This is a list of all substantial corrections made to *Computers & Typesetting* since the beginning of 2014. (More precisely, it lists errors corrected since the 19th printing of Volume A, the 9th printing of Volume B, the 8th printing of Volume C, the 6th printing of Volume D, and the 7th printing of Volume E. But it omits changes that are “purely cosmetic.”) Corrections made to the softcover version of *The TeXbook*, beginning with its 32nd printing, are the same as corrections to Volume A. Corrections to the softcover version of *The METAFONTbook*, beginning with its 11th printing, are the same as corrections to Volume C. Changes to the mini-indexes and master indexes of Volumes B, D, and E are not shown here unless they are not obviously derivable from what has been shown. Some (or all) of these errors have been corrected in the most recent printings.

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**Page A34, line 3 from the bottom**  
(01/09/20)

not, you can say ‘\errorcontextlines=100 \oops’ and try again. (That will usually

**Page A43, line 6**  
(07/24/14)

keyboard, or that have been preempted for formatting?

**Page A49, Cummings quote**  
(08/03/19)

(delete the period at the end of the line)

**Page A66, line 3 from the bottom**  
(08/26/17)

Such displays of box contents will be discussed further in Chapters 12 and 27.

**Page A105, lines 9–16**  
(01/16/21)

\vadjust\langle vertical mode material \rangle will use internal vertical mode to insert the specified material into the vertical list that encloses the paragraph, immediately after whatever line contained the position of the \vadjust. For example, you can say \vadjust\{\kern1pt\} to increase the amount of space between lines of a paragraph if those lines would otherwise come out too close together. (The author did that in the current line, just to illustrate what happens.) Also, if you want to make sure that a page break will occur immediately after a certain line, you can say \vadjust\{\eject\} anywhere in that line.

**Page A122, lines 3–8**  
(11/24/19)

\count255, \dimen255, \skip255, \muskip255, and \toks255 are traditionally kept available for such purposes. Furthermore, plain TeX reserves \dimen0 to \dimen9, \skip0 to \skip9, \muskip0 to \muskip9, and \box0 to \box9 for “scratchwork”; these registers are never allocated by the \new... operations. We have seen that \count0 through \count9 are special, and \box255 also turns out to be special; so those registers should be avoided unless you know what you are doing.
Page A155, line 8 from the bottom  
(01/17/21)

\mathopen{\hbox{$\left\{\text{strut}\right.$}}

Page A155, the bottom six lines  
(12/10/18)

Individual symbols: $\left...\right$ constructions are treated as "inner" subformulas, which means that they will be surrounded by additional space in certain circumstances. All other subformulas are generally treated as ordinary symbols, whether they are formed by $\overline{}$, $\hbox{}$, $\vcenter{}$, or simply being enclosed in braces. Thus, \mathord isn't really a necessary part of the \TeX{} language; instead of typing \texttt{$'1\mathord,234$'} you can get the same effect from \texttt{'$1\{,\}234$'}.

Page A158, line 19  
(12/10/18)

\textbf{Inner} is an inner atom produced by $\left...\right$;

Page A170, lines 18 and 19  
(12/10/18)

Subformulas delimited by $\left$ and $\right$ are treated as type Inner. The following table is used to determine the spacing between pairs of adjacent atoms:

Page A171, line 19 from the bottom  
(06/15/19)

Formula produces a result essentially equivalent to $\left(\langle\text{subformula}\rangle\right)$, when

Page A215, line 16 from the bottom becomes two lines  
(10/13/20)

\begin{itemize}
  \item Just after a token such as $\$3$ that begins math mode, to see if another token of category 3 follows.
\end{itemize}

Page A222, lines 21–23  
(01/16/21)

\begin{itemize}
  \item \hbox{box specification}{\{\text{horizontal mode material}\}} (see Chapter 12)
  \item \vbox{box specification}{\{\text{vertical mode material}\}} (see Chapter 12)
  \item \vtop{box specification}{\{\text{vertical mode material}\}} (see Chapter 12)
\end{itemize}

Page A222, lines 11–13 from the bottom  
(01/16/21)

The \vsplit operation is also explained in Chapter 15. In math modes an additional type of box is available: \vcenter{box specification}{\{\text{vertical mode material}\}} (see Chapter 17).

Page A232, line 14  
(01/10/21)

Tabs outside; \texttt{\textbackslash global\{settabs\}} will not do what you might think it should.

Page A233, lines 3–5  
(04/27/15)

Only two tabs are set in this case, because only two &'s appear in the sample line. (A sample line usually ends with $\&\text{\textbackslash cr}$, as it does here, because text material between the last tab and $\text{\textbackslash cr}$ isn't used for anything.)
Page A252, lines 5–7 (12/25/20)

blank, and the footnote is normally a centered page number, but you can specify any headline and footnote that you want by changing the token lists `\headline` and `\footline`. For example,

Page A253, lines 7–9 from the bottom (10/27/20)

`\everypar` or `\errhelp`, except that `\TeX` retains the begin-group symbol `{` at the beginning and the end-group symbol `}` at the end. These grouping characters help to keep the output routine from interfering with what `\TeX` was doing.

