a. The ratio and proportion signs are not generally used in modern mathematics textbooks. Words are used instead of the signs: "2 is to 4 as 5 is to 10."

b. If a mathematics text uses the ratio and proportion signs (or the ratio sign combined with the equals sign), the braille symbols should be used.

2 : 4 :: 5 : 10

RECURRING DECIMAL (Repeating decimal; a modified expression)

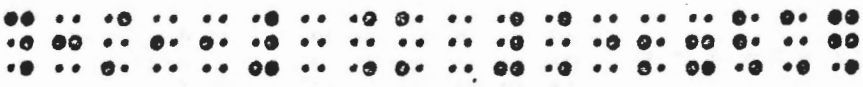
Horizontal bar: Dot:

a. In print, either a horizontal bar or a dot may be used to show a recurring decimal. (See Modification Indicators, Modified Expressions, Five-Step Rule.)

b. The horizontal bar is used in print by placing it over all the digits which are repeated; one horizontal bar symbol is used in the braille transcription.

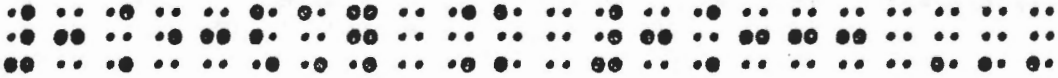
$\frac{1}{7} = .\overline{142857}$

c. If the dot is used, it is placed over each of the digits repeated; a single dot is used in braille for all the print dots.

$\frac{3}{11} = .2\dot{7}$ 

d. An ellipsis does not represent a recurring decimal; its meaning is "omitted" or "continue in the same manner."

$3.\dot{3} = 3.333 \ldots$



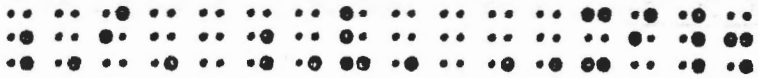
ROMAN NUMERALS

a. Capitalized Roman numerals are written with a single capital before one-letter numerals, and a double capital before numerals of more than one letter.

b. Roman numerals, capitalized and uncapitalized, must follow the rules for the English letter indicator. A capitalized single-letter Roman numeral and all uncapitalized Roman numerals must be preceded by the letter indicator when not part of a longer expression. A Roman numeral is part of a longer expression when it is enclosed in grouping symbols, is part of an enclosed list, is used with signs of operation or comparison, is part of a modified expression, is used with reference symbols, etc. (See English Letter Indicator.)

c. A questionable letter combination is not written as a Roman numeral.

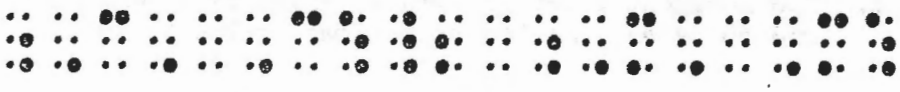
I, V, XI.



V + I = VI

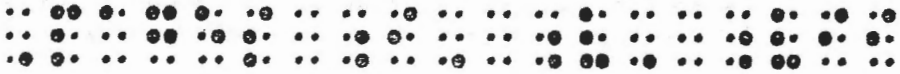
(I); (i), (ii).

C, $\overline{C}$; M, $\overline{M}$



Chap. I-V

Pages i, v, vii



iv + v + i = x

v = 5, x = 10

(I, i, II, ii)

