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TEXnical Typesetting: A Guide Through the TEX Typesetting Program

S. P. Ketterer

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
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TEXNICAL TYPESETTING: A GUIDE THROUGH THE TEX TYPESETTING PROGRAM

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TEXNICAL TYPESETTING: A GUIDE THROUGH THE TEX TYPESETTING PROGRAM

S. P. KETTERER

ABSTRACT

This manual is designed as a comprehensive hands-on instructional manual for learning the TEX* computer typesetting program in a classroom environment. Each section presents a new concept in careful detail, concluding with an exercise (TEXercise) to reinforce the learning of the concept. The manual introduces the novice TEX user to the program's basic command structure, along with the concepts of grouping, producing accents, making font changes, and generating mathematical symbols. The TEXercises guide the new user in generating text containing footnotes, multilevel lists, and hanging indentations, as well as in magnifying text for viewgraphs.

Once the basic text generation is defined, the more advanced topics of formatting math equations and tables are explained. A full range of math capabilities is presented—beginning with simple one-line equations, progressing through complex numbered and aligned equations, and concluding with matrices.

The sections on table generation present the basic concepts in TEX's table-formatting program and then build on them. The new user first learns to construct simple tables, and with careful explanations and guidance, learns to add one new table enhancement at a time. By the conclusion of these sections, the user can construct tables with horizontal and vertical rules and with column entries that are paragraphs.

The appendixes contain a detailed glossary of the TEX control sequences described in the manual, as well as those developed at Oak Ridge National Laboratory in a macro of formats and requirements of Martin Marietta Energy Systems, Inc. Other descriptions of macros in the appendixes are for standard Energy Systems notices and external and internal correspondence. An appendix is also included on typesetting tables that shows changes resulting from added control sequences and how those changes affect the table design.

1. INTRODUCTION

Up to now most of the documents written on how to use TEX have been directed more toward computer programmers than to nonprogrammers. Consequently nonprogrammers from many quarters have called for a manual that teaches TEX in lay

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terms. This manual seeks to answer that need; it addresses nonprogrammer novice users who need to generate the type of documents that TEX can produce best.

As a teaching tool, the manual is designed to function with the hands-on experience gained in a classroom. Therefore most of its samples are classroom illustrations (with no statistical significance). This combination of written text and personal guidance should lead to a sound understanding of TEX that the user can take back to the workplace and employ efficiently and enthusiastically.

For clarity, the manual is typeset in three different fonts. Explanatory and descriptive material is in a sans serif font, examples showing input to the terminal are in a typewriter font, and the output (generated by the sample input) and TEXercises are in a roman font. The reader can thus readily discern the type of information presented.

TEX is a powerful and reliable program. Its precise formatting capability (e.g., for tables and displayed equations) and range of font drivers result in high-quality, attractive documents. Learning to use it is challenging but rewarding. Knowing the program well is an achievement that users can take pride in.

2. LEARNING THE CHARACTERS YOU TYPE

TEX is a computerized typesetting program concerned primarily with producing high-quality technical manuscripts. A TEX user must be acquainted with the use of a computer (mainframe or personal) and a text editor. The text editor should not leave its own special formatting marks (line numbers, word processing commands, etc.) in the file it produces.

2.1 CONTROL SEQUENCES

Text in TEX is typed very much as it would be typed on a typewriter. The input (keyboard characters) can consist of any of the uppercase and lowercase letters and the 10 digits '0...9'. The following 16 punctuation characters may also be used for input:

. : ; , ? ! ‘ ’ ( ) [ ] - / *

The instructions needed to format the final output are a series of *control sequences*. These *control sequences* consist of the *backslash* '\' and then the name of the command. The command name can be of two types, either (1) a single nonalphabetic character '\!' or (2) one or more alphabetic characters, which must be terminated by a blank space '␣' if the name is to be followed by other alphabetic characters, as in '\noindent␣for instance'. TEX ignores spaces after control words. For example,

TEX ignores spaces after control words.

required typing

```
\TeX\␣ignores spaces after control words.
```

The extra '\␣' following '\TeX' produces the control space that is necessary. Typing

```
\TeX␣ignores spaces after control words.
```

produces

TEXignores spaces after control words.

2.2 SPECIAL CHARACTERS

TEX can produce special characters; for example, it makes hyphens, dashes (en-dash and em-dash), and the minus sign and uses the right and left single quotes for producing double quotes. TEX also has a provision for ellipses, so typing three periods (...) is no longer necessary.

Output symbol		Input
Hyphen	-	-
En-dash	–	--
Em-dash	—	---
Minus sign	−	$-$
Open quotes	“	``
Closed quotes	”	''
Ellipses	...	\dots

Ten special symbols are used in issuing TEX commands. If these symbols need to be printed in your final document, they must appear in your input file in the following manner.

Output symbol	Special TEX meaning when used directly	Input
\	Used to indicate the start of a TEX *control sequence*, usually referred to as a *backslash*	$\backslash$
{ and }	Grouping symbols, used to indicate range of action of a *control sequence* to the enclosed text	$\{$ and $\}$
$	Used to open and close text that is to be in math mode	\$
&	Alignment tab used in tables and aligned equations	\&
#	Parameter, used to signify a field within a table or in a *control sequence*	\#
^	Superscript	\^{}
_	Subscript	_
%	Comment symbol, ends a line without producing any space in the output and allows for a comment (a note to yourself) in the input file	\%
~	Used to introduce a single space in locations where a line break is not allowed (for example, typing 'Mr.~Smith' will prevent the line from breaking between 'Mr.' and 'Smith')	\~{}

2.3 ACCENTS

TEX makes it possible to typeset the most commonly used accents.

Output diacritical mark	Accent name	Input
è	grave accent	\`e
é	acute accent	\'e
ô	circumflex or "hat"	\^o
ö	umlaut or dieresis	\"o
ñ	tilde or "squiggle"	\~n
ō	macron or "bar"	\=o
ȯ	dot accent	\.o
ŏ	breve accent	\u o
č	háček or "check"	\v c
ő	long Hungarian umlaut	\H o
o͡o	tie-after accent	\t oo
ı	dotless *i*—to be used when *i* is accented	\i
ȷ	dotless *j*—to be used when *j* is accented	\j
ç	cedilla accent	\c c
ọ	dot-under accent	\d o
o̲	bar-under accent	\b o
œ,Œ	French ligature OE	\oe,\OE
æ,Æ	Latin and Scandinavian ligature AE	\ae,\AE
å,Å	Scandinavian A-with-circle	\aa,\AA
ø,Ø	Scandinavian O-with-slash	\o,\O
ł,L	Polish suppressed-L	\l,\L
ß	German "es-zet" or sharp S	\ss

2.4 FONTS

The following *control sequences* are for the type fonts as shown.

Typographic characteristic	Input	Typographic characteristic	Input
roman (default font)	\rm	*big italic*	\bit
small roman	\srm	*slanted*	\sl
big roman	\brm	*small slanted*	\ssl
boldface	\bf	*big slanted*	\bsl
small boldface	\sbf	typewriter	\tt
big boldface	\bbf	small typewriter	\stt
italic	\it	big typewriter	\btt
small italic	\sit		

If you want the entire text to be output in one of these fonts, type the name of the desired font at the beginning of the file—before the text.

A math italic font is produced when text is enclosed in math brackets '$...$' and thus needs no special reference in formulas. When you type '$x+y=z$', you get $x + y = z$.

TEXercise

Describe how you would use TEX to typeset the following.

1. 'Convention' dictates that commas and periods go inside quotes, like "this,"; but I think it's better to do "this".

2. If nominated ..., I will not serve.

3. El señor está bien, garçon.

4. Alice said, "I always use an en-dash instead of a hyphen when specifying page numbers like '480–491' in a bibliography."

5. Em-dashes are used for puncutuation in sentences—they are what we often call simply dashes.

6. French words like 'mathématique' 'and centimètre' are probably not in the vocabularies of George Póylya and Gabor Szegö.
   (*How would you design input so that the lines cannot be broken between the first and last names?*)

7. The item on sale cost $56.00—33% off the original price.

8. Is $x - y$ prime?

9. Procter & Gamble's stock climbed to $2, a 10% gain.

10. How would you type 'Æsop's Œuvres' and 'Sergeĭ Ĭur'ev'?

2.5 MATH SYMBOLS*

TEX's math symbols are available only in math mode. They must be enclosed inside dollar signs ('$...$' or '$$...$$'). The following is a list of all the math symbols available in TEX and their corresponding control sequences.

Lowercase Greek letters

α	\alpha	ι	\iota	ϱ	\varrho
β	\beta	κ	\kappa	σ	\sigma
γ	\gamma	λ	\lambda	ς	\varsigma
δ	\delta	μ	\mu	τ	\tau
ϵ	\epsilon	ν	\nu	υ	\upsilon
ε	\varepsilon	ξ	\xi	ϕ	\phi
ζ	\zeta	o	\omicron	φ	\varphi
η	\eta	π	\pi	χ	\chi
θ	\theta	ϖ	\varpi	ψ	\psi
ϑ	\vartheta	ρ	\rho	ω	\omega

Uppercase Greek letters

A	\Alpha	I	\Iota	P	\Rho
B	\Beta	K	\Kappa	Σ	\Sigma
Γ	\Gamma	Λ	\Lambda	T	\Tau
Δ	\Delta	M	\Mu	Υ	\Upsilon
E	\Epsilon	N	\Nu	Φ	\Phi
Z	\Zeta	Ξ	\Xi	X	\Chi
H	\Eta	O	\Omicron	Ψ	\Psi
Θ	\Theta	Π	\Pi	Ω	\Omega

Slanted uppercase Greek letters

A	\mit\Alpha	I	\mit\Iota	P	\mit\Rho
B	\mit\Beta	K	\mit\Kappa	Σ	\mit\Sigma
Γ	\mit\Gamma	Λ	\mit\Lambda	T	\mit\Tau
Δ	\mit\Delta	M	\mit\Mu	Υ	\mit\Upsilon
E	\mit\Epsilon	N	\mit\Nu	Φ	\mit\Phi
Z	\mit\Zeta	Ξ	\mit\Xi	X	\mit\Chi
H	\mit\Eta	O	\mit\Omicron	Ψ	\mit\Psi
Θ	\mit\Theta	Π	\mit\Pi	Ω	\mit\Omega

*Unless stated otherwise, these characters are available in math mode only.

Calligraphic capitals

$\mathcal{A}$	`\cal A`	$\mathcal{J}$	`\cal J`	$\mathcal{S}$	`\cal S`
$\mathcal{B}$	`\cal B`	$\mathcal{K}$	`\cal K`	$\mathcal{T}$	`\cal T`
$\mathcal{C}$	`\cal C`	$\mathcal{L}$	`\cal L`	$\mathcal{U}$	`\cal U`
$\mathcal{D}$	`\cal D`	$\mathcal{M}$	`\cal M`	$\mathcal{V}$	`\cal V`
$\mathcal{E}$	`\cal E`	$\mathcal{N}$	`\cal N`	$\mathcal{W}$	`\cal W`
$\mathcal{F}$	`\cal F`	$\mathcal{O}$	`\cal O`	$\mathcal{X}$	`\cal X`
$\mathcal{G}$	`\cal G`	$\mathcal{P}$	`\cal P`	$\mathcal{Y}$	`\cal Y`
$\mathcal{H}$	`\cal H`	$\mathcal{Q}$	`\cal Q`	$\mathcal{Z}$	`\cal Z`
$\mathcal{I}$	`\cal I`	$\mathcal{R}$	`\cal R`		

Miscellaneous symbols of type Ord

$\aleph$	`\aleph`	∞	`\infty`	$\forall$	`\forall`
$\hbar$	`\hbar`	$\prime$	`\prime`	$\exists$	`\exists`
$\imath$	`\iotabar`*	$\emptyset$	`\emptyset`	$\neg$	`\neg`
$\jmath$	`\smalliotabar`*	∇	`\nabla`	$\flat$	`\flat`
$\imath$	`\imath`	$\surd$	`\surd`	$\natural$	`\natural`
$\jmath$	`\jmath`	$\top$	`\top`	$\sharp$	`\sharp`
ℓ	`\ell`	$\bot$	`\bot`	$\clubsuit$	`\clubsuit`
$\wp$	`\wp`	$\|$	`|`	$\diamondsuit$	`\diamondsuit`
$\Re$	`\Re`	$\angle$	`\angle`	$\heartsuit$	`\heartsuit`
$\Im$	`\Im`	$\triangle$	`\triangle`	$\spadesuit$	`\spadesuit`
∂	`\partial`	$\backslash$	`\backslash`		

Oldstyle digits†

0	`\oldstyle 0`	4	`\oldstyle 4`	7	`\oldstyle 7`
1	`\oldstyle 1`	5	`\oldstyle 5`	8	`\oldstyle 8`
2	`\oldstyle 2`	6	`\oldstyle 6`	9	`\oldstyle 9`
3	`\oldstyle 3`				

"Large" operators

$\sum$ $\displaystyle\sum$	`\sum`	$\cap$ $\displaystyle\bigcap$	`\bigcap`	$\odot$ $\displaystyle\bigodot$	`\bigodot`
$\prod$ $\displaystyle\prod$	`\prod`	$\cup$ $\displaystyle\bigcup$	`\bigcup`	$\otimes$ $\displaystyle\bigotimes$	`\bigotimes`
$\coprod$ $\displaystyle\coprod$	`\coprod`	$\sqcup$ $\displaystyle\bigsqcup$	`\bigsqcup`	$\oplus$ $\displaystyle\bigoplus$	`\bigoplus`
$\int$ $\displaystyle\int$	`\int`	$\vee$ $\displaystyle\bigvee$	`\bigvee`	$\uplus$ $\displaystyle\biguplus$	`\biguplus`
$\oint$ $\displaystyle\oint$	`\oint`	$\wedge$ $\displaystyle\bigwedge$	`\bigwedge`		

*Available only through the TEX Support Group of Martin Marietta Energy Systems, Inc.
†Available in math and nonmath modes.