Page A256, line 19 (08/28/15)

`\baselineskip=24pt \lineskip=0pt`

Page A277, lines 9 and 10 from the bottom (08/26/17)

`⟨ hyphenation assignment ⟩ − → \hyphenation(filler){(hyphenations)}
| \patterns(filler){(patterns)}

Page A286, bottom two lines (and affecting the top lines of page 287) (08/26/17)

stands for zero or more `⟨ assignment ⟩` commands other than `\setbox`, possibly with `⟨ filler ⟩`. If the assignments are not followed by a `⟨ character ⟩`, where `⟨ character ⟩` stands

Page A287, lines 11–17 (04/22/20)

`\discretionary{disc text}{disc text}{disc text}.` A `⟨ disc text ⟩` has the form `⟨ filler ⟩{(horizontal mode material)}{}`, where the material is processed in restricted horizontal mode and should contain only fixed-width things. More precisely, the horizontal list formed by each `⟨ disc text ⟩` must consist only of characters, ligatures, kerns, boxes, and rules; there should be no glue or penalty items, etc. This command appends a discretionary item to the current list; see Chapter 14 for the meaning of a discretionary item. The space factor is not changed.

Page A292, lines 8–10 (04/22/20)

`\discretionary{disc text}{disc text}{disc text}.` This command has the same effect as in horizontal mode (see Chapter 25), but the third `⟨ disc text ⟩` must produce an empty list.

Page A299, line 11 from the bottom (11/01/20)

is corrupted or was prepared for a different version of `\TeX`.

Page A305, bottom line (06/30/20)

`\setbox0=\hbox{#1}\advance\dimen0 by -\wd0 \}.`
Page A309, line 2 becomes two lines (12/06/20)
represent text entered from the user's terminal, or with '<insert>', when they represent
text inserted during error recovery).

Page A316, lines 17 and 18 from the bottom (09/03/15)
(The next line must also not be too tall.) Here \specialstar is a box of height zero
and depth \strutdepth, and it puts an asterisk in the left margin:

Page A320, lines 5–9 from the bottom (06/27/15)
17.21. Assigning \delcode'{ would not work to allow '\left{', because the brace
has category 1 and isn't a legal ⟨delim⟩. Allowing brace delimiters would be a bad
idea because it would mess up other constructions, such as arguments to macros, and
components of alignments. Moreover, a user who gets away with '\left{ is likely to
try also '\bigl{', which fails miserably.

Page A326, line 12 (08/26/17)
its natural width. The \hbox version also invokes \everyhbox and \everymath.

Page A329, line 3 of answer 20.7 (05/15/19)
the three tokens \#1, \#2, [; the ⟨replacement text⟩ consists of the six tokens {1, \#6,

Page A329, line 6 of answer 20.7 (05/15/19)
is otherwise irrelevant. Thus, '\def\!!1\#2[#][##]!!#2' would produce an essentially

Page A329, line 5 from the bottom of answer 20.7 (05/15/19)
\!1<-x

Page A329, bottom line of answer 20.7 (05/15/19)
final parameter in the parameter text; '\!1' would have been rendered '\#1'.

Page A332, lines 13 and 14 (08/26/17)
21.10. If you say '{\let\the=0\edef\next{\write\cont{\{token list\}}\next}', the
\write will be executed after \edef expands everything except \the.

Page A332, bottom line (11/15/19)
\+&{\bf end};\cr % note that the semicolon isn't bold

Page A342, lines 12 and 13 (08/14/20)
of plain \TeX format; but some of them are primitive (built in), such as '\par' (end
of paragraph), '\noindent' (beginning of non-indented paragraph), and '/\' (italic
Braces are used for grouping, when supplying arguments to macros; so they cannot also be used as math delimiters, or as arguments to macros such as \textbackslash{big}. (One could change their catcodes to 12, and use some other pair of characters for grouping; but that would not be plain \TeX.)

The registers $\textbackslash{count}_{255}$, $\textbackslash{dimen}_{255}$, $\textbackslash{skip}_{255}$, $\textbackslash{toks}_{255}$, and $\textbackslash{muskip}_{255}$ are freely available in the same way. (3) All assignments to the scratch registers whose numbers are 1, 3, 5, 7, and 9 should be $\textbackslash{global}$; all assignments to the other scratch registers (0, 2, 4, 6, 8, 255) should be non-$\textbackslash{global}$. (This prevents the phenomenon of “save stack buildup” discussed in Chapter 27.) (4) Furthermore, it’s possible to use any register in a group, if you ensure that \TeX’s grouping mechanism will restore the register when you’re done with the group, and if you are certain that other macros will not make global assignments to that register when you need it. (5) But when a register is used by several macros, or over long spans of time, it should be allocated by $\textbackslash{newcount}$, $\textbackslash{newdimen}$, $\textbackslash{newbox}$, etc. (6) Similar remarks apply to input/output streams used by $\textbackslash{read}$ and $\textbackslash{write}$, to math families used by $\textbackslash{fam}$, to sets of hyphenation rules used by $\textbackslash{language}$, and to insertions (which require $\textbackslash{box}$, $\textbackslash{count}$, $\textbackslash{dimen}$, and $\textbackslash{skip}$ registers all having the same number).

\texttt{\def\wlog{\immediate\write-1} % this will write on log file (only)}
\texttt{\outer\def\newmuskip{\alloc@3 \muskip\muskipdef\@cclv}}
\texttt{\outer\def\newtoks{\alloc@5 \toks\toksdef\@cclv}}
\texttt{\def\fmtversion{3.1415926535} % identifies the current format}
and \if...\fi tests, as well as special operations like \the and \input, while the latter category includes the primitive commands listed in Chapters 24–26. The expansion of $$\texttt{\textbackslash \texttt{general display}}$$ to be invoked, with \eq defined to be $\alpha$. Furthermore, when an equation number $\beta$ is present, it should be stored in \eqn, and the test \ifeqno should be true. In such cases \ifeqno should distinguish \leqno from \eqno. Here

\setbox2=\lastbox \setbox\footins=\vbox{\box2}

since \lastbox will be the result of \rigidbalance, which is an hbox.