RUNOVER TO A NEW LINE

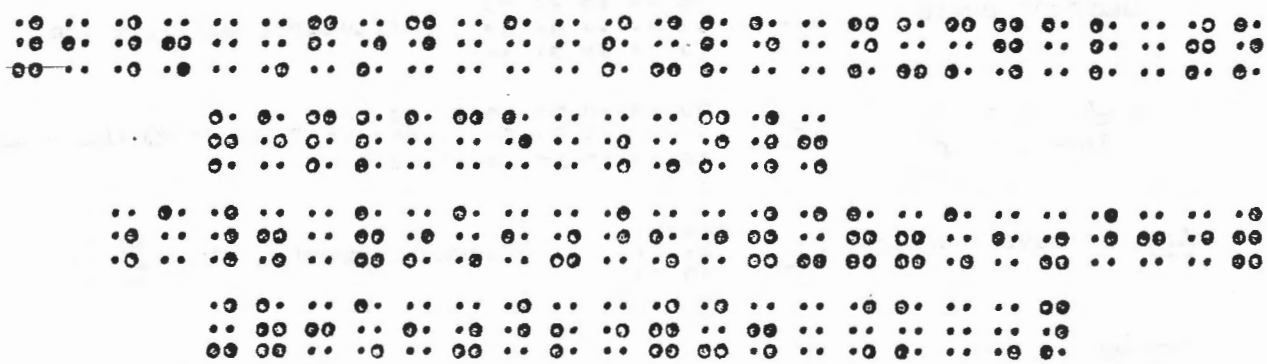
a. The runover of a mathematical expression should be avoided if possible. Subject to format rules for margins, an expression should begin a new line if this will permit the entire expression to be written without a runover. The text words preceding a mathematical expression should be alone on a line, leaving most of the line blank, to avoid a runover.

b. When a runover is necessary, the division is made giving priority to the following items in descending order:

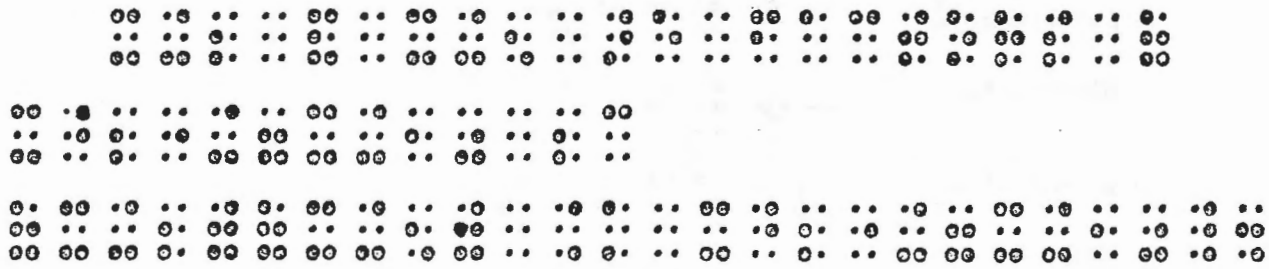
1) After a comma which occurs between items in an "enclosed list."
2) Before a symbol of comparison.
3) Before a symbol of operation.
4) Before a fraction line.
5) Before the base-line indicator.
6) Before a change-of-level indicator or within a superscript or subscript before one of the symbols listed above.
7) Between factors enclosed in grouping symbols.
8) After the termination indicator.

(Illustration 1) 1. Find a single numeral to replace N.

a. $(9 \cdot 10^5) + (7 \cdot 10^3) + (3 \cdot 10^2) + 4 = N$



(Illustration 2) $x + 2$ and $x + 5$ are factors of $x^2 + 7x + 10$ because $(x + 2)(x + 5) = x^2 + 7x + 10$.



SHAPE INDICATORS

Shape	⠓	Termination	⠓
Filled-in shape	⠓	Structural shape-modification	⠓
Shaded shape	⠓	Interior shape-modification	⠓ ⠓

SHAPES

Angle ∠ ⠓ ⠓

Obtuse angle ⌞ ⠓ ⠓ ⠓ ⠓ ⠓ (Structural modification)

Right angle ∟ ⠓ ⠓ ⠓ ⠓ ⠓ (Structural modification)

Straight angle — ⠓ ⠓ ⠓ ⠓ ⠓ (Structural modification)

Angle with interior arc ∠ ⠓ ⠓ ⠓ ⠓ ⠓ ⠓ ⠓ (Interior modification)