Binary operations

$\pm$	\pm	$\cap$	\cap	$\vee$	\vee
$\mp$	\mp	$\cup$	\cup	$\wedge$	\wedge
$\setminus$	\setminus	$\uplus$	\uplus	$\oplus$	\oplus
$\cdot$	\cdot	$\sqcap$	\sqcap	$\ominus$	\ominus
$\times$	\times	$\sqcup$	\sqcup	$\otimes$	\otimes
$*$	\ast	$\triangleleft$	\triangleleft	$\oslash$	\oslash
$\star$	\star	$\triangleright$	\triangleright	$\odot$	\odot
$\diamond$	\diamond	$\wr$	\wr	$\dagger$	\dagger
$\circ$	\circ	$\bigcirc$	\bigcirc	$\ddagger$	\ddagger
$\bullet$	\bullet	$\bigtriangleup$	\bigtriangleup	$\amalg$	\amalg
$\div$	\div	$\bigtriangledown$	\bigtriangledown		

Relations

$<$	<	$\smile$	\smile	$\sim$	\sim
$>$	>	$\frown$	\frown	$\simeq$	\simeq
$\leq$	\leq	$\succ$	\succ	$\lesssim$*	\lesssim*
$\geq$	\geq	$\succeq$	\succeq	$\gtrsim$*	\gtrsim*
$\prec$	\prec	$\gg$	\gg	$\asymp$	\asymp
$\preceq$	\preceq	$\supset$	\supset	$\approx$	\approx
$\ll$	\ll	$\supseteq$	\supseteq	$\cong$	\cong
$\subset$	\subset	$\sqsupseteq$	\sqsupseteq	$\bowtie$	\bowtie
$\subseteq$	\subseteq	$\ni$	\ni	$\propto$	\propto
$\sqsubseteq$	\sqsubseteq	$\dashv$	\dashv	$\models$	\models
$\in$	\in	$\mid$	\mid	$\doteq$	\doteq
$\vdash$	\vdash	$\equiv$	\equiv	$\perp$	\perp

Negated relations

$\not<$	\not<	$\not>$	\not>	$\neq$	\not=
$\not\leq$	\not\leq	$\not\geq$	\not\geq	$\not\equiv$	\not\equiv
$\not\prec$	\not\prec	$\not\succ$	\not\succ	$\not\sim$	\not\sim
$\not\preceq$	\not\preceq	$\not\succeq$	\not\succeq	$\not\simeq$	\not\simeq
$\not\subset$	\not\subset	$\not\supset$	\not\supset	$\not\approx$	\not\approx
$\not\subseteq$	\notsubseteq	$\not\supseteq$	\not\supseteq	$\not\cong$	\not\cong
$\not\sqsubseteq$	\not\sqsubseteq	$\not\sqsupseteq$	\not\sqsupseteq	$\not\asymp$	\not\asymp

Math accents

$\hat{a}$	\hat a	$\acute{a}$	\acute a	$\bar{a}$	\bar a
$\widehat{aaa}$	\widehat{aaa}	$\grave{a}$	\grave a	$\vec{a}$	\vec a
$\widetilde{aaa}$	\widetilde{aaa}	$\dot{a}$	\dot a	$\check{a}$	\check a
$\underset{\sim}{a}$	\undersim a*	$\ddot{a}$	\ddot a	$\tilde{a}$	\tilde a
$\underset{\approx}{a}$	\underapprox a*	$\breve{a}$	\breve a		

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Arrows

$\leftarrow$	\leftarrow	$\longleftarrow$	\longleftarrow	$\uparrow$	\uparrow
$\Leftarrow$	\Leftarrow	$\Longleftarrow$	\Longleftarrow	$\Uparrow$	\Uparrow
$\rightarrow$	\rightarrow	$\longrightarrow$	\longrightarrow	$\downarrow$	\downarrow
$\Rightarrow$	\Rightarrow	$\Longrightarrow$	\Longrightarrow	$\Downarrow$	\Downarrow
$\leftrightarrow$	\leftrightarrow	$\longleftrightarrow$	\longleftrightarrow	$\updownarrow$	\updownarrow
$\Leftrightarrow$	\Leftrightarrow	$\Longleftrightarrow$	\Longleftrightarrow	$\Updownarrow$	\Updownarrow
$\mapsto$	\mapsto	$\longmapsto$	\longmapsto	$\nearrow$	\nearrow
$\hookleftarrow$	\hookleftarrow	$\hookrightarrow$	\hookrightarrow	$\searrow$	\searrow
$\leftharpoonup$	\leftharpoonup	$\rightharpoonup$	\rightharpoonup	$\swarrow$	\swarrow
$\leftharpoondown$	\leftharpoondown	$\rightharpoondown$	\rightharpoondown	$\nwarrow$	\nwarrow
$\rightleftharpoons$	\rightleftharpoons				

Openings

$[$	\lbrack	$\langle$	\langle	$\lceil$	\lceil
$\{$	\lbrace or \{	$\langle\langle$	\langle\!\langle	$(\!($	(\!(
$\lfloor$	\lfloor	$[\![$	\lbrack\!\lbrack		

Closings

$]$	\rbrack	$\rangle$	\rangle	$\rceil$	\rceil
$\}$	\rbrace or \}	$\rangle\rangle$	\rangle\!\rangle	$)\!)$	)\!)
$\rfloor$	\rfloor	$]\!]$	\rbrack\!\rbrack		

Punctuation

:	\colon	...	\ldots	$\ddots$	\ddots
$\cdot$	\cdot	$\cdots$	\cdots	$\vdots$	\vdots

Alternate names

$\neq$	\ne, \neq, \not=	$\leq$	\le, \leq	$\vee$	\lor, \vee
$\rightarrow$	\to, \rightarrow	$\geq$	\ge, \geq	$\neg$	\lnot, \neg
$\leftarrow$	\gets, \leftarrow	$\{$	\{, \lbrace	$\wedge$	\land, \wedge
$\Longleftrightarrow$	\iff, \Longleftrightarrow	$\}$	\}, \rbrace	$\ni$	\owns, \ni
$\|$	\Vert, \parallel, \\|	$\|$	\vert, \mid, |		

Nonmath symbols*

§	\S	†	\dag	‡	\ddag
¶	\P				

*Available in math and nonmath modes.

TEXercise

Explain how you would get the following expressions in TEX.

1. $\gamma + \nu \in \Gamma$
2. Deleting an element from an n-tuple leaves an $(n-1)$-tuple.
3. $3 \cdot 1416$
4. If $x \not< y$, then $x \not\leq y - 1$.
5. $\mathcal{A}, \mathcal{B}, \ldots \mathcal{Z}$
6. $\hat{\imath}$
7. As easy as π (or Π)!
8. $f\colon A \to$
9. $f(n) \asymp n$
10. $x \times y \cdot z$
11. $x \circ y \bullet z$
12. $x \cup y \cap z$
13. $x \sqcup y \sqcap z$
14. $x \vee y \wedge z$
15. $x \pm y \mp z$
16. $x \leq y \neq z$
17. $x \sim y \simeq z$
18. $x \equiv y \not\equiv z$
19. $x \subset y \subseteq z$
20. $\vec{a} \cong \vec{c}$

3. GROUPING

Sometimes you may need to make something happen to only part of your text without affecting the rest of the text. Grouping is TEX's way of letting you keep the part you want changed separate. To mark where the change begins and where it ends, TEX uses the '{' and the '}' as *grouping symbols*. TEX provides two ways to group. The first method of grouping is for making a modification invisible outside the group. Fonts can be changed easily inside the text by grouping the word(s) to be changed to a different font inside braces and indicating the font change inside the braces. For example, typing

```
to be {\bf bold} is to {\sl emphasize} something
```

produces

to be **bold** is to *emphasize* something.

An *italic correction* command '\/' introduces a little extra space when used after letters in the '\it' and '\sl' fonts to compensate for a change in slope of the letters. The standard rule of thumb is to use '\/' just before switching from slanted or italic to roman or bold unless the next character is a period or comma. For example, type

```
{\it italics\/} for {\it emphasis}.
```

to get

italics for *emphasis.*

as compared with

italics for *emphasis.*

when the correction is not used.

The command '\hbox{...}' can be used when a group of letters or words needs to be locked together and not broken up. Any changes made inside an '\hbox' will apply only to what appears inside the box. For instance, '\hbox{\it xyz}' can also be used to make a font change to a portion of text.

The second method of grouping is for indicating how much of your text should be ruled by certain control sequences. For example,

```
\centerline{centered text}
```

produces

centered text ,

```
\rightline{right-justified text}
```

produces

right-justified text ,

and

```
\leftline{left-justified text}
```

produces

left-justified text .

Another control sequence that uses grouping is '\underbar', which draws a line under some text. The '\underbar' command can be used within text.

```
I want \underbar{this much} underlined.
```

produces

I want this much underlined.

Care must be taken to ensure that all the text in a group is enclosed in braces. For example, typing

```
\centerline This information should be centered.
```

produces

T

his information should be centered.

And typing

```
\underbar words
```

produces

words .

A group can be nested inside another group, such as

```
\centerline{This information should be {\it centered}.}
```

This information should be *centered.*

In addition to the '`\centerline`', '`\rightline`', and '`\leftline`' commands, TEX offers a '`\line`' command that, when combined with an '`\hfil`' command, can give virtually any line format. The '`\hfil`' appears to push the text on either side of it as far as it can. For example,

```
\line{left\hfil right;}
```

gives

left right;

and

```
\line{Spread\hfil out\hfil to\hfil the\hfil right.}
```

yields

Spread out to the right.

TEXercise

Explain how to typeset the following.

1. Ulrich Dieter, *Journal für die reine und angewandte Mathematik* **201**, 37–70.
2. *How do you typeset a* roman *word in the midst of an italicized sentence?*
3. Roman *Slanted* *Italic* `Typewriter` **Boldface**
4. To <u>really</u> emphasize something, use <u>**bold, underlined text**</u>.
5. What do you think happens if you type the following:

```
\centerline What will happen here?
```

4. FORMATTING A TEX FILE

4.1 FILLING LINES AND PAGES

If you want TEX to force a break between lines at a certain point in the middle of a paragraph, just type '\break'. However, that might cause the line to really space out. Typing

```
This is how this line was generated.\break
```

produces

This is how this line was generated.

If you want TEX to fill up the right-hand part of a line with blank space just before a forced line break without indenting the next line, type '\hfil\break'. Typing

```
This is how this line was generated.\hfil\break
```

gives you

This is how this line was generated.

A vertical counterpart to the '\hfil' command moves the text vertically much the same way as an '\hfil' moves it horizontally. A '\vfill' at the bottom of some text will move all the text to the top of the page. Similarly, if you want to center text vertically on a page, your screen should look like this:

```
\null
\vfill
page body
\vfill
```

The '\null' command is at the top of the page because TEX ignores the extra spaces between words and between paragraphs, as well as any extra space that might be left over when it has just introduced a page break. The '\null' command tricks TEX into thinking something is at the beginning of the line, paragraph, or page so it does not ignore the extra space. If '\null' were not used here, TEX would ignore the space created by the first '\vfill' because that space comes after a page break. As a result, the page body would appear at the top of the page rather than vertically centered on the page.

To have text at the top and bottom of the page with lots of empty space in the middle, use

```
text
\vfill
text
```

4.2 ENDING SENTENCES, PARAGRAPHS, PAGES, AND DOCUMENTS

TEX interprets '.␣' (period/blank space) as the end of a sentence and puts a little extra space between the '.' and the beginning of the next sentence. One blank space after the '.' ends the sentence. However, because TEX reads multiple spaces as only one space, using two or more spaces at the end of a sentence will not change the output.

A blank line in TEX ends a paragraph, as does the control sequence '\par'. The blank-line method is preferable because it makes the screen more readable.

To end a page inside a TEX document, place a '\vfill\eject' at the desired page break in the TEX file. To end the entire document, place a '\bye' (shortcut for '\vfill\eject\end') as the very last entry in the file.

4.3 DEFAULTS

The TEX Support Group of Martin Marietta Energy Systems, Inc., has designed a set of general-purpose defaults for page formatting that you invoke by putting the command '\input mmes' as the first entry of a TEX file. Most of the time the defaults defined in this macro will suit your formatting needs. **If the default is your desired format, you do not have to make special reference to it.** However, the defaults can be changed as shown in the following table; and, in most cases, these formatting commands should appear at the beginning of the TEX file.

Default	To change the default
Font measures 12 point roman, '\rm', which is the font used to indicate output in this manual.	Indicate the font name you want for the entire file at the beginning of the file, '\bf', or group in braces, '{\sl for just a portion of your text}'.
Amount of vertical space between baselines is 12 points, which is single spacing '\baselineskip=12pt'. A '\baselineskip' of 14 points is the vertical spacing used in this manual.	To get space-and-a-half vertical spacing, use '\baselineskip=18pt', and to get double vertical spacing use '\baselineskip=24pt'. If you need to add extra vertical space between lines, use '\vskip_pt' (or '_in').
Amount of vertical space between the paragraphs of a document is 0 points, '\parskip=0pt'.	This manual uses a '\parskip' of 14 points, '\parskip=14pt'. The '\parskip' can be set to any desired amount by using '\parskip=_pt' (or '_in').
Amount of paragraph indentation is 20 points, '\parindent=20pt'. This paragraph is indented the default amount of 20 points.	This manual uses a paragraph indentation of 0 points, '\parindent=0pt'. Paragraph indentation can be set to any amount, '\parindent=_pt' (or '_in'). Precede any paragraph you do not want indented with '\noindent'. And if you need extra horizontal space at the beginning of a line, use the command '\null\hskip _pt' (or '_in').
Horizontal width of lines is 6.5 inches, '\hsize=6.5in'.	Horizontal width can be set to any desired size, '\hsize=_in'. This manual uses an '\hsize' of 5.75 inches, '\hsize=5.75in'.
Vertical length of page is 9 inches, '\vsize=9in'.	Vertical length can be set to any desired size, '\vsize=_in'.
Text is right-justified.	The '\raggedright' command turns off right-justification.
Hyphenation occurs automatically.	To avoid all hyphenation, use the command '\hyphenpenalty=10000'. When TEX does not make a desirable hyphenation, discretionary hyphens can be inserted at acceptable locations by using the control sequence '\-', for example, the words 're\-cord' and 'rec\-ord'. If a specific occurrence of a word is not to be hyphenated, put that word in an '\hbox', '\hbox{*word*}' Or, if that word is not to be hyphenated throughout the document, put the command '\hyphenation{*word*}' at the beginning of the document.