\def\par{\endgraf\penalty5000 \endgraf} % square bullet

\vrule height6pt depth2pt width0pt \relax} % a strut for \insertmargin

15e. Enclose the vbox that was constructed in Rule 15c or 15d by delimiters ($\lambda$, $\rho$) whose height plus depth is at least $\sigma_{20}$, if $C > T$, and at least $\sigma_{21}$ otherwise. Shift the delimiters up or down so that they are vertically centered with respect to the axis. Replace the generalized fraction by an Ord atom whose nucleus is the resulting sequence of three boxes ($\lambda$, vbox, $\rho$). Go to rule 19.
Page A454, lines 17 and 18 from the bottom (04/13/20)

of the process; the trial word consists of all the letters found in admissible items, up to a maximum of 63. Notice that all of these letters are in font f.

Page A458 and following, selected amendments to the index (01/18/21)

[1] (progress report), 23, 119
\aa, 52, 356.
\AA, 52, 356.
(disc text), 287, 292.
(general text), 278, 279, 280.
(horizontal mode material), 278, 285, 287.
integral signs, see \int, \oint, \smallint.
(math mode material), 287, 289-290.
\nul, 311, 312, 316, 332, 335, 351, 354, 360-362, 419.
\o, 52, 356.
\O, 52, 356.
programs, for computers, 38, 165, 234.
repeating templates, see periodic preambles.
replacement text, 200-204, 212, 280, 300, 320.
right delimiters, see closings.
struts, 82, 125, 131, 142, 155, 178, 245-247, 255, 329, 416, 422, 423.
(vertical mode material), 278, 280-282, 290.

Page B21, lines 33 and 34 (04/02/17)

[‘41 → ‘46, ‘60 → ‘71, ‘136,’141 → ‘146,’160 → ‘171] must be printable. Thus, at least 80 printable characters are needed.

Page B28, lines 3 and 4 (04/02/17)

not serious since we assume that this part of the program is system dependent.

Page B28, line 2 from the bottom (04/02/17)

\texttt{var k: 0..23;    \{index to current digit; we assume that |n| < 10^{23} \}}
Page B35, line 2 of §83 becomes two lines (06/27/20)

\begin{verbatim}
loop begin continue : if interaction \neq error_stop_mode then return;
    clear_font_error_prompt ; prompt_input( "?\n" );
\end{verbatim}

Page B36, line 11 of §84 (07/03/20)

"E": if base_ptr > 0 then if input_stack[base_ptr].name_field \geq 256 then

Page B36, line 5 of §85 becomes two lines (07/03/20)

\begin{verbatim}
if base_ptr > 0 then
    if input_stack[base_ptr].name_field \geq 256 then print("E\n",
\end{verbatim}

Page B40, line 5 from the bottom (08/07/20)

\begin{verbatim}
("Try to insert an instruction for your file.")
\end{verbatim}

Page B58, lines 2 and 3 of §136 (10/11/20)

the values corresponding to \texttt{\textbackslash hbox{}}. The \texttt{subtype} field is set to \texttt{min\_quarterword}, for historic reasons that are no longer relevant.

Page B88, line 16 (10/22/20)

The mode is temporarily set to zero while processing \texttt{\write} texts.

Page B102, lines 3 and following of §241 (12/11/20)

information, something special is needed. The program here simply assumes that suitable values appear in the global variables \texttt{sys\_time}, \texttt{sys\_day}, \texttt{sys\_month}, and \texttt{sys\_year} (which are initialized to noon on 4 July 1776, in case the implementor is careless).

\begin{verbatim}
procedure fix_date_and_time;
    begin sys_time \leftarrow 12 \times 60; sys_day \leftarrow 4; sys_month \leftarrow 7; sys_year \leftarrow 1776; \{ self\_evident truths \}
        time \leftarrow sys_time; \{ minutes since midnight \}
        day \leftarrow sys_day; \{ day of the month \}
        month \leftarrow sys_month; \{ month of the year \}
        year \leftarrow sys_year; \{ Anno Domini \}
    end;
\end{verbatim}

Page B103, replacement for §246 (12/11/20)

246. Of course we had better declare a few more global variables, if the previous routines are going to work.

\begin{verbatim}
(global variables 13) + \equiv
old_setting : 0 .. max_selector;
sys\_time, sys\_day, sys\_month, sys\_year: integer; \{ date and time supplied by external system \}
\end{verbatim}
The enclosing { and } characters of a macro definition are omitted, but an output routine will be enclosed in braces.

routines that should be aborted, but we can sketch the ideas here: For a runaway definition or a runaway balanced text, we will insert a right brace; for a runaway preamble, we will insert a special \cr token and a right brace; and for a runaway argument, we will set long_state to outer_call and insert \par.

function strtok(b: pool_pointer): pointer;  { converts str_pool[b .. pool_ptr - 1] to a token list }

begin continue: get_token;  { set cur_cmd, cur_chr, cur_tok }

if cur_tok < left_brace_limit then

help2("I'm going to ignore the # sign you just used," )
(as well as the token that followed it."); error; goto continue;

help1("This \read has unbalanced braces."); align_state ← 1000000; limit ← 0; error;

494. Here is a procedure that ignores text until coming to an \or, \else, or \fi at the current level of \if ... \fi nesting. After it has acted, cur_chr will indicate the token that was found, but cur_tok will not be set (because this makes the procedure run faster).

begin wlog(banner); slow_print(format_ident); print (""u"" ); print_int(sys_day); print_chr("u");
months ← 'JANFEBMARAPRILMAYJUNJULAUGSEPTEMBER';
for k ← 3 * sys_month = 2 to 3 * sys_month do wlog(months[k]);
print_chr("u"); print_int(sys_year); print_chr("u"); print_two(sys_time div 60); print_chr(";");
print_two(sys_time mod 60);
command is being processed. Beware: For historic reasons, this code foolishly conserves a tiny bit of string pool space; but that can confuse the interactive 'E' option.