Arc, Concave downward ⌣ ⠓ ⠓ Concave upward ⌢ ⠓ ⠓

Arrows

Left-pointing ← ⠓ ⠓ ⠓ ⠓

Right-pointing (Uncontracted) → ⠓ ⠓ ⠓ ⠓

(Contracted) → ⠓ ⠓

Down-pointing ↓ ⠓ ⠓ ⠓ ⠓ ⠓

Up-pointing ↑ ⠓ ⠓ ⠓ ⠓ ⠓

SHAPES, continued

Circle

Circle with interior cross (Interior modification)

Circle with interior dot (Interior modification)

Circle with interior minus (Interior modification)

Diamond

Ellipse

Hexagon, regular

Intersecting lines

Is parallel to

Is not parallel to

Is perpendicular to

Is not perpendicular

Parallelogram

Quadrilateral

Rectangle

SHAPES, continued

Square

Square with interior dot (Interior modification)

Square with interior plus (Interior modification)

Square with interior horizontal bar (Interior modification)

Square with interior vertical bar (Interior modification)

Square with interior plus or minus (Interior modification)

Square, filled-in (Filled-in modification)

Square, shaded (Shaded modification)

Star

Triangle, equilateral or regular

Inverted triangle

Isosceles triangle (Structural modification)

Right triangle (Structural modification)

Scalene triangle (Structural modification)

SHAPES, continued

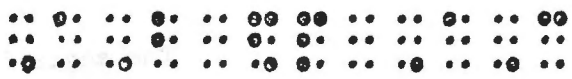
a. A shape is a braille symbol representing a pictured mathematical expression; it is not a substitute for a word or phrase. The shape indicator is an essential part of the symbol, and the termination indicator is required for modified shapes.

b. The symbols of a shape are written without spaces. A space is left between a shape and an identifying numeral or letter, but no spaces are required between shapes and signs of operation, or with other signs which are not ordinarily spaced. Shapes used to represent an omission are spaced according to rules of spacing for the omitted item.

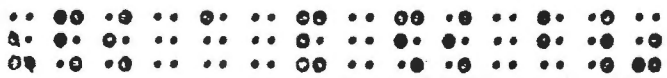
□ + △ = △ + □

AB || CD

AB ⊥ AC

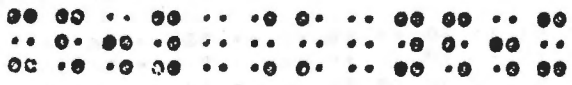


"∠a and ∠b"

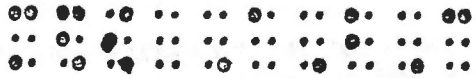


$\frac{\triangle}{4} + \frac{1}{4} = \bigcirc$

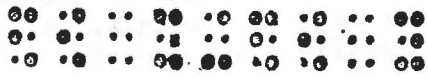
x □ y = y □ x



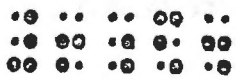
m∠ ABC



∠x + ∠y



$6_{\square}$



└ A

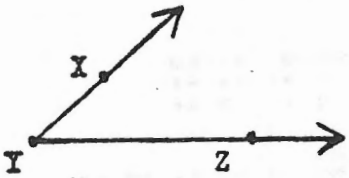
SHAPES, continued

c. The plural or possessive of a shape symbol may be shown in print by an added "s" after the shape or an "s" within the shape. In braille, an uncapitalized "s" is written after the shape. Follow the print copy for use of an apostrophe.

△s ABC and DEF

m∠s a, b, c.

d. When textbooks use drawings of mathematical figures, the drawings are reproduced in the braille copy; the shape symbols are used in references to the drawings, not as substitutes for the drawings. (In the following example, the drawing would be reproduced; the sentence is shown in braille.)