Default	To change the default
A page in TEX is output so that the text begins 1 inch down from the top edge and 1 inch to the right of the left edge of the paper.	The '\hoffset' command can be used to shift the output horizontally on the page to the right or left of its normal position, and the '\voffset' command can be used to shift the output on the page vertically up or down from its normal position. If text needs to be offset greater than the 1-inch default, the amount of '\hoffset' or '\voffset' would be the amount greater than 1 inch the offset needs to be ('.25in' for an offset of 1.25 inches). And if text needs to be offset less than the 1-inch default, the amount of '\hoffset' or '\voffset' would be negative the amount less than 1 inch the offset needs to be ('-.25in' for an offset of 0.75 inch).
Page numbers appear automatically numbered and centered at the bottom of pages.	To prevent page numbers completely, insert a '\nopagenumbers' command at the beginning of the file. If only the first page number of a document needs to be suppressed, input '\nofirstpagenum' at the beginning of the file. If a file should begin with a certain page number, insert '\pageno=_' (desired page number) at the beginning of the file. To get page numbers centered at the top of the page, insert the command '\toppagenumbers' at the beginning of the file. To suppress only the first page number in a '\toppagenumbers' document, type '\nofirstpagenum' before the '\toppagenumbers' command. Inserting the command '\splitpagenumbers' at the beginning of a file will put the first page number at the bottom of the page and center subsequent page numbers at the top.
TEX breaks pages inside of paragraphs but will not allow orphan and widow lines.	To prevent page breaking inside of paragraphs altogether, type the commands '\interlinepenalty=10000' and '\raggedbottom' at the beginning of the file.

TEXercise

Typeset the following exercise using space-and-a-half vertical spacing, the default paragraph indentation and paragraph skip, a horizontal size of 4.5 inches, and the default vertical size. Make the page number 5 centered at the top. When you have typeset the exercise once, run it again using '`\hoffset`' at the beginning of the file to move the text 1 inch to the right to center the text horizontally on the page.

5

Probably one of the first things you had to get used to in typesetting was learning to type the digit '1' instead of using the lowercase letter 'l' as you do when using a typewriter. Typing double quotes (" and ") is also different in typesetting—a typewriter allows for using **only** the double-quote mark. Most typesetting programs have their own unique ways of forming double quotes. Pages 4–5 of this *TEXnical Typesetting* manual describe ways of getting special characters using the TEX typesetting program.

When using a typewriter, you have to make all the line- and page-breaking decisions; whereas in typesetting, most of those decisions, including hyphenation, are made for you.

And finally,

Ligatures—letter combinations that are treated as a unit, such as ff, fi, fl, ffi, and ffl—are provided automatically in most typesetting systems. *Kerning*, moving some letter combinations closer together for better appearance ('`A`' next to '`V`'), is also automatic in most typesetting systems.

Some Author

5. CHANGING PARAGRAPH SIZES AND SHAPES

5.1 USING '\leftskip' AND '\rightskip'

Sometimes you may need to indent specific blocks of text either left or right to accommodate a figure placement on the page. For these instances, TEX provides the '\leftskip' and '\rightskip' commands. A '\leftskip' of a given amount ['\leftskip _in' (or '_pt')] produces text that is indented that amount from the left margin, and a '\rightskip' of a given amount ['\rightskip _in' (or '_pt')] produces text that is indented that amount from the right margin.

The results of a '\leftskip' or '\rightskip' setting can affect text as long as you need the setting to apply, including multiple paragraphs. The text to be affected by the '\leftskip' or '\rightskip' should be contained within a group (enclosed inside braces) and should end with '\par'.

The following are input and output for text with a '\leftskip' of 2 inches followed by more text with a '\rightskip' of 2 inches. Because the amount of '\parskip' is 20pt by default, a '\noindent' was used at the beginning of each paragraph in the following examples so that the paragraphs would be output in block style. Some extra vertical space ('\vskip 12pt') is inserted between each paragraph because the default amount of vertical skip between paragraphs is 0pt.

```
{\leftskip 2in
\noindent
This is text that needed to be indented 2 inches from the left
margin.  Here the '\leftskip' applies to two paragraphs.
\vskip 12pt
\noindent
Each line of the paragraph will be indented from the left margin
and that 2-inch indentation will remain in effect as long as the
text is contained inside the group.\par}
```

> This is text that needed to be indented 2 inches from the left margin. Here the '\leftskip' applies to two paragraphs.
>
> Each line of the paragraph will be indented from the left margin, and that 2-inch indentation will remain in effect as long as the text is contained inside the group.

```
{\rightskip 2in
\noindent
This is text that needed to be indented 2 inches from the right
margin.  Here the '\rightskip' applies to two paragraphs.
\vskip 12pt
\noindent
Each line of the paragraph will be indented from the right
margin, and that 2-inch indentation will remain in effect as long
as the text is contained inside the group.\par}
```

{\rightskip 2in
\noindent
This is text that needed to be indented 2 inches from the right margin. Here the '\rightskip' applies to two paragraphs.
\vskip 12pt
\noindent
Each line of the paragraph will be indented from the right margin, and that 2-inch indentation will remain in effect as long as the text is contained inside the group.\par}

TEXercise

Typeset the following two paragraphs. The first paragraph has an indentation of 3 inches, and the second paragraph has an indentation of 1 inch.

{\rightskip 3in
\noindent
In this paragraph, each line is indented 3 inches from the right margin. The 3-inch margin will stay in effect as long as the text is contained inside the braces and until the paragraph ends.\par}

{\leftskip 1in
\noindent
In this paragraph, each line is indented 1 inch from the left margin. The 1-inch margin will stay in effect as long as the text is contained inside the braces and until the paragraph ends.\par}

5.2 USING '\narrower' AND '\narrower\narrower'

Sometimes when quoting a lengthy passage, you may need to indent the left and right margins the same amount. The '\narrower' control sequence indents both the left and right margins the amount of one '\parindent'; '\narrower\narrower' indents both margins the amount of two '\parindent's. As with '\leftskip' and '\rightskip', the results of a '\narrower' or a '\narrower\narrower' setting can affect text as long as you need the setting to apply, including multiple paragraphs. Text to be affected by '\narrower' or '\narrower\narrower' should be contained within a group (enclosed inside braces) and should end with '\par'.

The following example illustrates how '\narrower' affects left and right paragraph margins. Notice that the paragraph is preceded by a '\noindent' to suppress the normal first-line '\parindent' of 20pt.

```
{\narrower
\noindent
Set off small quotes inside text by using either double or single
quotation marks.  To set off longer quotations, use either
the '\narrower' or '\narrower\narrower' control sequence.  Both
the left and right margins will be indented the amount of one or
two paragraph indentations.  Indenting text using '\narrower'
or '\narrower\narrower' makes the quoted text obvious to the
reader.  How could you use '\leftskip' and '\rightskip' to get
the same results?\par}
```

{\narrower
\noindent
Set off small quotes inside text by using either double or single quotation marks. To set off longer quotations, use either the '\narrower' or '\narrower\narrower' control sequence. Both the left and right margins will be indented the amount of one or two paragraph indentations. Indenting text using '\narrower' or '\narrower\narrower' makes the quoted text obvious to the reader. How could you use '\leftskip' and '\rightskip' to get the same results?\par}

TEXercise

Typeset the following and indent the text of the paragraph double the amount of the default paragraph indentation.

Below is a paragraph that appears to be a quotation, but it is actually just some text. These two introductory sentences are part of the TEXercise.

> TEX makes several provisions for changing paragraph shapes. Margins can easily be indented specific amounts from both sides to accommodate figure placement. Quotations can be handled efficiently by indenting both the left and right margins the amount of one or two paragraph indentations. These special allowances demonstrate yet another difference between typesetting and typewriting.

5.3 HANGING INDENTATIONS

The usual paragraph shape used in TEX will probably meet most of your typesetting needs. However, for unusual paragraphs, TEX provides the '`\hangafter`' and '`\hangindent`' control sequences. The command '`\hangafter=`⟨*number of lines*⟩' specifies how long the indentation is to last, and the command '`\hangindent=`⟨*dimension*⟩' specifies the amount of the hanging indentation. The settings for the '`\hangafter`' and '`\hangindent`' commands should be inserted before the paragraph to be affected. The result of these commands will remain in effect only for the current paragraph. When you leave a blank line to signal the beginning of the next paragraph, the effect of '`\hangafter`' and '`\hangindent`' will disappear and will need to be reset if you want the same result on the next paragraph. For the first line of a hanging indentation to work as you would expect it to, '`\noindent`' should precede the paragraph. And because '`\parskip`' is 0pt by default, inserting a '`\vskip 12pt`' will provide some extra vertical space between paragraphs.

The following are the four paragraph shapes that TEX provides for using '\hangafter' and '\hangindent' commands.

If you want all the lines below and including a certain number of lines indented on the left, use the settings '\hangafter $>$ 0' and '\hangindent $>$ 0'. This paragraph was set with a '\hangafter' value of 2 ('\hangafter=2') and a '\hangindent' value of 60pt ('\hangindent=60pt'). This part of the paragraph was added just to add more length so that what '\hangafter' and '\hangindent' do is easier to see.

If you want all the lines below and including a certain number of lines indented on the right, use the settings '\hangafter $>$ 0' and '\hangindent $<$ 0'. This paragraph was set with a '\hangafter' value of 2 ('\hangafter=2') and a '\hangindent' value of -60pt ('\hangindent=-60pt'). This part of the paragraph was added just to add more length so that what '\hangafter' and '\hangindent' do is easier to see.

If you want the beginning lines of a paragraph indented on the left a certain amount, use the settings '\hangafter $<$ 0' and '\hangindent $>$ 0'. This paragraph was set with a '\hangafter' value of -2 ('\hangafter=-2') and a '\hangindent' value of 60pt ('\hangindent=60pt'). This part of the paragraph was added just to add more length so that what '\hangafter' and '\hangindent' do is easier to see.

If you want the beginning lines of a paragraph indented on the right a certain amount, use the settings '\hangafter $<$ 0' and '\hangindent $<$ 0'. This paragraph was set with a '\hangafter' value of -2 ('\hangafter=-2') and a '\hangindent' value of -60pt ('\hangindent=-60pt'). This part of the paragraph was added just to add more length so that what '\hangafter' and '\hangindent' do is easier to see.

TEXercise

Try your hand at these out-of-the-ordinary paragraph shapes. In each paragraph, the amount of the indentation is 40pt.

In this paragraph, the first line is the width of the entire horizontal size, and all the subsequent lines are indented 40 points to the right of the left margin. Extra sentences appear here so you can see how the specifications turn out. If what you wanted did not come out right, the specifications should be changed. Try your hand at this one.

In this paragraph, the first two lines are indented 40 points to the right of the left margin, and all the subsequent lines are the width of the entire horizontal size. Extra sentences appear here so you can see how the specifications turn out. If what you wanted did not come out right, the specifications should be changed. Try your hand at this one.

In this paragraph, the first two lines are the width of the entire horizontal size, and all the subsequent lines are indented 40 points to the left of the right margin. Extra sentences appear here so you can see how the specifications turn out. If what you wanted did not come out right, the specifications should be changed. Try your hand at this one.

In this paragraph, the first two lines are indented 40 points to the left of the right margin, and all the subsequent lines are the width of the entire horizontal size. Extra sentences appear here so you can see how the specifications turn out. If what you wanted did not come out right, the specifications should be changed. Try your hand at this one.

5.4 LINE-FOR-LINE OUTPUT

Instances may occur when you want the output to appear line for line the same as the input. For those cases, TEX provides the following control sequences. (Like the previously mentioned control sequences '`\leftskip`', '`\rightskip`', '`\narrower`' and '`\narrower\narrower`', text to be affected by the control sequences for obtaining line-for-line output should be enclosed inside a group, and the group should be ended with '`\par`'.)

```
{\obeylines\obeyspaces\let␣=\␣\parskip=0pt\parindent=0pt
Roses are red,
Violets are blue.
I think \TeX's great.
How about you?\par}
```

Roses are red,
Violets are blue.
I think TEX's great.
How about you?

TEXercise

Typeset this paragraph line for line.

Life is like a dogsled team—
if you're not the lead dog,
the view is always the same.

6. GENERATING FOOTNOTES

The '\note' control sequence[1] provides automatic numbering and placement of footnotes. First type the '\note' control sequence after the text that the footnote references; then enclose the text of the footnote in braces. For a sequentially numbered footnote, use the '\note' control sequence repeatedly throughout a document—TEX keeps up with the numbering.[2] The command '\clearnotenumber' before the '\note' sequence allows you to start the numbering sequence over in the same document. Here[1] I wanted to start over with the numbering.

Sometimes the reference mark for a footnote may be a symbol. In such instances, use the '\footnote' control sequence.* The '\footnote' command has two parts. First comes the reference mark (enclosed in braces) that will appear both in the paragraph and in the footnote itself, and then comes the text of the footnote, also enclosed in braces.

TEX's default footnote puts one space between the reference mark and the text of the footnote. That extra space can be removed with some extra programming.

TEXercise

Typeset the following text containing footnotes. (Your footnotes will appear at the bottom of your page and not close to the text as they appear in the TEXercise.)

Footnote numbers should be typed slightly above the line in the text and should not be enclosed in parentheses or followed by periods or slash marks.[1] Footnotes should be numbered consecutively throughout a chapter of a book or an article in a journal.[2] The same reference number should not be repeated in the text.[1] Symbols or letters sometimes indicate footnotes.**

---

[1] *A Manual of Style* (The University of Chicago Press, 1975), p. 340.
[2] Ibid., p. 341.
[1] Ibid., p. 342.
** Ibid.

---

[1] The author typed 'sequence\note{The author...}' here.

[2] Typing the second '\note' here produced a sequentially numbered footnote ('...with the numbering.\note{Typing the second...}').

[1] To start the footnote numbering over again, 'Here\clearnotenumber\note{To start the footnote...} was typed.

* Here, the author typed 'control sequence.\footnote{*}{Here, the...}'.

7. GENERATING LEVELED LISTS

Item lists can come in two varieties in TEX. The program can generate automatically numbered and lettered two-level item lists, or the user can specify the item tags to generate multilevel lists.

7.1 AUTOMATICALLY GENERATED TAGS IN TWO-LEVEL LISTS

The first variety of list provides for automatically sequenced lists for two levels of indentation. Automatically numbered item and automatically lettered subitem lists can be generated using the '\itm' (item) and '\sitm' (subitem) commands. Items are indented from the left margin the amount of '\parindent', and subitems are indented twice that amount.

```
\itm Itemized lists are very useful.
\sitm For listing things.
\sitm For making a series of points.
\itm You can even use subitems.
\sitm Indentation of items is one paragraph indentation.
\sitm Indentation of subitems is two paragraph indentations.
```

1. Itemized lists are very useful.
   a. For listing things.
   b. For making a series of points.
2. You can even use subitems.
   a. Indentation of items is one paragraph indentation.
   b. Indentation of subitems is two paragraph indentations.