Page B219, lines 18–20 of §545
so-called boundary character of this font; the value of next_char need not lie between be and ec. If the very last instruction of the big kern array has skip-byte = 255, there is a special ligature/kerning program for a boundary character at the left, beginning at location 256 * op-byte +

Page B299, line 4 from the bottom of §722
begin char_warning(cur_f, go(cur_e)); math_type(a) ← empty; cur_i ← null_character;

Page B333, line 5 of §793 becomes two lines
cur_loop ← link(cur_loop); link(p) ← new_glue(glue_ptr(cur_loop));
subtype(link(p)) ← tab_skip_code +1;

Page B348, insert a new line after line 5 of §826
stat if tracing_paragraphs > 0 then end_diagnostic(true); tats

Page B348, insert a new line to be the seventh line after the previous change
stat if tracing_paragraphs > 0 then begin_diagnostic; tats

Page B377, line 6
hn: 0 .. 64; { the number of positions occupied in he; not always a small_number }

Page B417, mini-index
The entry 'height, §981.' here and on many later odd-numbered pages should be 'height = macro, §135.'

Page B522, line 3 of §1306.
to be in the range a ≤ x ≤ b. System error messages should be suppressed when undumping.
loop. (Actually there’s one way to get error messages, via prepare_mag; but that can’t cause infinite recursion.)

If final_clean_up is bypassed, this program doesn’t bother to close the input files that may still be open.

begin (Finish the extensions 1378); new_line_char ← −1;

begin c ← cur_char; if c ≠ 1 then new_line_char ← −1;

begin clear_terminal;
loop

begin goto breakpoint;
    {go to every declared label at least once}
breakpoint: m ← 0; @{'BREAKPOINT'}@

they occupy in a typical production system (executable code size for dark blocks, global data size for light blocks). In this way the chart indicates a total of about 12 × 22 = 264K bytes of memory, plus 12 × 10 = 120K for the dynamic memory region not shown explicitly. The dynamic memory is often considerably larger in practice, because it is desirable to accommodate large macro packages and large pages.

20 More About Macros ....................................... 175

that has already been designed. All you’ll see is ‘(io.mf The letter O [79])’ or possibly only ‘(io.mf [79])’, followed by ‘*’. Now the fun starts: You should type

uniformdeviate -100 -36.1628
z slanted 1/6 (0.16667y+x, y)
(a,b)zscaled(3,4) (-4b+3a, 3b+4a)
(a,b)zscaled dir 30 (-0.5b+0.86603a, 0.86603b+0.5a)
(a,b)dotprod(3,4) 4b+3a
Page C72, lines 4–18 (07/16/20)

\[(\text{numeric atom}) \rightarrow (\text{numeric variable})\]
\[| (\text{numeric token primary})\]
\[| ((\text{numeric expression})\]
\[| \text{normaldeviate}\]
\[| \text{length (string primary)}\]
\[| \text{length (path primary)}\]
\[| \text{length (pair primary)}\]
\[| \text{angle (pair primary)}\]
\[| \text{xpart (pair primary)}\]
\[| \text{ypart (pair primary)}\]
\[| (\text{numeric operator})(\text{numeric primary})\]
\[| (\text{numeric token primary}) \rightarrow (\text{numeric token}) / (\text{numeric token})\]
\[| (\text{numeric token not followed by } '/ (\text{numeric token})')\]
\[| (\text{numeric primary}) \rightarrow (\text{numeric atom not followed by } [\text{expression}],)\]
\[| (\text{numeric expression}), (\text{numeric expression})\]

Page C76, lines 8–16 from the bottom (11/11/17)

... to the edge of the type. (With plain \textsc{Metafont}'s \texttt{beginchar} each character has a “bounding box” that runs from $(0,h)$ at the upper left and $(w,h)$ at the upper right to $(0,-d)$ and $(w,-d)$ at the lower left and lower right; variable $d$ represents the depth of the type. The values of $w$, $h$, and $d$ might change from character to character, since the individual pieces of type need not have the same size in a computer-produced font.)

Page C80, line 14 (06/13/20)

\texttt{penpos (suffix)}((\text{unknown}), (\text{known})).

Page C83, line 16 (06/13/20)

\texttt{### 0.5a=-c-0.5b+1.5}

Page C83, line 19 (06/13/20)

the only dependent variable is now $d$, which equals $0.5c + 0.75b + 0.75$. (This is

Page C96, line 13 from the bottom (10/31/20)