The angle in this picture has three names: ∠ XYZ, ∠ZYX, and ∠Y.

e. Shape symbols not included in the NEMETH CODE TEXT may be created by using the shape indicator and one or two letters from the word to be represented as a shape. No contractions are used in the letters, and a note of explanation to the reader must be included. Avoid letter combinations which are already used as specific shape symbols.

mn (moon)

tr (tree)

ap (apple)

SHAPES, continued

f. A right-pointing regular arrow used without modification is represented in the contracted form. The uncontracted right-pointing arrow is part of a more complex modification.

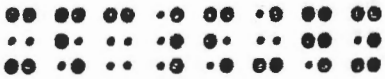
$\overrightarrow{AB}$

g. Filled-in or shaded shapes are shown by writing the symbol for the shape indicator, the filled-in (dots 4-5-6) or shaded (dots 4-6) shape indicator, the basic shape.

x ■ y

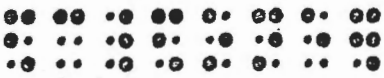
h. Shapes with structural modification are shown by writing the shape indicator, basic shape being modified, structural shape-modification indicator, letter or letters representing the modification, termination indicator.

x ⊕ y



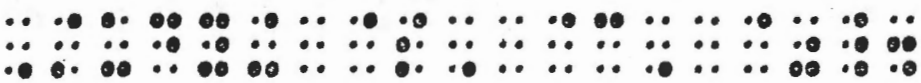
i. Shapes with interior modification are shown by writing the shape indicator, basic shape, interior shape-modification indicator, inside sign, termination indicator.

one



j. When a mathematical term is combined with a shape, and the whole has no mathematical meaning, the shape should be omitted, or possibly made as a raised-line drawing.

Studying $, ¢, %.



SUBSCRIPTS, SUPERSCRIPTS, AND LEVEL INDICATORS

Level Indicators

Subscript

Base line

Superscript

Comma and optional space

Second Order Level Indicators

Subscript to a subscript

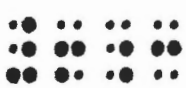
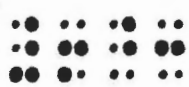
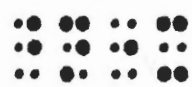
Superscript to a subscript

Subscript to a superscript

Superscript to superscript

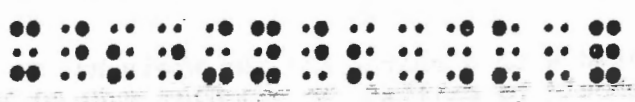
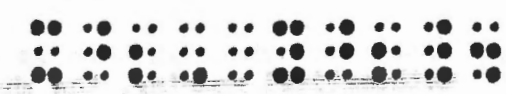
a. A subscript or superscript is a sign, usually in smaller print, slightly below or above the adjacent sign. A subscript or superscript may precede or follow the mathematical term.

6_3 (6, subscript 3) 6^3 (6, superscript 3) ${}^{n}x$ (x, left super n)

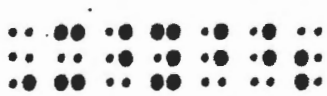
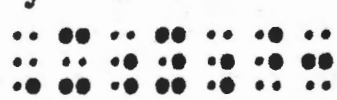
  

b. When a mathematical term with a superscript or subscript is followed without a space by additional material, the base line indicator is needed to show that the second term is not a continuation of the superscript or subscript. A space, comma, punctuation indicator, or another level indicator terminates the previous level indicator and the base line indicator is not required.

$x^2 + y^2 = ?$ $x^2, y^2.$

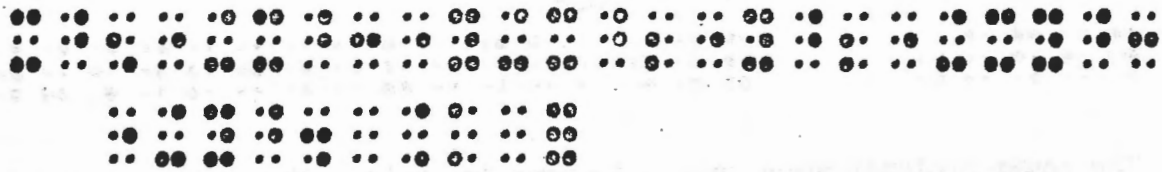
X^{y^2} (second level indicator) X_{y^3} (superscript to a subscript)

  ?