With numbered or lettered items, the numbering and lettering will continue in sequence throughout the document. If you need to start the lettering or numbering over within the document, use '\enditems' as illustrated below.

```
\itm Itemized lists are very useful.
\itm Especially when they are automatically numbered.
\enditems
\itm And they can even start over with the numbering sequence!
\itm Which is a real plus!
```

1. Itemized lists are very useful.
2. Especially when they are automatically numbered.

1. And they can even start over with the numbering sequence!
2. Which is a real plus!

Use the command '\itempar' to begin a new paragraph within an item and the command '\subitempar' to begin a new paragraph within a subitem.

```
\itm Here is my first item.
\itempar I have another paragraph that goes with the first item.
\itempar I even have another paragraph to tag along, too.
\itm Here is my second item.
\sitm And how about my subitem.
\subitempar My subitem has another paragraph.
```

1. Here is my first item.
   I have another paragraph that goes with the first item.
   I even have another paragraph to tag along, too.
2. Here is my second item.
   a. And how about my subitem.
      My subitem has another paragraph.

TEXercise

Typeset this TEXercise containing automatically numbered and lettered lists.

1. This is an example of an automatically numbered item.
2. This is an example of how the text of lists is sequentially numbered.
   a. This is an example of a second-level list.
      How about this for a paragraph inside a subitem!
   b. This is an example of how the text of subitems is sequentially lettered.

1. Now I want to start the item numbering over.
   And now you see a new paragraph within my item.
2. How about that!

The tags for the items can be changed by using the commands in the following table and then calling for '`\itm`'.

`\numbereditems`	the default for items (no special reference needed)
`\letternumitems`	sequential lowercase letters
`\Letternumitems`	sequential uppercase letters
`\romanitems`	sequential lowercase Roman numerals
`\Romanitems`	sequential uppercase Roman numerals
`\squareditems`	■
`\dotteditems`	•
`\dasheditems`	—

And the tags for the subitems can be changed by using the commands in the following table and then calling for '`\sitm`'.

`\numberedsubitems`	sequential Arabic numerals
`\letteredsubitems`	the default for subitems (no special reference needed)
`\Letteredsubitems`	sequential uppercase letters
`\romansubitems`	sequential lowercase Roman numerals
`\Romansubitems`	sequential uppercase Roman numerals
`\squaredsubitems`	■
`\dottedsubitems`	•
`\dashedsubitems`	—

Therefore,

```
\Romanitems\squaredsubitems
\itm Itemized lists are very useful.
\sitm For listing things.
\sitm For making a series of points.
\itm You can even use subitems.
\sitm Indentation of items is one paragraph indentation.
\sitm Indentation of subitems is two paragraph indentations.
```

will produce

I. Itemized lists are very useful.
   - ■ For listing things.
   - ■ For making a series of points.

II. You can even use subitems.
   - ■ Indentation of items is one paragraph indentation.
   - ■ Indentation of subitems is two paragraph indentations.

TEXercise

Typeset the following list.

A. The first two steps are as follows:
   i. Tie the string to the green pole.
   ii. Use identical lengths of string.

B. The next two steps are as follows:
   i. Everyone gets a string.
   ii. All dance around the pole.

7.2 USER-GENERATED TAGS IN MULTILEVEL LISTS

If you prefer to input the item tags yourself and need only two levels of item lists, you can use the '`\item`' and '`\itemitem`' control sequences (no automatic numbering or lettering takes place). The '`\item`' sequence generates a paragraph indented the amount of one paragraph indentation, and the '`\itemitem`' sequence generates a paragraph indented the amount of two paragraph indentations. The item tags appear to the left of the paragraph, are right justified, and are one space away from the text of the paragraph. Beside the '`\item`' or '`\itemitem`' control sequence, put the item tag inside braces and follow the tag with the text of the paragraph. Numbers, letters, special characters, and math symbols (remember to enclose the math symbols in '$...$'s) may be put inside the braces.

For example,

```
\item{1.}This is the first item in my first-level list.
\itemitem{a.}This is the first item in my second-level list.
\item{2.}This is the second item in my first-level list.
\itemitem{b.}This is the second item in my second-level list.
```

produces

1. This is the first item in my first-level list.
   a. This is the first item in my second-level list.
2. This is the second item in my first-level list.
   b. This is the second item in my second-level list.

Sometimes two levels are not enough when making outlines or other extensive lists. The '`\multipleitem`' control sequence accommodates any number of levels required. After you enter the '`\multipleitem`' command, specify the number of the level of the list (how many paragraph indentations are to take place) inside braces, and follow that with the item tag enclosed in braces. The text of the paragraph follows.

Typing

```
\multipleitem{1}{I.}First level of a multilevel list.
\multipleitem{2}{A.}Second level of a multilevel list.
\multipleitem{3}{1.}Third level of a multilevel list.
\multipleitem{4}{a.}Fourth level of a multilevel list.
\multipleitem{4}{}Now to get a paragraph inside any level item.
\multipleitem{1}{II.}First level of a multilevel list.
```

gives you

I. First level of a multilevel list.
   A. Second level of a multilevel list.
      1. Third level of a multilevel list.
         a. Fourth level of a multilevel list.
            Now to get a paragraph inside any level item.
II. First level of a multilevel list.

8. CREATING VIEWGRAPHS

To generate viewgraphs, text can be magnified by 20% ('\mag=1200'), 44% ('\mag=1440'), or 72.8% ('\mag=1728'). Specify the magnification at the very beginning of the input file, before the '\input mmes'.

TEX will then enlarge everything in that file by the percentage you specified in the magnification, including the dimensions of the '\hsize' and the '\vsize' and any other measurements contained in your file. If you are using a magnification of 1200 and you want to use the default '\hsize' of 6.5 inches, you will actually get a line length of 6.5 inches increased by 20% (6.5 inches + 20% of 6.5 inches), or 7.8 inches, which is probably not what you want. To cancel out the effect magnification has on any dimension, insert the command 'true' before the dimension. Therefore, to adjust the material to fit the default page size, use '\hsize=6.5truein' and '\vsize=9truein'. You can also put 'true' before any '\baselineskip' or '\vskip' specifications to unmagnify the point or inch units.

As an example, the input for a viewgraph that is magnified by 20% on a page using the default '\hsize' and the default '\vsize' with space-and-a-half '\baselineskip' would be

```
\mag=1200
\input mmes
\hsize=6.5truein
\vsize=9truein
\baselineskip=18truept
```

TEXercise

Generate the following viewgraph, magnify it by 72.8%, make the '\hsize' the default amount, make the '\vsize' the default amount, and double-space the text.

- There are parameters that must change in order for TEX to set viewgraphs successfully.
  - Desired magnification must be set at the very beginning of the input file (1200, 1440, or 1728).
  - The horizontal and vertical sizes should be specified in true inches or true points to prevent magnifying text off the page.
- The viewgraph must be typeset.

9. USING TEX FOR MATH

A math formula is enclosed either within single dollar signs '$...$' if it is to appear in a line with ordinary text or double dollar signs '$$...$$' if it is to be displayed on a separate line, called *display math mode*.

9.1 SUPERSCRIPTS AND SUBSCRIPTS

The '^' (caret) indicates a superscript and the '_' (underscore bar) indicates a subscript. To get x^2, type 'x^2'; to get, y_2 type 'y_2'. Both the superscript and subscript characters apply only to the next character. When you want a multiple-character superscript or subscript, group the superscript after the '^' and the subscript after the '_' in braces. For example, to provide x^{2y} type 'x^{2y}'; for y_{2x} type 'y_{2x}'. A superscript or a subscript may contain a superscript or subscript, such as 'x^{y_2}', which produces x^{y_2}. You can also have both a superscript and subscript to one character and specify them in any order, so 'x_y^z' and 'x^z_y' produce the same result, x_y^z. Notice how the '^' and the '_' affect the limits in large operators in in-line and display math modes.

`$\sum^{n=1}_m$` yields $\sum_m^{n=1}$ `$\int^0_{x+y}$` yields $\int_{x+y}^0$

`$$\sum^{n=1}_m$$` yields $$\sum_{m}^{n=1}$$ `$$\int^0_{x+y}$$` yields $$\int_{x+y}^{0}$$

9.2 SQUARE ROOTS, OVERLINES, AND UNDERLINES

Square roots ('\sqrt'), overlines ('\overline'), and underlines ('\underline') behave in the same manner as superscripts and subscripts.

`$$\sqrt{x+y}$$`	$\sqrt{x+y}$
`$$\overline{x+y}$$`	$\overline{x+y}$
`$$\underline{x+y}$$`	$\underline{x+y}$

TEXercise

Display these eight math expressions on separate lines.

$x_2 y_2$ $\quad$ $\overline{m+n} - x^{dr}$ $\quad$ $x^2 y^2$ $\quad$ $\sum_{x>1}^{y} + \int_{-m}^{+x}$

x_y^2 $\quad$ $xy^3 + \underline{x_y}$ $\quad$ x^{2^y} $\quad$ $\sqrt{y_2}$

9.3 FRACTIONS

Use the control sequence '\over' to specify fractions; TEX will create a fraction line of the appropriate length. A fraction begins with a '{' followed by the numerator, the command '\over', the denominator, and a closing '}'. The proper sequence for fractions is '${numerator\over denominator}$' for fractions in text and '$${numerator\over denominator}$$' for fractions in display math mode.

The notation

```
$${x+y+z\over 1}$$
```

produces the fraction

$$\frac{x+y+z}{1}$$

TEXercise

Display the following six fractions.

$\frac{x+y^2}{k+1}$ $\quad$ $x + \frac{y^2}{k} + 1$ $\quad$ $\frac{x+y^2}{k} + 1$

$x + \frac{y^2}{k+1}$ $\quad$ $\frac{x}{y^2} k + 1$ $\quad$ $\frac{\frac{x}{y^2}}{k+1}$

9.4 RELATED CONTROL SEQUENCES

In addition to fractions, TEX has two other related control sequences for stacking letters and numbers—'\atop' and '\buildrel'. Output for an '\atop' control sequence is exactly like output for a fraction except '\atop' eliminates the fraction line.

The notation

```
$${a\atop 1+b}$$
```

produces

$$\begin{matrix} a \\ 1+b \end{matrix}$$

To put letters and symbols over left and right arrows and other relations, TEX provides the '\buildrel' control sequence. There are two differences between the '\buildrel' and the '\atop' control sequences. (1) Only one character (or one group of characters inside braces) can be used on the bottom of a '\buildrel'. That bottom character or group will appear its normal size, and the top character(s) will appear the size of a superscript. (2) A '\buildrel' causes that bottom character to align on the baseline, and an '\atop' causes the top and bottom characters to split the baseline.

`$${\buildrel a+1\over\longrightarrow}$$`	yields	$\overset{a+1}{\longrightarrow}$
`$${a+1\atop\longrightarrow}$$`	yields	$\begin{matrix} a+1 \\ \longrightarrow \end{matrix}$

TEXercise

Use '\atop and '\buildrel' in the following formulas.

$$0 \le i \le m$$
$$0 < j < n$$

$$a+b = \overset{x \times y}{\longleftrightarrow}$$
$$\frac{x}{y} = \begin{matrix} x \\ y \end{matrix}$$
$$\frac{x}{y} = \overset{x}{y}$$

9.5 FONT CHANGES INSIDE MATH FORMULAS

The names of common math functions like 'log', 'sin', and 'cos' are always set in roman type inside equations. The following 32 control sequences lead to roman type with appropriate spacing.

```
\arccos   \cos    \csc   \exp   \ker      \limsup   \min   \sinh
\arcsin   \cosh   \deg   \gcd   \lg       \ln       \Pr    \sup
\arctan   \cot    \det   \hom   \lim      \log      \sec   \tan
\arg      \coth   \dim   \inf   \liminf   \max      \sin   \tanh
```

You can switch to roman type for other words in equations that need to be in roman type by enclosing those words in braces and calling the '`\rm`' font. You type '`$\exp(x+{\rm constant})$`' to get $\exp(x + \text{constant})$. Because TEX ignores spaces in math, separate more than one word in roman type with control spaces '`\␣`'. Or, enclose the roman words in an '`\hbox`'. Therefore, to get

$$x^3 + \text{lower order terms}$$

type

```
$$x^3+{\rm lower\␣order\␣terms}$$
```

or

```
$$x^3+\hbox{lower order terms}$$
```

TEXercise

Typeset these math expressions.

$$\sqrt{\log x}$$

$$\sin 2\theta = 2 \sin\theta \cos\theta$$

$$0(n \log n \log\log n)$$

$$\Pr(X > x) = \exp(-x\mu)$$

$$\sqrt{\text{Var}(X)}$$

$$\text{LL}(k) \rightarrow \text{LR}(k)$$

$$y_2 + \text{constant time} = \cos\theta$$

9.6 HORIZONTAL SPACING AND TYPE STYLE CHANGES INSIDE MATH FORMULAS

Normally, you can depend on TEX to space characters correctly in equations. However, in a few instances TEX may not make the horizontal spacing you desire. After you have run TEX and determined you need more or less horizontal space, use the following control sequences. (These four control sequences will work only inside math modes ('$...$' or '$$...$$'.)

`\,`	thin space ($\frac{1}{6}$ of the letter 'M' in the current font)
`\>`	medium space ($\frac{2}{9}$ of the letter 'M' in the current font)
`\;`	thick space ($\frac{5}{18}$ of the letter 'M' in the current font)
`\!`	negative thin space ($-\frac{1}{6}$ of the letter 'M' in the current font)

As you have probably noticed, TEX outputs math equations in four different sizes. Formulas displayed on lines by themselves use one size ['`\displaystyle`' ($x+y-z$)], formulas embedded in the text use a smaller size ['`\textstyle`' ($x+y-z$)] for the large operators, superscripts and subscripts use a yet smaller size ['`\scriptstyle`' ($x+y-z$)], and second-order superscripts and subscripts use an even smaller size ['`\scriptscriptstyle`' ($x+y-z$)]. If you want to force a size that TEX might not otherwise assign, use the '`\displaystyle`', '`\textstyle`', '`\scriptstyle`', and '`\scriptscriptstyle`' control sequences. When you have run TEX and determined that TEX did not make your desired size choice in a math formula, you can change the type style by calling the type style you want to change to and putting in braces what you are changing. For instance, if you type `${1\over 3}$` in text, you get $\frac{1}{3}$; but if you type `$\displaystyle{1\over 3}$` in text, you will get $\displaystyle\frac{1}{3}$.