... illustrates the use of $u\#$, $s\#$, $ht\#$, $logo_{pen}$, $leftstemloc$, $o$, $xgap$, and $barheight$:}
pixels. (Some typesetting systems use both of these device-dependent amounts to alter their current position on a page, just after typesetting each character. Other systems, like typical \texttt{dvi} software associated with \TeX{}, assume that \texttt{chardy} = 0 but use \texttt{chardx}

\begin{verbatim}
s# := 5pt #; define_pixels(s); % side of the square
z_1 = (0, 0); z_2 = (s, 0); z_3 = (0, s); z_4 = (s, s);
for k = 1 upto 4: z[k+4] = z[k] + (4/5 * s, 1/5 * s); endfor
pickup pencircle scaled Ap; draw z_5 - - z_6 - - z_7 - - cycle;
pickup pencircle scaled 1.6pt; erase draw z_2 - - z_4 - - z_3;
pickup pencircle scaled Ap; draw z_1 - - z_2 - - z_4 - - z_3 - - cycle;
for k = 1 upto 4: draw z[k] - - z[k+4]; endfor
\end{verbatim}

\begin{verbatim}
for k = 0 upto 4: z[k] = center + (radius, 0) rotated(90 + \frac{360}{5} k); endfor
\end{verbatim}

changed. Plain \texttt{METAFONT} has a \texttt{tensepath} operation that does this. For example, \texttt{tensepath unitsquare = (0, 0) - - (1, 0) - - (1, 1) - - (0, 1) - - cycle.}

only about 0.28 with respect to the initial and final directions; since \texttt{METAFONT} insists that tensions be at least 0.75, this anomalous path could never have arisen if the control

might produce a transcript that includes the following diagnostic information:

\begin{verbatim}
\texttt{rotatedaround(EXPR0)(EXPR1)->}
\texttt{shifted-(EXPR0)rotated(EXPR1) shifted(EXPR0)}
\end{verbatim}

(i.e., parameters in parentheses), then we name zero or one or two undelimited parameters. Then comes an \texttt{‘=’} sign, followed by the replacement text, and \texttt{enddef}. The \texttt{‘=’} sign might also be \texttt{:=’}; both mean the same thing.

Chapter 14’s syntax rules for \texttt{⟨path primary⟩}, via \texttt{⟨pair primary⟩}. A pair expression is not considered to be of type \texttt{path} unless the path interpretation is the only possibility.
<table>
<thead>
<tr>
<th>Page C176, line 7 from the bottom</th>
<th>(07/09/20)</th>
</tr>
</thead>
</table>
| \[
\begin{align*}
\text{if } \#(x) & : t_x \text{ else } t_x \text{ fi } := x; \text{ endfor}
\end{align*}
\] |

<table>
<thead>
<tr>
<th>Page C180, line 3 from the bottom</th>
<th>(06/24/20)</th>
</tr>
</thead>
</table>
| \[\text{"=\text{ or ":=} following } \text{let.} \]

<table>
<thead>
<tr>
<th>Page C187, line 11 from the bottom</th>
<th>(07/12/20)</th>
</tr>
</thead>
</table>
| \[\text{substring} (\text{pair expression}) \text{ of } (\text{string primary}) \]

<table>
<thead>
<tr>
<th>Page C189, line 14</th>
<th>(06/13/20)</th>
</tr>
</thead>
</table>
| \[\text{". \, and followed by }, ", \, followed by lines of context as in METAFONT's normal error} \]

<table>
<thead>
<tr>
<th>Page C200, line 12 from the bottom</th>
<th>(08/27/20)</th>
</tr>
</thead>
</table>
| \[y_1 = y_2 = \text{good.y(5[-d, h] +1.1pt)}; \]

<table>
<thead>
<tr>
<th>Page C202, line 17 from the bottom</th>
<th>(06/13/20)</th>
</tr>
</thead>
</table>
| \[\text{command, and it works only when the penpos angle is 0. If the penpos command is} \]

<table>
<thead>
<tr>
<th>Page C210, bottom eight lines, and top ten lines of page C211</th>
<th>(07/16/20)</th>
</tr>
</thead>
</table>
| \[\langle \text{numeric atom} \rangle \rightarrow \langle \text{numeric variable} \rangle \mid \langle \text{numeric argument} \rangle \mid \langle \text{numeric token primary} \rangle \mid \langle \text{internal quantity} \rangle \mid \langle \text{normaldeviate} \rangle \mid \langle \text{numeric expression} \rangle \mid \langle \text{begingroup statement list} \rangle \langle \text{numeric expression} \rangle \langle \text{endgroup} \rangle \mid \langle \text{length} \langle \text{numeric primary} \rangle \rangle \mid \langle \text{length} \langle \text{pair primary} \rangle \rangle \mid \langle \text{length} \langle \text{path primary} \rangle \rangle \mid \langle \text{ASCII} \langle \text{string primary} \rangle \rangle \mid \langle \text{oct} \langle \text{string primary} \rangle \rangle \mid \langle \text{hex} \langle \text{string primary} \rangle \rangle \mid \langle \text{pair part} \langle \text{pair primary} \rangle \rangle \mid \langle \text{transform part} \langle \text{transform primary} \rangle \rangle \mid \langle \text{angle} \langle \text{pair primary} \rangle \rangle \mid \langle \text{turningnumber} \langle \text{path primary} \rangle \rangle \mid \langle \text{totalweight} \langle \text{picture primary} \rangle \rangle \mid \langle \text{numeric operator} \langle \text{numeric primary} \rangle \rangle \mid \langle \text{directiontime} \langle \text{pair expression} \rangle \rangle \langle \text{of} \langle \text{path primary} \rangle \rangle \mid \langle \text{numeric token primary} \rangle \rightarrow \langle \text{numeric token} \rangle / \langle \text{numeric token} \rangle \mid \langle \text{numeric token not followed by ", \rangle} / \langle \text{numeric token} \rangle \rangle \mid \langle \text{numeric primary} \rangle \rightarrow \langle \text{numeric atom not followed by \{ expression\} } , \rangle \mid \langle \text{numeric atom} \rangle \langle \text{expression} \rangle \langle \text{expression} \rangle \]

<table>
<thead>
<tr>
<th>Page C214, line 6 becomes two lines</th>
<th>(07/17/20)</th>
</tr>
</thead>
</table>
| \[\langle \text{future pen primary} \rangle \rightarrow \langle \text{future pen argument} \rangle \mid \langle \text{pencircle} \rangle \]

| substring (pair expression) of (string primary)