SUBSCRIPTS AND SUPERSCRIPTS, continued

c. A subscript or superscript is not terminated by a runover to a new line unless the new line begins with a sign of comparison or unrelated material.

$x^5 + x^3y + x^2y^2 + xy^3 + y^4 = ?$



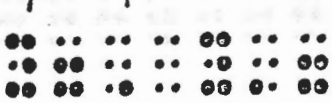
d. Radicals or grouping symbols do not terminate a subscript or superscript. The base line indicator is necessary for termination.

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

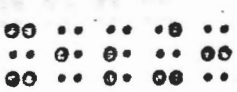
(8_3)

e. No subscript indicator is required for a letter or function name with a right numeric subscript of the first order, and no base line indicator is used after the numeral. Such a subscript must not carry a subscript or superscript of its own, but the original letter or word may be modified by primes or by a superscript. (A prime is not a superscript, and requires no indicator.)

y_7, y'_7



$x_{12} + 3$



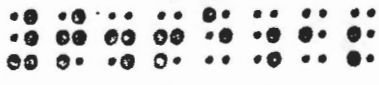
Na_2CO_3

H_2SO_4

f. Letters used in a non-decimal number system are never capitalized, regardless of print, and must be preceded by a numeric indicator if they are "open" numerals.

$46T_{12}$

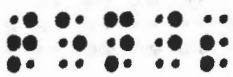
$T46E_{12}$



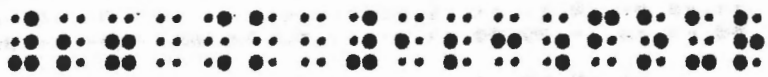
SUBSCRIPTS AND SUPERSCRIPTS, continued

g. No contractions are used in words which carry superscripts or subscripts, or in words which are used as superscripts or subscripts. When more than one word is used as a sub- or superscript, each is preceded by the correct indicator.

ten^2



$27 = 123_{\text{four}}$



h. The comma-optional space symbol is used to replace the comma and space of two or more consecutive superscripts or subscripts. This contracted form is not used when a comma and space are on the base line.

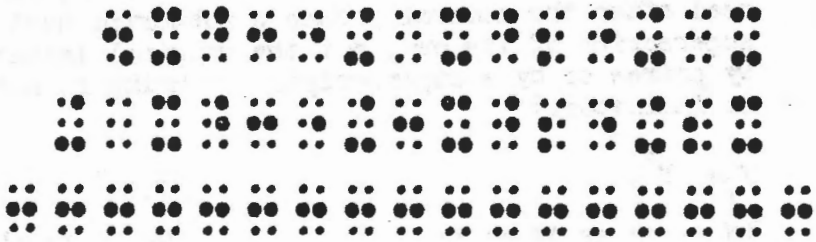
$x_{i,\ j,\ k}$

$x_{(a,\ b)}$

$x_{1,\ 2}$

i. When spaces are left for the purpose of alignment, indicators are used as though such spaces were not present.

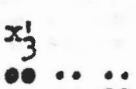
$$\begin{array}{l} 4x^3 + x^2 + x \\ \underline{+ x^3 + 3x^2 + 2x} \end{array}$$



j. If primes are shown in addition to subscripts or superscripts, the primes are written first, unless the prime is separated from the expression.

x'^2

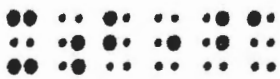
x'_3



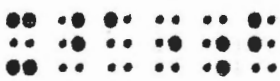
$x^{*\prime}$

k. When both subscript and superscript are shown, the subscript is written first unless the print position indicates that the superscript is first.

x^a_b



$x^a{}_b$



TALLY MARK |

a. Space between groups of five if tallies are shown grouped in print.

b. Use a multipurpose indicator between tallies and punctuation indicator.