10. NUMBERING AND ALIGNING DISPLAYED EQUATIONS

TEX will put an equation number at the right-hand margin if you use the '\eqno' control sequence.

```
$$x^2-y^2=(x+y)(x-y).\eqno(1)$$
```

produces

$$x^2 - y^2 = (x + y)(x - y). \tag{1}$$

When you encounter a multiline equation consisting of several equations that should be lined up on their '=' signs, you will need to use the '\eqalign' control sequence. If you want the equation numbered, use '\eqno' just as you would if the equation were one line. The equation numbers will appear vertically centered among all the lines of the '\eqalign'. In an '\eqalign', the '&' is the character that marks the symbol on which the equation is to be aligned; the equation aligns on the character that follows the '&'. The '\cr' is used to mark the end of each line of the equation. An opening brace should appear after the '\eqalign' control sequence, and a closing brace should appear after the last '\cr' in the aligned equation.

For example,

```
$$
\eqalign { X_1+Z_3-P^2 &= 2m\cr
           Y_1+Q^4 &= n\cr
         }
         \eqno(2)
$$
```

produces

$$\begin{aligned} X_1 + Z_3 - P^2 &= 2m \\ Y_1 + Q^4 &= n \end{aligned} \tag{2}$$

TEX does its own job of horizontally spacing equations and ignores blank spaces. This frees you to structure the input into any desired format. The input for aligned equations is designed so that the beginning and end of the displayed equation ('$$') are clearly marked on lines by themselves. The start of the alignment, '\eqalign {', occupies the next line. The remaining lines contain the text of the equation, and the '&' and the following alignment character are aligned vertically. Each line ends with a '\cr'. The closing '}' of the '\eqalign' is aligned vertically under the opening '{', and the equation number is on a line by itself. Structuring the format for aligned equations in a similar format makes the input easier to read, debug, and change.

Sometimes the left-hand sides of aligned equations are blank, and the alignment is done with respect to symbols other than the '='.

```
$$
\eqalign { T(n) &\leq T(2^{1+n})\cr
                &\leq c(3^{1+n})-2^{1+n}\cr
                &>    3c\cdot 3^{1+n}\cr
                &=    3cn^{1+n}\cr
         }
         \eqno(3)
$$
```

produces

$$\begin{aligned} T(n) &\leq T(2^{1+n}) \\ &\leq c(3^{1+n}) - 2^{1+n} \\ &> 3c \cdot 3^{1+n} \\ &= 3cn^{1+n} \end{aligned} \tag{3}$$

To handle several aligned equations, some numbered and some not, TEX provides '\eqalignno'. This control sequence is used just like '\eqalign', except that on each line you need an equation number, add '&' and the equation number just before the '\cr'.

```
$$
\eqalignno { (x+y)(x-y) &= x^2-xy+yx-y^2\cr
                        &= x^2-y^2;              &(4)\cr
             (x+y)^2    &= x^2+2xy+y^2           &(5)\cr
           }
$$
```

produces

$$\begin{aligned} (x+y)(x-y) &= x^2 - xy + yx - y^2 \\ &= x^2 - y^2; && (4) \\ (x+y)^2 &= x^2 + 2xy + y^2. && (5) \end{aligned}$$

TEXercise

Using what you have just learned about '\eqno', '\eqalign', and '\eqalignno', typeset the following displayed equations (Eqs. 6–10).

$$\frac{1}{x - q^k z} = \sum_{n \geq 0} z^n \tag{6}$$

$$\begin{aligned} P(x) &= a_0 + a_1 + a_2 x^2, \\ P(0 - x) &= a_0 - a_1 x + a_2 x^2. \end{aligned} \tag{7}$$

$$\alpha = f(z) \tag{8}$$

$$\begin{aligned} \beta_x &= f(z^2) \\ \gamma + 1 &= f(z^3) \end{aligned} \tag{9}$$

$$\begin{aligned} e^{-x^2} dx^2 &\geq e^{-x^2+y^2} dx\, dy \\ &> e^{-r^2} r dr d\theta \\ &\leq \frac{e^{-r^2}}{2} d\theta \\ &= dx\, dr - e^{r-x^2} \end{aligned} \tag{10}$$

If you encounter math formulas that need to be numbered on the left, use the '\leqno' control sequence anywhere you would ordinarily use the '\eqno' control sequence.

Typing

```
$$x+y+z\leqno(11)$$
```

produces

$$x + y + z \tag{11}$$

The '\leqno' control sequence can also be used in an '\eqalign' to obtain a left-numbered equation.

Typing

```
$$\eqalign{
          x+y+z &= 2n\cr
          2n    &= p-1\cr
         }
         \leqno(12)
$$
```

produces

$$x + y + z = 2n$$
$$2n = p - 1 \tag{12}$$

If you are in an aligned equation and the numbers need to be on individual lines of the equation on the left, replace the '\eqalignno' control sequence with the '\leqalignno' control sequence.

Typing

```
$$\leqalignno{
             x+y+z &= 2n      &(13)\cr
             2n    &= p-1     &(14)\cr
            }
$$
```

produces

$$x + y + z = 2n \tag{13}$$
$$2n = p - 1 \tag{14}$$

11. USING MATH DELIMITERS

11.1 SIZES OF DELIMITERS

TEX chooses the size of parentheses or other delimiters [see page 147 in *The TEXbook* for a complete list (Knuth 1986)] for you if you use the control sequences '`\left`' and '`\right`' along with the delimiter you need. As an example, type '`$$1+\left({1\over 1-x^2}\right)^2$$`' to get

$$1+\left(\frac{1}{1-x^2}\right)^2$$

In some situations TEX does not choose the size delimiter you want. For those special cases, '`\bigl`', '`\Bigl`', '`\biggl`', and '`\Biggl`' can be used for opening delimiters; and '`\bigr`', '`\Bigr`', '`\biggr`', and '`\Biggr`' can be used for closing delimiters. Here is what happens to parentheses when '`\big`' '`\Big`', '`\bigg`', and '`\Bigg`' control sequences are used.

```
$\Biggl($ $\biggl($ $\Bigl($ $\bigl($ $\bigr)$ $\Bigr)$ $\biggr)$ $\Biggr)$
```

$$\Biggl(\quad \biggl(\quad \Bigl(\quad \bigl(\quad \bigr) \quad \Bigr) \quad \biggr) \quad \Biggr)$$

The '`\left`' and '`\right`' delimiters must open and close on the same side of the '`&`' and on the same line of an aligned equation! Typing

```
$$\eqalign {x+y &= \left(2a\cr
                &= {2\over\pi}\right)\cr
           }
$$
```

produces an error message because the delimiters do not open and close on the same line of the aligned equation.

If you need to omit one of the delimiters on a line of an aligned equation, simply type a '`.`' in place of the missing delimiter. The period does not print but acts to end the grouping.

Trying

```
$$\eqalign {x+y &= \left(2a\right.\cr
                &= \left.{2\over\pi}\right)\cr
           }
$$
```

will work because the delimiters open and close on the same line of the aligned equation, but the sizes of the delimiters do not match.

$$\begin{aligned} x+y &= \left(2a \right. \\ &= \left. \frac{2}{\pi} \right) \end{aligned}$$

To typeset such an expression and get the right size parentheses, you actually need to tell TEX what sizes of delimiters to use.

```
$$\eqalign {x+y &= \biggl(2a\biggr.\cr
                &= \biggl.{2\over\pi}\biggr)\cr
           }
$$
```

$$\eqalign{x+y &= \biggl(2a\cr &= \biggl.{2\over\pi}\biggr)\cr}$$

TEXercise

Typeset these expressions containing different sizes of delimiters.

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial^2}\right)$$

$$\left[(a+b)\right]=\left(\frac{1}{\mu}\right)$$

$$1+\left(\frac{\pi}{2x-y^2}\right.$$

$$\left.=x-y-z\right)$$

11.2 NOTATIONS WITH BRACES

Several different notations use the symbols '{' and '}'. In simple situations, use braces to indicate a set of objects, for example, $\{a, b, c\}$. In typesetting such formulas, remember to use '\{' and '\}' for the braces, '$\{a,b,c\}$'. In a case such as $\{x \mid x > 5\}$, use the control sequence '\mid' for the vertical bar '$\{x\mid x>5\}$'.

Single braces can indicate a choice:

$$x+y=\begin{cases}2z, & \text{if } y\neq 0\\ z-1, & \text{if } y\geq 1\\ \frac{y}{z} & \text{otherwise}\end{cases}$$

Use the '\cases' control sequence to get such a construction:

```
$$x+y=\cases{2z,&          if $y\neq 0$\cr
             z-1,&         if $y\geq 1$\cr
             {y\over z}&   otherwise\cr
            }
$$
```

Each of the cases has two parts separated by an '&'. The information to the left of the '&' appears in math mode, and the information to the right of the '&' appears as ordinary text. If a portion or all of the right side of the '\cases' should appear in math, use '$...$', just as you would in ordinary text.

Each case should be followed by a '\cr'. Notice that '\cases' prints a left '{' but no corresponding right '}'.

Horizontal braces are used over or under parts of a displayed equation and can specify superscripts or subscripts as shown in the following example.

```
$$\overbrace{x+y+z}^{a>0}$$
$$\underbrace{x+y+z}_{a>0}$$
```

$$\overbrace{x+y+z}^{a>0}$$

$$\underbrace{x+y+z}_{a>0}$$

TEXercise

Typeset these expressions containing braces.

$$\{1-\mid n\mid -y\}=\frac{a-b-c}{n_2}$$

$$A=\begin{cases}3z, & \text{else } y-1\\ Y-n, & \text{therefore } y>1\end{cases}$$

$$\overbrace{X_1+Y_{n+a}=-1}^{X_n=0}$$

11.3 MATRICES

One of the most common uses of large delimiters is in printing matrices. The '\matrix' control sequence makes it convenient to deal with the most common types of matrices.

All you do is type the following.

```
$$
   A = \left[ \matrix {x-\lambda&      1&          0\cr
                       0&              x-\lambda&  1\cr
                       0&              0&          x-\lambda\cr
                      }
       \right]
$$
```

The result is the equation below.

$$A = \left[\matrix {x-\lambda&   1&   0\cr
                      0&   x-\lambda& 1\cr
                      0&   0&   x-\lambda\cr} \right]$$

Because parentheses are used more often than other delimiters in matrices, '\pmatrix' automatically inserts the parentheses for you. To substitute parentheses for the brackets in the previous matrix, type

```
$$
   A = \pmatrix {x-\lambda&      1&          0\cr
                 0&              x-\lambda&  1\cr
                 0&              0&          x-\lambda\cr
                }
$$
```

to produce the desired result:

$$A = \left(\matrix {x-\lambda&   1&   0\cr
                      0&   x-\lambda& 1\cr
                      0&   0&   x-\lambda\cr} \right)$$

TEXercise

Typeset the following matrices.

$$X = \begin{pmatrix} a_1 & a_2 & a_n \\ a_m & a_{mn} & a_{2n} \end{pmatrix}$$

$$Y = \begin{vmatrix} y_z & x-2z & 0 & 2xy \\ x^2 & z-2y & 1 & xy^2 \\ 1-2y & 2y-2z & 0 & yz-1_{xy} \end{vmatrix}$$

$$M = \begin{Bmatrix} 1 & 0 & 0 \\ b & 1-b & 0 \\ 0 & a & 1-a \end{Bmatrix}$$

11.4 AUTOMATICALLY GENERATED DELIMITERS

TEX has three control sequences that automatically generate opening and closing delimiters in math mode—'\choose', '\brack', and '\brace'. These control sequences stack letters and numbers without the fraction line.

```
$${n+1\choose k}$$
```

$${n+1\choose k}$$

```
$${n+1\brack k}$$
```

$${n+1\brack k}$$

```
$${n+1\brace k}$$
```

$${n+1\brace k}$$

12. USING '\settabs' TO SET TABLES

The '\settabs' method of making a table lets you specify where the tab settings are to be, either by giving the number of columns (assuming they are to be evenly spaced) or by supplying a set of sample entries made up of the largest entry for each individual column. The tabs you set with the '\settabs' command remain set until you reset them, even though you type ordinary paragraphs as usual. A very large table set with '\settabs' may extend over several pages.

In using the '\settabs' method, use the '\+' control sequence to start each row and the '\cr' control sequence to end it. The '&' is the tab character that separates the different columns.

12.1 THE FIXED-COLUMN-WIDTH '\settabs' METHOD

TEX makes it easy to produce lines that are divided into *n* equal-size columns. The following are input and output for a table with five equal-size columns using '\settabs'.

```
\settabs5\columns
\+This is&five-column&output&using the&\settabs command.\cr
\+&&Text that starts in the third column.\cr
\+&Text that starts in the second column.\cr
\+&&&Fourth-column text.\cr
\+First-column entry.&&&&And finally, fifth-column!\cr
```

This is five-column output using the \settabs command.
Text that starts in the third column.
Text that starts in the second column.
Fourth-column text.
First-column entry. And finally, fifth-column!

This is not an attractive display, but it illustrates that TEX has set up five tabs, each left-justified and equally spaced. Notice text can extend beyond the current tab position (and even the right margin).

TEXercise

Use '\settabs *n*\columns' in typesetting the following table.

Chapter	*Page(s)*	*Paragraph Beginning With**
2	6	When it became clear ...
9	32–37	And now the judge ...
11	56–63	The change in appearance ...
14	100–105	The verdict was ...

*This is an example of a footnote.

12.2 THE VARIABLE-COLUMN-WIDTH '\settabs' METHOD

Sometimes you do not need tabs to be equally spaced. The variable-column-width method of '\settabs' requires you to supply a sample line for the table that is used for dimensions only and is not printed. Take the largest entry of each column and add some desired amount of space between the entries. A '\quad' of space (width of the letter 'M' in the current font) or a '\qquad' of space (width of two '\quad's), can be used in allowing for the space needed between columns.