Page C217, lines 20–25

(\text{program}) \rightarrow (\text{statement list}) (\text{non-title statement}) \text{end}
\text{ | (statement list)} (\text{non-title statement}) \text{dump}
\text{ | (statement list)} \rightarrow (\text{empty}) | (\text{statement}) ; (\text{statement list})
\text{ | (statement)} \rightarrow (\text{empty}) | (\text{title})
\text{ | (equation)} | (\text{assignment}) | (\text{declaration})
\text{ | (definition)} | (\text{compound}) | (\text{command})

Page C219, line 25

to see which of its subscripts and suffixes have occurred. For example, if you’re

Page C224, lines 7–9 from the bottom

\begin{align*}
y_{4r} &= -0.9848 \text{thinn} + 259.00049 \\
x_{4r} &= -0.08682 \text{thinn} + 144 \\
y_4 &= -0.4924 \text{thinn} + 259.00049
\end{align*}

Page C226, lines 9 and 10

This means that the preloaded base you have specified cannot be used, because it is corrupted or was prepared for a different version of METAFONT.

Page C228, line 27

1.94 endfor

Page C228, line 4 from the bottom

might want to review now.) You probably also have a \textit{proof} mode diagram:

Page C234, line 4 of answer 4.6

\begin{verbatim}
\text{for } k = 1 \text{ upto } 6: \text{ } z[k]' = 2[z[k], z_0]; \text{endfor}
\end{verbatim}

Page C241, line 2

\texttt{\textbackslash mode=cheapo; input cheaplogo10}

Page C242, line 11 of answer 13.7

\begin{verbatim}
\text{for } k = 1 \text{ upto } 4: \text{ } z[k + 4] = z[k] + (3^{\frac{1}{2}}, 3^{\frac{1}{3}}); \text{endfor}
\end{verbatim}
Page C243, lines 7 and 8 (11/08/15)

\[ \text{draw subpath}(k, k+1) \text{ of star; cullit;} \]
\[ \text{undraw subpath}(k+2, k+3) \text{ of start withpen emser; cullit;} \]

Page C243, line 3 of answer 13.11 (06/17/20)

\[ \text{def overdraw expr c = begingroup save region;} \]

Page C243, lines 12–16 of answer 13.11 (05/24/20)

\[ \text{beginchar}("M", 1.25 in \#, .5 in \#, 0); \text{ pickup pencircle} \text{ scaled .4 pt;} \]
\[ z_1 = (20, -13); z_2 = (30, -6); z_3 = (20, 1); z_4 = (4, -7); \]
\[ z_5 = (-12, -13); z_6 = (-24, -4); z_7 = (-15, 6); \]
\[ \text{path M; } M = (\text{origin} \ldots z_1 \ldots z_2 \ldots z_3 \ldots z_4 \ldots z_5 \ldots z_6 \ldots z_7 \ldots \text{ origin} \ldots -z_7 \ldots -z_6 \ldots -z_5 \ldots -z_4 \ldots -z_3 \ldots -z_2 \ldots -z_1 \ldots \text{ cycle}) \]

Page C246, line 2 of answer 14.13 (08/16/20)

\[ \text{path } z_0 - z_1 \text{ is equivalent to } 'z_0 \ldots \text{ controls 1/3[z}_0, z_1\text{]} \text{ and 2/3[z}_0, z_1\text{]} \ldots z_1' \text{, and the} \]

Page C247, line 1 of answer 15.5 (06/13/20)

\[ \text{15.5. } \text{beginchar}(126, 25\#, h\text{height}\# + \text{bonder}\#, 0); "\text{Dangerous left bend}"; \]

Page C247, replacement for answer 15.7 (07/21/20)

\[ \text{15.7. } \text{Replace lines 10 and 11 by} \]
\[ \text{pickup pencircle} \text{ scaled 3/4 pt yscale 1/3 rotated } -60; \]
\[ \text{draw } (z_1 \ldots p) \text{ transformed } t; \]
\[ \text{addto currentpicture also currentpicture} \]
\[ \text{rotatedaround}((.5 w, .5 h) \text{ yscale aspect ratio}, -180); \]

Page C249, line 1 of answer 18.9 (08/02/20)

\[ \text{18.9. } \text{beginchar}("H", 13 u\#, "ht"\#, 0); \text{ pickup broadpen}; \]

Page C249, line 11 of answer 18.9 (08/02/20)

\[ \text{filldraw bot serifedge}_4 \]

Page C250, line 4 of answer 19.1 (04/19/20)

because it saves a wee bit of time and because '; ' often belongs before endfor.

Page C250, replacement for answer 19.3 (07/12/20)

\[ \text{19.3. } \text{Yes, if and only if } n - \frac{1}{2} \text{ is an even integer. (Because ambiguous values are rounded upwards.)} \]
22.1 (a) If and only if \( n \) is an integer between 0 and 255. (b) If and only if \( s \) is a string of length 1.