~~||||~~ ~~||||~~ ||.

THEREFORE; SINCE ∴

∴ A = B

TILDE Simple: ∼ Extended: ∼∼

a. In set notation, the simple tilde means the difference between, and is used as a sign of operation.

b. The extended tilde may be used in print as is related to.

n(C ∼ D) = 1 a ∼∼ b (a is related to b)

TIME (Clock reading)

2:45 P.M.

2:45-3:30 PM

TRANSCRIBERS' NOTE SYMBOL

a. Transcriber's notes, enclosed in note symbols, follow rules for grouping signs for punctuation and contractions. Transcriber's notes at the beginning of braille volumes are not enclosed in note symbols, but are written according to the rules of TEXTBOOK FORMAT.

b. A short note, seven words or less, is inserted in the text at the most appropriate place for the reader.

In x^2, the ^{2} is the exponent.

TYPE-FORM INDICATORS

Boldface

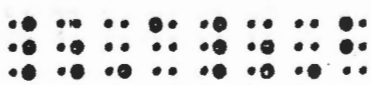
Sanserif

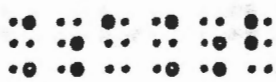
Italic

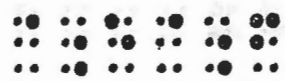
Script

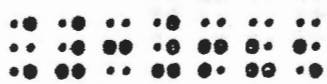
a. Except for regular type, the type-form of a letter or numeral must be shown by using the correct type-form indicator before the letter indicator or numeric indicator. If the type-form has no mathematical significance, it should be disregarded.

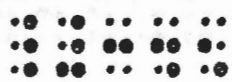
b. When letters are not in regular type, two or more unspaced letters must each have a type-form indicator and letter indicator. Two or more numerals of the same type require only one type-form indicator and numeric indicator. If different type forms are used, each must be preceded by a type-form and numeric indicator.

AB (boldface) 

ab (italics) 

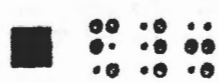
ef (script) 

3685 (italics 3, regular 685) 

345 (boldface 345) 

c. The boldface-type indicator is used before signs of operation or comparison when they are shown in boldface, but only if the type is of mathematical significance. When shapes are filled in, the boldface-type indicator (the same symbol as the filled-in shape indicator) follows the shape indicator.

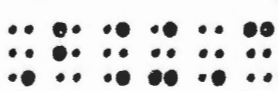
(boldface equals sign)

(filled-in square) 

(boldface plus sign) a + b

UNION (Cup) ∪

a. Union is a sign of operation; no spaces are needed unless modified.

B ∪ C 

VERTICAL BAR | ⠸ DOUBLE VERTICAL BAR || ⠸⠸

Enlarged | ⠸⠸ Enlarged || ⠸⠸⠸⠸

a. Single vertical bars may be used to indicate "absolute value."

|B| ⠸⠸⠸⠸

b. The vertical bar is used for the straight side of a division format symbol, either regular or inverted, and the enlarged vertical bar is used for the side of synthetic division format. (See Division Format.)

⠸⠸⠸⠸
⠸⠸⠸⠸
⠸⠸⠸⠸
⠸
⠸
⠸

c. Enlarged single or double vertical bars may be used at either or both ends of mathematical expressions such as systems of equations, determinants, and matrices. Each line of the expression carries the enlarged sign of grouping. (See Enlarged Grouping Symbols.)

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

⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸
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⠸⠸⠸⠸⠸⠸⠸

d. As a comparison sign, the vertical bar means "such that." It is usually a part of an expression within braces used in set notation.

$\{x \mid |x| < 10\}$ ⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸
⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸
⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸⠸

e. A single boldface vertical bar meaning <u>end of proof</u> must be spaced from any surrounding material.

| ⠸⠸ (boldface vertical bar)

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