Following are input and output for a table using the variable-column-width method of '\settabs'.

```
\settabs\+Something Blue\qquad&And a Three\qquad&The End of\cr
\+Old&A One&The End of\cr
\+New&And a Two&This\cr
\+Borrowed&And a Three&Silly\cr
\+Something Blue&And a Four&Table\cr
```

Old	A One	The End of
New	And a Two	This
Borrowed	And a Three	Silly
Something Blue	And a Four	Table

TEXercise

Use the variable-column-width '\settabs' to typeset the following table with a '\qquad' of space between all columns.

Unit	**Abbr.**	**Number of meters**	**U. S. equivalent**
kilometer	km	1,000	0.62 mile
hectometer	hm	100	109.36 yards
dekameter	dam	10	32.81 feet
meter	m	1	39.37 inches
decimeter	dm	0.1	3.94 inches
centimeter	cm	0.01	0.39 inch
millimeter	mm	0.0001	0.039 inch

13. USING '\halign' TO SET TABLES

Two dollar signs ('$$') at the start and end of a table center the table horizontally and vertically. Because the '$$' puts the display in math mode, use a '\vbox' following the '$$' to temporarily take the table out of math mode. All the information inside a '\vbox' will be kept from splitting across pages. Place a '{' after the '\vbox' command and a matching '}' at the end of the table.

To allow TEX to automatically calculate column width in a table, insert an '\halign' command (*horizontal alignment*) on the line after the '$$\vbox{'. A horizontal width for a table can be specified in the '\halign' command by setting '\halign to\hsize' (current line length) or '\halign to ⟨*desired dimension*⟩'. Or, if you want TEX to calculate the width of a table, the '\halign' entry for the table would be '\halign{'. The information inside an '\halign' should be grouped inside braces. Insert a '{' after the '\halign' command and a matching '}' at the end of the table.

Next a *preamble* is needed to specify how the different columns of a table are to be treated. The preamble begins after the '\halign{'. Its major elements are

#	sticks the text of each column entry in this place.
&	separates the different columns of the table.
#\hfil	left-justifies the column entry.
\hfil#	right-justifies the column entry.
\hfil#\hfil	centers the column entry.
\cr	must end the preamble and each individual line of the table.

You need to put some space between the columns because the default is no space between columns. The command '\tabskip' must be introduced to allow for the intercolumn space. If you are using '\halign to\hsize' or '\halign to ⟨*desired dimension*⟩', your '\tabskip' must have some degree of stretchability so the table can stretch to the specified dimension. A '\tabskip' with stretchability allows TEX the ability to stretch the space between the columns so that the table will expand to fill the dimension you specified. As an example, '\tabskip=1em plus 1fil' puts a space at least the width of one '\quad' between columns and uses the 'plus 1fil' to stretch the space between the columns as much as necessary to make the table the specified width. Or, if you want a certain fixed amount of space between columns and you want TEX to determine the width of the entire table, '\tabskip' can be fixed ('\tabskip=.25in', for example). The exact dimensions of the '\tabskip' can vary, depending on table size and personal preference. Experimenting with various '\tabskip' specifications is a good way to get the feel for what the '\tabskip' control sequence does in a table.

The '\tabskip' specification may appear outside the '\halign' or within the preamble. In this way, '\tabskip' before the '\halign' puts '\tabskip' before the first column, '\tabskip' inside the preamble before the first '&' puts '\tabskip' before the second column, and that amount of '\tabskip' will be in effect until another specification for '\tabskip' appears.

The following example demonstrates how a preamble and '\tabskip' work in constructing a table.

```
$$\vbox{          \tabskip=.25in     vertically and horizontally centered
                                     table and tabskip of 0.25 inch before
                                     first column
\halign{                             beginning of a horizontal alignment
                                     (table) with no specific horizontal
                                     width
    \hfil#        \tabskip=.5in&     first column, with template '\hfil#'
                                     (right-justified text) and tabskip of
                                     0.5 inch
    #\hfil&                          second column with template
                                     '#\hfil' (left-justified text) and
                                     tabskip of 0.5 inch
    \hfil#\hfil   \tabskip=1in       third column with template
                                     '\hfil#\hfil' (centered text) and
                                     tabskip of 1 inch after the last
                                     column
\cr
    :
}}$$
```

Below is the input for a 5-inch-wide, three-column, five-line table with the first column right-justified, the second column centered, and the third column left-justified. The '\tabskip=1em plus 1fil' will be in effect before and after the table and between all the columns of the table.

```
$$\vbox{                                  \tabskip=1em plus 1fil
\halign to 5in{
     \hfil#&
     \hfil#\hfil&
     #\hfil
\cr
     smart&        rather silly&     short\cr
     stuffed&      canned&           frozen\cr
     banana&       rutabaga&         squash\cr
     donkey&       elephant&         gorilla\cr
     once&         twice&            thrice\cr
}}$$
```

Notice that the input for the previous table is structured so that only one preamble template is on a line (indented a few spaces to the right). Each of these templates represents one column of the table. The end of the preamble is clearly marked by a '\cr' appearing at the end of the preamble on a line by itself. All the '\tabskip' specifications are placed to the right of the column templates and align vertically. The text of the table is input one row at a time, and each row ends with a '\cr'. Because all spaces after the '&' are ignored, the text can be arranged horizontally in columns much as it will appear in the output table. And, finally, the '}}$$' clearly marks the end of the table on a line by itself. This organization of the input makes the table more readable and easier to debug and change.

TEXercise

1. Copy the input for the table at the bottom of page 62 and output it.

2. Did you notice the table was not 5 inches wide? That is because '\tabskip' was put before the '\halign' and therefore appeared before the first column and remained after the last column. Measure and see for yourself. To get rid of that extra tabskip and stretch the table out to 5 inches, change your input to look like the following table.

```
$$\vbox{                                \tabskip=0pt
\halign to 5in{
    \hfil#                              \tabskip=1em plus 1fil&
    \hfil#\hfil&
    #\hfil                              \tabskip=0pt
\cr
    smart&      rather silly&    short\cr
    stuffed&    canned&          frozen\cr
    banana&     rutabaga&       squash\cr
    donkey&     elephant&        gorilla\cr
    once&       twice&           thrice\cr
}}$$
```

TEXercise (continued)

3. Experiment with various specifications for '\tabskip' and '\halign' dimensions in the same table.

4. When you feel comfortable with what '\tabskip' and '\halign' do and how they work, typeset this table.

Unit	Abbr.	Length	Metric equivalent
square mile	sq mi	640 acres	2.590 square km
acre		4840 square yards	0.405 hectare
square rod	sq rd	0.006 acre	25.293 sq m
square yard	sq yd	9 square feet	0.836 sq m
square foot	sq ft	144 square inches	0.093 sq m
square inch	sq in	0.007 square foot	6.451 sq cm

NOTE:

In the fourth practice exercise, some extra vertical space appears between the headings and the first line of the table. When you are working inside an '\halign', using the control sequence '\vskip_pt' will produce an error message. The command '\noalign' allows you to exit the table temporarily. After the '\noalign' command, you enclose in braces what action you want taken. Therefore, when you need extra vertical space between lines of a table, use the command '\noalign{\vskip _pt}'. When you are inputting the table, put all '\noalign' specifications on separate lines by themselves.

14. MAKING CHANGES TO THE PREAMBLE INSIDE A TABLE

Sometimes you may want to do something in a table different from what is contained in the preamble. The '\omit' control sequence actually allows you to omit what is in the preamble for a particular column and call for a different arrangement. When you get to the column you want changed, type '\omit{*text*}\hfil' for a left-justified entry, '\omit\hfil{*text*}' for a right-justified entry, and '\omit\hfil{*text*}\hfil' for a centered entry. In the following table, the heading for each column needed to be centered over the column instead of left-justified.

Cardinal	Ordinal
one quadrillion	one quadrillionth
one quintillion	one quintillionth
one sextillion	one sextillionth

```
$$\vbox{                                    \tabskip=0pt
\halign to 3in{
     #\hfil                                 \tabskip=1em plus 1fil&
     #\hfil                                 \tabskip=0pt
\cr
     \omit\hfil{\bf Cardinal}\hfil&
     \omit\hfil{\bf Ordinal}\hfil\cr
     \noalign{\vskip 5pt}
     one quadrillion&     one quadrillionth\cr
     one quintillion&     one quintillionth\cr
     one sextillion&      one sextillionth\cr
}}$$
```

A '\multispan{*number of columns*}' allows you to span the specified number of columns and either center or right or left justify the information. To span four columns of a table and left justify the text, use '\multispan4{*text*}\hfil'; to right justify the same entry, use '\multispan4\hfil{*text*}'; and to center the information, use '\multispan4\hfil{*text*}\hfil'. As with the '\omit' command, '\multispan' should be placed in the exact column where the text it refers to appears in the table. Most frequently '\multispan' is used inside tables for headings and footnotes.

There are two important considerations to remember in using a '\multispan'. One is that '\multispan' does an '\omit' for each column spanned. The instructions for all columns spanned are omitted; therefore, no need exists to use an '\omit' for any columns contained in a '\multispan'. The other important consideration is that when you need to span more than nine columns, the number of columns must appear inside braces. If you leave the braces off, TEX sees only the first number and spans only that number of columns. For example, '\multispan21' spans only two columns, whereas '\multispan{21}' spans 21 columns. In the following table, the

heading for the table needed to be centered across the three columns of the table. Notice how '\multispan' is used.

Cardinal Numbers

Name	Arabic	Roman
one	1	I
two	2	II
three	3	III
four	4	IV

```
$$\vbox{                                \tabskip=0pt
\halign to 2.5in{
     \hfil#\hfil                        \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#\hfil                        \tabskip=0pt
\cr
     \multispan3\hfil{\bf Cardinal Numbers}\hfil\cr
     \noalign{\vskip 9pt}
     Name&      Arabic&      Roman\cr
     \noalign{\vskip 9pt}
     one&       1&           I\cr
     two&       2&           II\cr
     three&     3&           III\cr
     four&      4&           IV\cr
}}$$
```

TEXercise

Typeset this table using '\omit' and '\multispan' commands.

English Units of Measurement

Length	Area	Volume
inch or in.	square inch or sq. in.	cubic inch or cu. in.
foot or ft.	square foot or sq. ft.	cubic foot or cu. ft.
yard or yd.	square yard or sq. yd.	cubic yard or cu. yd.
rod or rd.	square rod or sq. rd.	
mile or mi.	square mile or sq. mi.	

The '\hidewidth', '\rlap' (*right lap*), and '\llap' (*left lap*) control sequences can also be used to vary from the application of the formatting rules specified in the preamble. The former prevents the width of the entry from being used to determine column width. This command is used most often when headings are wider than the column entries they head and need to be centered over right- or left-justified columns. The '\rlap' or '\llap' command is used to put information (enclosed in braces) to the right or left of a column without affecting the width of the column.

In setting this table, the second column was set up as right-justified; and the heading for that column, which is wider than the column it heads, needed to be centered above the column entries. Using '\omit\hfil{*text*}\hfil' in the heading line for that column produced the following result. (Notice the use of '\rlap' and '\llap', too.)

Order*	**Average cost**	**Date**
23	30.00	3/22/86
24	400.00	3/23/86
36	758.49	3/25/86
41	1000.00	3/27/86

*This is a footnote.

```
$$\vbox{                                \tabskip=0pt
\halign to 3.5in{
     \hfil#\hfil                        \tabskip=1em plus 1fil&
     \hfil#&
     \hfil#\hfil                        \tabskip=0pt
\cr
     {\bf Order}\rlap{*}&
     \omit\hfil{\bf Average cost}\hfil&
     {\bf Date}\cr
     \noalign{\vskip 9pt}
     23&     30.00&       3/22/86\cr
     24&     400.00&      3/23/86\cr
     36&     758.49&      3/25/86\cr
     41&     1000.00&     3/27/86\cr
     \noalign{\vskip 9pt}
     \multispan3\llap{*}{This is a footnote.}\hfil\cr
}}$$
```

The width of the heading for the second column was wider than the column entries. Therefore, the heading width determined column width, and the heading was centered over the column, making the heading appear flush right. Using '`\hidewidth{`*text*`}\hidewidth`' instead of '`\omit\hfil{`*text*`}\hfil`' for the second column heading produced the desired format.

Order*	**Average cost**	**Date**
23	30.00	3/22/86
24	400.00	3/23/86
36	758.49	3/25/86
41	1000.00	3/27/86

*This is a footnote.

```
$$\vbox{                                \tabskip=0pt
\halign to 3.5in{
     \hfil#\hfil                        \tabskip=1em plus 1fil&
     \hfil#&
     \hfil#\hfil                        \tabskip=0pt
\cr
     {\bf Order}\rlap{*}&
     \hidewidth{\bf Average cost}\hidewidth&
     {\bf Date}\cr
     \noalign{\vskip 9pt}
     23&     30.00&       3/22/86\cr
     24&     400.00&      3/23/86\cr
     36&     758.49&      3/25/86\cr
     41&     1000.00&     3/27/86\cr
     \noalign{\vskip 9pt}
     \multispan3\llap{*}{This a footnote.}\hfil\cr
}}$$
```

When the decimal points in a column must align, for example

```
0.2010
297.1
```

the '`\specialdigit`' command should be inserted before the beginning of the table. This causes the '`@`' character to produce an empty (null) space the width of a digit. Such nulls work best when inserted into centered table entries but can also be used with either right- or left-justified entries. Using the '`\specialdigit`' to align the above numbers on the decimal point, the input would be

```
@@0.2010
297.1@@@
```

TEXercise

Typeset these tables, using '\multispan', '\omit', '\hidewidth', '\llap', '\rlap', and '\specialdigit' commands.

Table I.

Chemical Elements

Symbol	Element name	Number	Weight
Al	aluminum	13	26.9815
Sb	antimony	51	121.75
Ar	argon	18	39.948
As	arsenic	33	74.9216
Ba	barium	56	137.34

Table II.

Summary of Telephone Usage and Costs

Telephone number	Percentage of use	Calls made per month	Cost
686-5049*	12.3	47	$ 34.70
306-3945	30.1	100	97.83
387-4967	18.4	59	63.39
683-6725	75.5	202	139.87
385-7857	49.7	156	101.76
259-1942	82.0	573	211.65
		Total	$649.50

*This is a footnote.