I found no right delimiter to match a left one. So I’ve put one in, behind the scenes; this may fix the problem.

\[
\begin{align*}
\text{font_size} & \text{ font_slant} \\
\text{font_normal_space} & \text{ font_normal_stretch} \\
\text{font_normal_shrink} & \text{ font_x_height} \\
\text{font_quad} & \text{ font_extra_space}
\end{align*}
\]

{ = : = \langle empty \rangle \langle numeric\# \rangle; \\
\text{ligtable(ligs/kerns)} & \text{ charlist(codes)} \\
\text{extensible(codes)} & \text{ fontdimen(info)} \\
\text{headerbyte(info)}
\}

\[
\begin{align*}
\text{proofrule} & \text{ screenrule} \\
\text{proofrulethickness} & \langle \text{numeric\#} \rangle; \text{ proofoffset} \langle \text{pair} \rangle.
\end{align*}
\]

You can say either ‘\text{incr} x’ or ‘\text{incr} (x)’, within an expression; but neither of them are valid statements by themselves.

\[
\text{\textbackslash smode="specmode"; mag=\langle\text{magnification}\rangle; input \langle\text{font file name}\rangle}
\]

\[
\text{def openit = openwindow currentwindow from origen \% and please correct to (screen_rows,screen_cols) at (-50,300) enddef; \% "(-50,300)" too} \text{ def showit_ = display currentpicture inwindow currentwindow enddef; \% first time only}
\]

Plain \textsc{METAFONT} has several other terse commands similar to ‘openit’ and ‘showit’:

\[
\text{blacker:=.1; \% make pens a teeny bit blacker}
\]
Page C289, line 20  (10/07/20)
   if {{(pair x) cand x>(0,0)}}: A else: B fi.

Page C291, line 18  (07/24/20)
   save u_; setu_ u; let switch_ = if; if false: enddef.

Page C292, line 10 from the bottom  (10/23/20)
be known by saying 'if known (p−q): p = q else: false fi'; transforms could be handled

Page C293, lines 13 and 14 from the bottom  (10/27/20)
f(−1) is false! When c → 0, the quantity a^2 + b^2 approaches −∞ when c is positive, +∞ when c is negative. An attempt to 'solve f(1,−1)' will divide by zero and come

Page C295, line 2  (07/04/20)
'interpolate (1,1) . . (3,2) . . (15,4) of 7' the approximate value 3.37.

Page C299, bottom four lines of code become five  (08/06/20)
   primarydef t Bernstein nn = begingroup save r; r =
   begingroup for n=nn downto 2:
   for k=1 upto n-1: u_\([k]\):=t([u_\([k]\),u_\([k+1]\)])
   endfor endfor u_\([1]\) endgroup; numeric u_\([[]]\);
   r endgroup enddef;

Page C299, line 5 after the code becomes two lines  (08/06/20)
brackets are nested inside of brackets. However, the auxiliary variables 'u_\([[]]\)' must not remain independent at the end.

Page C305, lines 14–18  (07/08/20)
   width_adj#:=0pt#; % width adjustment for certain characters
   serif_fit#:=0pt#; % extra sidebar near lowercase serifs
   low_asterisk:=false; % should the asterisk be centered at the axis?
   math_fitting:=false; % should math-mode spacing be used?

Page C317, line 21 becomes two lines  (11/11/17)
   ⟨label⟩ → ⟨code label⟩ | ⟨code⟩ :: | :
   ⟨code label⟩ → ⟨code⟩ ;
Page C318, lines 10–16 from the bottom (11/11/17)

<table>
<thead>
<tr>
<th>(code label)</th>
<th>(labeled code)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(extensible command)</td>
<td>(\rightarrow) extensible (code label)</td>
</tr>
<tr>
<td>(four codes)</td>
<td>(\rightarrow) (code)</td>
</tr>
</tbody>
</table>

Notice that a (code label) can appear in a ligtable, charlist, or extensible command. These appearances are mutually exclusive: No code may be used more than once as a label. Thus, for example, a character with a ligature/kerning program cannot also be extensible, nor can it be in a charlist (except as the final item).

Page C333, line 29 (10/25/19)

"if charcode>0:currentpicture:=currentpicture scaled mg;fi;"

Page C333, bottom two lines become one (11/11/17)

if unknown scale: scale := max(1,round(pixels_per_inch/300)); fi

Page C339, line 3 (05/21/20)

ing 'ß', 'æ', 'œ', and 'ø') and the uppercase letters (including 'Æ', 'Œ', and 'Ø') are

Page C341, line 14 from the bottom (11/11/17)

prints the \text{table} and the \text{text}; \text{bigtest} gives you the works, plus a mysterious word

Page C345 and following, selected amendments to the index (01/20/21)


(addto command), 118, 220.

bell-shaped distribution, 251.

black, 270, 332–333.

(code) and (code label), 317.

concatenation, of paths, 70–71, 123, 127–129, 130, 137, 245, 266.

of strings, 69, 73, 84–85, 137, 278, 286, 312.

directiontime, 135, 136, 211, 245, 265, 298.

distance, 76, 84, see also length.

dotprod, 68–69, 178, 238, 265.

efficiency, 39, 99, 116, 141, 144, 147, 228, 230, 234, 244, 264, 265, 277, 291, 297, 298.

empty option in for list, 171, 172, 299.

forbidden tokens, 173, 218–219, 286.

*from, 191, 230, 252, 277, 312.

Giotto di Bondone, 139.

independent variables, 81–83, 88, 224, 236, 299.

\init, 337, 342.

internal quantities, 54–55, 88, 218, 262, 265–266.

*inwindow, 191, 230, 277.

(keep or drop), 118, 220.


*length, 66, 69, 72, 210, 238.

I believe that the final bug in METAFONT was discovered on January 2021. I now believe that the final bug was discovered on 03 July 2020 and removed in version 2.71828182. The finder's fee has converged to $327.68.