15. USING RULES IN A TABLE

15.1 CORRECT VERTICAL SPACING IN RULED TABLES

When creating a table containing horizontal or vertical rules or a combination of both, insert the command '\offinterlineskip' on the line after the '$$\vbox{'. A '\strut' must be used in conjunction with '\offinterlineskip' to obtain correct vertical spacing. The '\strut#&' must appear as the first-column entry in the preamble; it applies to each row. An '&' needs to begin each line of the table when the '\strut' is the first-column entry in the preamble.

If your '\baselineskip' is different from the default (12 points), insert a '\makestrut' command at the beginning of your file after the specification for '\baselineskip'. The '\makestrut' adjusts the size of the '\strut' inside the table to fit the current value of '\baselineskip'. However, if '\baselineskip' is the default amount, you do not need to insert '\makestrut' in your file.

15.2 HORIZONTAL RULES

A horizontal rule that spans the current width of '\hsize' can be obtained with the command '\hrule'. However, a horizontal rule that spans the entire width of a table is obtained with the command '\noalign{\hrule}'.

The following example illustrates how to obtain horizontal rules and the correct ordering of '\makestrut', '\offinterlineskip', and '\strut' to obtain proper vertical spacing in a double-spaced, ruled table.

word	opposite	word	opposite
vertical	horizontal	create	destroy
foreign	native	current	obsolete
hopeful	pessimistic	encourage	hinder

```
\baselineskip=24pt
\makestrut
$$\vbox{                                        \tabskip=0pt
\offinterlineskip
\halign to 4.5in{
     \strut#&
     #\hfil                                     \tabskip=1em plus 1fil&
     #\hfil&
     #\hfil&
     #\hfil                                     \tabskip=0pt
\cr
     \noalign{\hrule}
     &   word&       opposite&      word&        opposite\cr
     \noalign{\hrule}
     &   vertical&   horizontal&    create&      destroy\cr
     &   foreign&    native&        current&     obsolete\cr
     &   hopeful&    pessimistic&   encourage&   hinder\cr
     \noalign{\hrule}
}}$$
```

The '\hrulefill' command is used with '\multispan' when a horizontal rule does not span the entire width of the table. An '\hrulefill' is like an '\hfil' except that the blank space is filled with a horizontal rule. The rules stop where the tabskip glue separates columns.

In the following table, notice how the '\multispan' and the '\hrulefill' command are used.

Basketball Standings

Name	Shots attempted	Shots made	%
Ted E. Bear	30	10	33.3
Jack Horner	30	20	66.6

```
$$\vbox{                                        \tabskip=0pt
\offinterlineskip
\halign to\hsize{
     \strut#&
     #\hfil                                     \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#\hfil&
     \hfil#\hfil                                \tabskip=0pt
\cr
     &      \multispan4\hfil{\bf Basketball Standings}\hfil\cr
     \noalign{\vskip 6pt}
     \noalign{\hrule}
     \noalign{\vskip 6pt}
     &   Name&           Shots Attempted&   Shots Made&   \%\cr
     &   &               \multispan3\hrulefill\cr
     \noalign{\vskip 6pt}
     &   Ted E. Bear&    30&                10&           33.3\cr
     &   Jack Horner&    30&                20&           66.6\cr
     \noalign{\vskip 6pt}
     \noalign{\hrule}
}}$$
```

TEXercise

Typeset the following double-spaced table, using '\makestrut', '\offinterlineskip', '\strut', '\noalign{\hrule}', '\multispan', and '\hrulefill' commands.

Living expenses

Month	Total item costs	
	Clothing	Food
March 1987	87.75	127.34
April 1987	94.50	167.45
May 1987	98.34	240.98

15.3 VERTICAL RULES

A "column" must be allocated to every vertical rule, and such a column can be assigned the template '`\vrule#&`'. Then you obtain a vertical rule by leaving the column entries blank.

The following example illustrates how to obtain vertical rules in a table.

alpha	beta	gamma
delta	epsilon	zeta
eta	theta	iota

```
$$\vbox{                                                \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                                            \tabskip=.5in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#                                            \tabskip=0pt
\cr
     \noalign{\hrule}
     &&     alpha&&     beta&&      gamma&\cr
     &&     delta&&     epsilon&&   zeta&\cr
     &&     eta&&      theta&&      iota&\cr
     \noalign{\hrule}
}}$$
```

Two lines were added to the previous table that did not need the two center vertical rules. Notice how '`\omit`' was used in those last two lines to omit the vertical rules.

alpha	beta	gamma
delta	epsilon	zeta
eta	theta	iota
kappa	lambda	mu
nu	xi	omicron

```
$$\vbox{                                                    \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                                                \tabskip=.5in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#                                                \tabskip=0pt
\cr
     \noalign{\hrule}
     &&     alpha&&          beta&&          gamma&\cr
     &&     delta&&          epsilon&&       zeta&\cr
     &&     eta&&            theta&&         iota&\cr
     \noalign{\hrule}
     &&     kappa&\omit&     lambda&\omit&   mu&\cr
     &&     nu&\omit&        xi&\omit&      omicron&\cr
     \noalign{\hrule}
}}$$
```

TEXercise

Use '\makestrut', '\strut', '\noalign{\hrule}', '\vrule', and '\omit' commands to set up the following space-and-a-half-spaced tables. Both tables contain '\tabskip' of 0.25 inch.

Aries	Taurus	Gemini
Cancer	Leo	
Virgo	Libra	Signs of the Zodiac
Scorpio	Sagittarius	
Capricorn	Aquarius	Pisces

Country	Coin	
Mexico	Centavo	Peso
France	Centime	Franc

15.4 HORIZONTAL RULES SPANNING SPECIFIC COLUMNS IN VERTICALLY RULED TABLES

When a vertically ruled table has specific columns that need to be spanned with an '`\hrulefill`', notice the outcome when only the columns to contain the horizontal rule are spanned.

tables	chairs	television
sofas	mirrors	radios
desks	lamps	stereos
rugs	dressers	bookshelves

```
$$\vbox{                                    \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                                \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     #\vrule                                \tabskip=0pt
\cr
     \noalign{\hrule}
     &&     tables&&     chairs&&       television&\cr
     &&           &&     \multispan3\hrulefill&\cr
     &&     sofas&&      mirrors&&       radios&\cr
     &&     desks&&      lamps&&         stereos&\cr
     &&     rugs&&       dressers&&      bookshelves&\cr
     \noalign{\hrule}
}}$$
```

You may want the horizontal rules to stretch to meet the vertical rules. The following example shows the effect of increasing the '`\multispan`' to include both vertical rules.

tables	chairs	televisions
sofas	mirrors	radios
desks	lamps	stereos
rugs	dressers	bookshelves

```
$$\vbox{                                    \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                                \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     #\vrule                                \tabskip=0pt
\cr
     \noalign{\hrule}
     &&     tables&&     chairs&&       television&\cr
     &&           &\multispan5\hrulefill\cr
     &&     sofas&&      mirrors&&      radios&\cr
     &&     desks&&      lamps&&        stereos&\cr
     &&     rugs&&       dressers&&     bookshelves&\cr
     \noalign{\hrule}
}}$$
```

Because the horizontal rule is now the correct width, you need to remove the extra vertical space for the rows to meet. The '`\strut`' at the beginning of the row containing the '`\hrulefill`' causes the extra vertical space. In the following example the beginning '`\strut`' of that row has been omitted, and the desired result occurs.

tables	chairs	televisions
sofas	mirrors	radios
desks	lamps	stereos
rugs	dressers	bookshelves

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                            \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     #\vrule                            \tabskip=0pt
\cr
     \noalign{\hrule}
     &&     tables&&     chairs&&       television&\cr
     \omit&&      &\multispan5\hrulefill\cr
     &&     sofas&&      mirrors&&      radios&\cr
     &&     desks&&      lamps&&        stereos&\cr
     &&     rugs&&       dressers&&     bookshelves&\cr
     \noalign{\hrule}
}}$$
```

TEXercise

Typeset the following vertically ruled table containing '\multispan' and '\hrulefill' commands.

Employee	Information	
	Birthdate	Number
I. L. Befrank	03/02/36	384995
L. O. Down	05/17/27	395843
I. T. Hinknot	02/09/43	493929
C. A. Nuhearme	11/14/39	392040
S. T. Raightarrow	09/15/45	493020

15.5 VERTICAL SKIP IN VERTICALLY RULED TABLES

When vertical rules are used in a table, '\noalign{\vskip _pt}' will not work to increase the vertical distance between two rows. Notice how the vertical rules are omitted in the following table when '\noalign{\vskip 6pt}' is used.

State	Abbr.	Capital	Area
Arkansas	Ark.	Little Rock	53,104
Indiana	Ind.	Indianapolis	36,291
Missouri	Mo.	Jefferson City	69,686

```
$$\vbox{                                        \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                                    \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#                                    \tabskip=0pt
\cr
     \noalign{\hrule}
     \noalign{\vskip 6pt}
     &&   State&&      Abbr.&&   Capital&&          Area&\cr
     \noalign{\vskip 6pt}
     \noalign{\hrule}
     \noalign{\vskip 6pt}
     &&   Arkansas&&   Ark.&&    Little Rock&&      53,104&\cr
     &&   Indiana&&    Ind.&&    Indianapolis&&     36,291&\cr
     &&   Missouri&&   Mo.&&     Jefferson City&&   69,686&\cr
     \noalign{\vskip 6pt}
     \noalign{\hrule}
}}$$
```

A solution to increasing the vertical space in a vertically ruled table is to insert an additional row the desired height of the vertical skip. Notice in the following example how the added rows contain nothing in the columns but still generate the vertical rules.

State	Abbr.	Capital	Area
Arkansas	Ark.	Little Rock	53,104
Indiana	Ind.	Indianapolis	36,291
Missouri	Mo.	Jefferson City	69,686

```
$$\vbox{                                        \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                                    \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#                                    \tabskip=0pt
\cr
     \noalign{\hrule}
     height 6pt
     &&   &&          &&        &&              &\cr
     &&   State&&     Abbr.&&   Capital&&        Area&\cr
     height 6pt
     &&   &&          &&        &&              &\cr
     \noalign{\hrule}
     height 6pt
     &&   &&          &&        &&              &\cr
     &&   Arkansas&&  Ark.&&   Little Rock&&    53,104&\cr
     &&   Indiana&&   Ind.&&   Indianapolis&&   36,291&\cr
     &&   Missouri&&  Mo.&&    Jefferson City&& 69,686&\cr
     height 6pt
     &&  &&           &&        &&              &\cr
     \noalign{\hrule}
}}$$
```

TEXercise

Typeset the following single-spaced table containing '`\tabskip`' of 0.5 inch and additional vertical skips of 6 points.

Author	Literary Work
Pearl Buck	*The Good Earth*
Charles Dickens	*A Christmas Carol*
Ernest Hemingway	*For Whom the Bell Tolls*
Tennessee Williams	*A Streetcar Named Desire*

15.6 OMITTING VERTICAL RULES WHEN USING '`\multispan`' AND '`height`'

Look what happens in the following vertically ruled table when you have a multi-spanned title and need some extra vertical space before and after the title.

Days of the Week		
Sunday	Monday	Tuesday
Wednesday	Thursday	Friday
Saturday	Sunday	Monday

```
$$\vbox{                              \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                          \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#                          \tabskip=0pt
\cr
     \noalign{\hrule}
     height 6pt
     &&      &&                &&               &\cr
     &&      \multispan5\hfil{\bf Days of the Week}\hfil&\cr
     height 6pt
     &&      &&                &&               &\cr
     \noalign{\hrule}
     height 6pt
     &&      &&                &&               &\cr
     &&      Sunday&&          Monday&&         Tuesday&\cr
     &&      Wednesday&&       Thursday&&       Friday&\cr
     &&      Saturday&&        Sunday&&         Monday&\cr
     height 6pt
     &&      &&                &&               &\cr
     \noalign{\hrule}
}}$$
```

When you use 'height' and insert the blank row, the ampersands that cause the vertical rules to appear in the table also produce the vertical rules you see when the extra vertical space is added. To remove those unwanted vertical rules, put an '`\omit`' next to the ampersands that produce the vertical rules you want eliminated.

Days of the Week		
Sunday Wednesday Saturday	Monday Thursday Sunday	Tuesday Friday Monday

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign{
     \strut#&
     \vrule#                            \tabskip=.25in&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#&
     #\hfil&
     \vrule#                            \tabskip=0pt
\cr
     \noalign{\hrule}
     height 6pt
     &&     &\omit&                    &\omit&                &\cr
     &&     \multispan5\hfil{\bf Days of the Week}\hfil&\cr
     height 6pt
     &&     &\omit&                    &\omit&                &\cr
     \noalign{\hrule}
     height 6pt
     &&     &&                  &&              &\cr
     &&     Sunday&&           Monday&&         Tuesday&\cr
     &&     Wednesday&&        Thursday&&       Friday&\cr
     &&     Saturday&&         Sunday&&         Monday&\cr
     height 6pt
     &&     &&                  &&              &\cr
     \noalign{\hrule}
}}$$
```

TEXercise

Typeset the following single-spaced table containing '\tabskip' of 0.5 inch and extra vertical skips of 4 points.

Phone Messages	
Mr. Smith Mr. Hill Mr. Johnson	Please phone Returned your call Will call again

16. CREATING PARAGRAPHS INSIDE TABLES

Sometimes you have to set a table that contains a sentence, a paragraph, or paragraphs as column entries. Rather than manually breaking each line, the command '\vtop' can be used inside an '\halign' table. Using a '\vtop' causes the output to be right-justified and hyphenated, and each paragraph is indented the default paragraph amount. Like text in a '\vbox', all the information in a '\vtop' will not be split across pages, and you must enclose it inside braces. Inside a '\vtop' give an '\hsize' specification, the command '\normalbaselines', and a '\strut#\strut' for proper vertical spacing of the entry. Because TEX treats each '\vtop' as a paragraph, default paragraph indentation occurs unless you set '\parindent' to 0pt.

Two '\vtop's were used inside the '\halign' in the following table.