The input function brings the next line of input from the specified file into available

is not serious since we assume that this part of the program is system dependent.
Page D28, line 7 (04/02/17)

\[ \text{var} \, k: 0 \ldots 23; \{ \text{index to current digit; we assume that } |n| < 10^{23} \} \]

Page D32, line 2 of §78 becomes two lines (06/27/20)

\[ \text{loop begin} \, \text{continue: if} \, \text{interaction} \neq \text{error stop node} \, \text{then return;} \]
\[ \quad \text{clear for error prompt; prompt input("\text{r}_n");} \]

Page D32, line 11 of §79 (07/03/20)

"E": if file_ptr > 0 then if input stack [file_ptr].name Field \geq 256 then

Page D33, line 5 of §80 (07/03/20)

if file_ptr > 0 then
\[ \quad \text{if input stack [file_ptr].name Field} \geq 256 \text{ then print ("E to edit your file.");} \]

Page D37, line 9 of §93 (08/07/20)

("Try to insert an instruction for me (e.g., 'I show x;'),")

Page D82, line 2 from the bottom (09/19/19)

\[ \text{define boundary char} = 41; \{ \text{the boundary character for ligatures} \} \]

Page D85, lines 3 and 4 of §194 (and §194 actually moves to page D86) (12/11/20)

information, something special is needed. The program here simply assumes that suitable values appear in the global variables \text{sys.time}, \text{sys.day}, \text{sys.month}, and \text{sys.year} (which are initialized to noon on 4 July 1776, in case the implementor is careless).

Page D85, the final six lines of §194 (and §194 actually moves to page D86) (12/11/20)

\[ \text{procedure fix date and time;} \]
\[ \quad \text{begin} \, \text{sys.time} \leftarrow 12 \times 60; \, \text{sys.day} \leftarrow 4; \, \text{sys.month} \leftarrow 7; \, \text{sys.year} \leftarrow 1776; \{ \text{self-evident truths} \} \]
\[ \quad \text{internal[time]} \leftarrow \text{sys.time} \times \text{unity}; \{ \text{minutes since midnight} \} \]
\[ \quad \text{internal[day]} \leftarrow \text{sys.day} \times \text{unity}; \{ \text{day of the month} \} \]
\[ \quad \text{internal[month]} \leftarrow \text{sys.month} \times \text{unity}; \{ \text{month of the year} \} \]
\[ \quad \text{internal[year]} \leftarrow \text{sys.year} \times \text{unity}; \{ \text{Anno Domini} \} \]
\[ \quad \text{end;} \]

Page D86, replacement for §196 (12/11/20)

196. Of course we had better declare a few more global variables, if the previous routines are going to work.

\[ \langle \text{Global variables 13} \rangle + \equiv \]
\[ \text{old setting: } 0 \ldots \text{max selector}; \]
\[ \text{sys.time, sys.day, sys.month, sys.year: integer; } \{ \text{date and time supplied by external system} \} \]

Page D97, line 2 of §221 (05/26/17)

the definition of attribute nodes) that it is convenient to let \text{info}(p) = 0 \text{ stand for } \text{'}[]\text{'}.
but the log \( n \) factor is buried in our implicit restriction on the maximum raster size.) The

\[ \text{for } n \gets 0 \text{ to } n1 - n0 - 1 \text{ do } \text{env.move}[n] \gets \text{mm0}; \]

direction \((\text{right}_u(p), \text{left}_v(q))\); and there’s a line of length \( \geq \text{delta} \) from vertex \( q \) to vertex \( r \),

name points to the \text{egtb} address of the macro being expanded, if the current token list

help2("After \'exitif\(_u\langle\text{boolean}\_expr\rangle\_' \_u\_l\text{expect}u\_t\_u\text{see}_u\_a\text{semicolon.}\")

{ invokes a user-defined sequence of commands }

(A user who tries some shenanigan like ‘\textbf{for } \ldots \textbf{let endfor}’ will be foiled by the \text{get}\_\text{symbol} command is being processed. Beware: For historic reasons, this code foolishly conserves a tiny bit of string pool space; but that can confuse the interactive 'E' option.)

\begin{verbatim}
begin wlog(banner); slow_print(format_ident); print("\_u\_l\text{day}\); print\_int(sys\_year); print\_char("\_u\_l\text{\":}\); print\_char("\_u\_l\text{\":}\); print\_average(sys\_time div 60); print\_char("\_l\text{\":}\); print\_char("\_u\_l\text{\":}\); print\_two(sys\_time mod 60);।
\end{verbatim}

if name = str\_ptr \(-\ 1\) then \{ conserve string pool space (but see note above) \}
cur_type = path_type means that cur.exp points to the first node of a path; nobody else points

so-called boundary character of this font; the value of next_char need not lie between bc and ec. If
the very last instruction of the lig.kern array has skip_byte = 255, there is a special ligature/kerning program for a boundary character at the left, beginning at location 256 * op.byte +

traditional halt; no ligature or kerning command is performed.

Page D474, line 2 from the bottom

help1("A colon should follow a headerbyte or fontdimen location."); back_error;

to be in the range a ≤ x ≤ b. System error messages should be suppressed when undumping.

If final_cleanup is bypassed, this program doesn’t bother to close the input files that may still be open.

Page D520, line 18 of §1212 becomes two lines

begin clear_terminal;

Page D520, lines 11 and 12 from the bottom of §1212 become three lines

begin goto breakpoint;
    { go to every declared label at least once }
breakpoint: m ← 0; @(‘BREAKPOINT’)

they occupy in a typical production system (executable code size for dark blocks, global data size for light blocks). In this way the chart indicates a total of about 8 × 22 = 176K bytes of memory, plus 8 × 15 = 120K for the dynamic memory region not shown explicitly. The dynamic memory is often considerably larger in practice, because it is desirable to accommodate large macro packages and large pictures.