PUNCTUATION

Punctuation mark	**Use**	**Example**
Apostrophe	Often forms plurals of letters, figures, and words referred to as words	Dotting *i*'s, crossing *t*'s, adding up all 7's, and aligning all your *the*'s will ensure a better grade.
Colon	Introduces a clause or phrase that explains, illustrates, or restates what has gone before	Monday was a good day: I won the sweepstakes, and oil was discovered on my land.
Parentheses	Set off explanatory material	Vacations (as we all know) can be a time of rest and relaxation.

```
$$\vbox{                                    \tabskip=0pt
\offinterlineskip
\halign to\hsize{
  \strut#&
  #\hfil                                    \tabskip=1em plus 1fil&
  \vtop{\hsize=2in\parindent=0pt\normalbaselines\strut#\strut}&
  \vtop{\hsize=2in\parindent=0pt\normalbaselines\strut#\strut}
                                            \tabskip=0pt
\cr
  &  \multispan3\hfil{\bf PUNCTUATION}\hfil\cr
  \noalign{\vskip 6pt}
  \noalign{\hrule}
  \noalign{\vskip 6pt}
  &  {\bf Punctuation}&
     \omit\hfil{\bf Use}\hfil&
     \omit\hfil{\bf Example}\hfil\cr
  &  {\bf mark}\cr
  \noalign{\vskip 6pt}
  \noalign{\hrule}
  \noalign{\vskip 6pt}
  &  Apostrophe&Often forms plurals of letters, figures, and
     words referred to as words&
     Dotting {\it i\/}'s, crossing {\it t\/}'s, adding up all
     {\it 7\/}'s, and aligning all your {\it the\/}'s will
     ensure a better grade.\cr
  \noalign{\vskip 6pt}
  &  Colon&Introduces a clause or phrase that explains,
     illustrates, or restates what has gone before&
     Monday was a good day: I won the sweepstakes and oil was
     discovered on my land.\cr
  \noalign{\vskip 6pt}
  &  Parentheses&Set off explanatory material&
     Vacations (as we all know) can be a time of rest and
     relaxation.\cr
```

Sometimes a column entry in a table needs to be centered vertically. A '\vcenter' allows you to do this; however, a '\vcenter ' must appear in math mode. The '\hsize' of the '\vcenter' should be the same width as the column over which it is being centered. Notice the headings on the following table when '\vcenter' is used.

PUNCTUATION

Punctuation mark	Use	Example
Apostrophe	Often forms plurals of letters, figures, and words referred to as words	Dotting *i*'s, crossing *t*'s, adding up all 7's, and aligning all your *the*'s will ensure a better grade.

```
$$\vbox{                                        \tabskip=0pt
\offinterlineskip
\halign to\hsize{
  \strut#&
  #\hfil                                        \tabskip=1em plus 1fil&
  \vtop{\hsize=2in\parindent=0pt\normalbaselines\strut#\strut}&
  \vtop{\hsize=2in\parindent=0pt\normalbaselines\strut#\strut}
                                                \tabskip=0pt
\cr
  &  \multispan3\hfil{\bf PUNCTUATION}\hfil\cr
  \noalign{\vskip 6pt}
  \noalign{\hrule}
  \noalign{\vskip 6pt}
  &
\omit$\vcenter{\hsize=1in\parindent=0pt\normalbaselines\strut
                    \centerline{\bf Punctuation}
                    \centerline{\bf mark}\strut}$&
     \omit\hfil{\bf Use}\hfil&
     \omit\hfil{\bf Example}\hfil\cr
  \noalign{\vskip 6pt}
  \noalign{\hrule}
  \noalign{\vskip 6pt}
  &  Apostrophe&Often forms plurals of letters, figures,
     and words referred to as words&
     Dotting {\it i\/}'s, crossing {\it t\/}'s, adding up all
     {\it 7\/}'s, and aligning all your {\it the\/}'s will
     ensure a better grade.\cr
}}$$
```

TEXercise

Use '\vtop' and '\vcenter' to set this table.

Worker	Attitudes toward work
I. M. Eager	This worker is a responsible and loyal employee who will work hard on the challenges encountered in the workplace. Tasks are approached in a meticulous and orderly fashion, and doing the best job possible is a high priority.
Un Der Stress	This employee tends to be easily affected by stress on the job. Others are sought out for support if the pressure builds. Minor difficulties are likely to become serious emergencies.

REFERENCE

Knuth, D. E. 1986. *The TEXbook*, Addison Wesley Publishing Company, Reading, Mass.

APPENDIX A

GLOSSARY

Control sequence	Definition	Page
\$	Used to print $	4
\&	Used to print &	4
\#	Used to print #	4
\%	Used to print %	4
$\{$	Used to print {	4
$\}$	Used to print }	4
\^{}	Used to print ^	4
_	Used to print _	4
\~{}	Used to print ~	4
\/	Introduces a small amount of extra space when used after letters in the '\it' and '\sl' fonts to compensate for a change in slope of the letters (italic correction)	13
\␣	Treated as a space that is not to be ignored (control space)	3, 25, 29, 44
\+	Used in a '\settabs' table to denote the start of each row	57, 58
\,	Used inside math to get a horizontal skip of 1/6 the letter 'M' in the current font (thin space)	45
\>	Used inside to get a horizontal skip of 2/9 the letter 'M' in the current font (medium space)	45
\;	Used inside math to get a horizontal skip of 5/18 the letter 'M' in the current font (thick space)	45
\!	Used inside math to get a negative horizontal skip of 1/6 the letter 'M' in the current font (negative thin space)	45

Control sequence	Definition	Page
`\atop`	Used inside math; stacks letters and numbers without fraction line `${a\atop b}$` prints $\begin{smallmatrix}a\\b\end{smallmatrix}$	43
`\backslash`	Used inside math to print \	4
`\baselineskip`	Allocates amount of vertical space between baselines; '`\baselineskip=12pt`' is single spacing (default), '`\baselineskip=18pt`' is space-and-a-half spacing, and '`\baselineskip=24pt`' is double spacing	19
`\bbf`	Gives **big boldface** font	5
`\bf`	Gives **boldface** font	5

`\bigl`
`\biggl`
`\Bigl`
`\Biggl`
`\bigr`
`\biggr`
`\Bigr`
`\Biggr`
	Used inside math for opening and closing delimiters when TEX does not not choose the size delimiter you want	51, 52

`\bit`	Gives *big italic* font	5
`\boldmath`	Produces bold math (available only with `mmes`) `\boldmath$a+b$` prints $\boldsymbol{a+b}$	
`\brace`	Used inside math to stack letters and numbers without fraction line; encloses them in braces `${a\brace b}$` prints $\left\{\begin{smallmatrix}a\\b\end{smallmatrix}\right\}$	55
`\brack`	Used inside math to stack letters and numbers without fraction line; encloses them in brackets `${a\brack b}$` prints $\left[\begin{smallmatrix}a\\b\end{smallmatrix}\right]$	55

Control sequence	Definition	Page
\break	Forces TEX to break text between lines at a certain point in a paragraph and causes a spaced-out line	17
\brm	Gives big roman font	5
\bsl	Gives *big slanted* font	5
\btt	Gives `big typewriter` font	5
\buildrel	Used inside math to put letters and symbols over left and right arrows and other relations `${\buildrel a\over =}$` prints $\buildrel a \over =$	43
\bye	Gives the same result as typing '\vfill\eject\end' in ejecting the current page and ending the document	18

\cases	Used inside math to generate a single brace that indicates a choice
	`$a=\cases{b,&if $\ge1$\cr`
	`&if $b\le0$\cr`
	`}`
	`$`
	prints
	$a = \begin{cases} b, & \text{if } \geq 1 \\ & \text{if } b \leq 0 \end{cases}$
		53

\centerline	Centers text on the current line	14, 15
\choose	Used inside math; stacks letters and numbers without fraction line and encloses in parentheses `${a\choose b}$` prints $\binom{a}{b}$	55

Control sequence	Definition	Page
\clearnotenumber	Used in conjunction with '\note' to clear previous footnote numbers; starts the numbering sequence over (available only with mmes)	31
\cr	Denotes a carriage return; marks the end of line in aligned equations and '\settabs' and '\halign' tables	47–88
\dasheditems	Used with '\itm' to produce dashed (—) item list (available only with mmes)	35
\dashedsubitems	Used with '\sitm' to produce dashed (—) subitem list (available only with mmes)	35
\displaystyle	Used inside math; style of type used in displayed formulas	45
\dotteditems	Used with '\itm' to produce dotted (•) item list (available only with mmes)	35
\dottedsubitems	Used with '\sitm' to produce dotted (•) subitem list (available only with mmes)	35
em	Specifies a unit of measure the width of one '\quad' in the current font	61
\enditems	Used in conjunction with '\itm' and '\sitm' lists; clears previous numbers and/or letters and starts the sequence over (available only with mmes)	33
\eqalign	Used inside math to allow for lining up of equations on any letter or symbol	47–52

Control sequence	Definition	Page
\eqalignno	Used inside math to allow for lining up of equations on any letter or symbol; some lines of the alignment have equation numbers and some do not (equation numbers align at right margin)	48–50
\eqno	Used inside math; puts equation number at the right margin of a one-line equation and centered among all lines of an '\eqalign' at the right margin	47–50
\evenpage	Causes a page eject, and if the current page is an even-numbered page, leaves an extra blank page so that the following text is guaranteed to begin on an even-numbered page (available only with mmes)	
\footnote	Generates footnotes with symbols or letters for reference marks	31
\halign	Represents method of making a table with horizontal alignment in which TEX automatically calculates column width	61–88
\hangafter	Controls lines with hanging indentation and specifies how long the indentation is to last	26–28
\hangindent	Specifies the amount of the hanging indentation	26–28
\hbox	Used when a group of letters or words need to be locked together and not broken up	13, 19, 44

Control sequence	Definition	Page
height	Provides extra vertical skip inside an '\halign' vertically ruled table; an empty additional row must be inserted along with the desired height of vertical skip	80–83
\hfil	Pushes text horizontally on either side of it as far as it can	15
\hfil\break	Forces TEX to break text between lines at a certain point in a paragraph and fills up the right-hand part of a line with blank space just before the forced break	17
#\hfil	Denotes left-justified column entry in the preamble of an '\halign' table	61, 62
\hfil#	Denotes right-justified column entry in the preamble of an '\halign' table	61, 62
\hfil#\hfil	Denotes centered column entry in the preamble of an '\halign' table	61, 62
\hidewidth	Ignores the width of a column in an '\halign' table and does not use it in determining column width	67, 68
\hoffset	Shifts the output horizontally on the page to the right or left of its normal position	20
\hour	Prints the current time of day (available only with mmes)	
\hrule	Produces a horizontal rule the current width of '\hsize'	71

Control sequence	Definition	Page
`\hrulefill`	Used in an '`\halign`' table with '`\multispan`' when a horizontal rule does not span the entire width of the table	72, 73
`\hsize`	Specifies the horizontal width of lines; default '`\hsize`' is 6.5 inches	19, 39
`\hyphenpenalty=10000`	Avoids all hyphenation	19
`\input external`	Invokes macro package for generating external correspondence (available only with `mmes`)	139, 144
`\input internal`	Invokes macro package for generating internal correspondence (available only with `mmes`)	149
`\input mmes`	Invokes macro package of general-purpose defaults developed at Martin Marietta Energy Systems, Inc.	18
`\interlinepenalty=10000` `\raggedbottom`	Prevents page breaking between paragraphs; both commands should be used together	20
`\it`	Gives *italic* font	5, 13
`\item`	Generates a paragraph indented the amount of one '`\parindent`' with a tag that appears to the left of the paragraph, right-justified, and one space away from the text	36
`\itemitem`	Generates a paragraph indented the amount of two '`\parindent`'s with a tag that appears to the left of the paragraph, right-justified, and one space away from the text	36

Control sequence	Definition	Page
\itempar	Used to start new paragraphs within an item list using '\itm' control sequence (available only with mmes)	34
\itm	Produces an automatically numbered item list (available only with mmes)	33–35
\left	Used inside math when the user wants TEX to choose the size of left delimiter	51
\leftline	Generates left-justified line	14
\leftskip	Produces text that is indented a specified amount from the left margin	23, 24
\leqalignno	Used inside math to allow for lining up of equations on any letter or symbol, some lines of the alignment having equation numbers and some not (equation numbers align at left margin)	50
\leqno	Used inside math to put equation number at the left margin of a one-line equation and centered among all lines of an '\eqalign' at the left margin	49, 50
\letterediteems	Used with '\itm' to produce item list with sequential lowercase letters (available only with mmes)	35
\letteredsubitems	Used with '\sitm' to produce subitem list with sequential lowercase letters; no special reference is needed because this is the default for subitems (available only with mmes)	35

Control sequence	Definition	Page
\Letthereditems	Used with '\itm' to produce item list with sequential uppercase letters (available only with mmes)	35
\Letteredsubitems	Used with '\sitm' to produce subitem list with sequential uppercase letters (available only with mmes)	35
\line	Used with an '\hfil' for the placement of text in a line that is the current '\hsize'	15
\llap	Used in an '\halign' table to put information to the left of a column without affecting the width of that column	67, 68
\mag=1200	Magnifies text by 20%; must be the first entry of the file being magnified	39
\mag=1440	Magnifies text by 44%; must be the first entry of the file being magnified	39
\mag=1728	Magnifies text by 72.8%; must be the first entry of the file being magnified	39
\makestrut	Ensures that '\strut' will be adjusted to the current baselineskip; input before a ruled '\halign' table whose baselineskip is different from the default of 12 points (available only with mmes)	71
\matoffset	Advances '\voffset' and '\hoffset' to position the output page for photomats (available only with mmes)	

Control sequence	Definition	Page

\matrix	Used inside math to stack rows of entries on top of each other and enclose those entries in specified delimiters
	`$a=\left[`
	`\matrix{1&1&0\cr`
	`0&0&0\cr`
	`}`
	`\right]`
	`$`
	prints
	$a = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$
		54

\Mc$_{\sqcup}$	Produces the raised 'c' in such proper names as McDonald (available only with mmes)	
\mid	Used inside math to generate a vertical bar midway between two entries	52
\mon	Prints the current month name (available only with mmes)	
\multipleitem	Generates item list with more than two levels; the number following '\multipleitem' indicates the number of paragraph indentations that will occur (available only with mmes)	37
\multispan	Does an '\omit' of what is in the preamble for specified number(s) of columns in an '\halign' table; spans the specified number of columns; and either centers, or right- or left-justifies entry	65, 66, 72

Control sequence	Definition	Page
\narrower	Indents text the amount of '\parindent' from the left and right margins	25
\narrower\narrower	Indents text the amount of two '\parindent's from the left and right margins	25
\need⟨*dimension*⟩	Determines that if there is not ⟨*dimension*⟩ remaining on the current page, a page break occurs (available only with mmes)	
\noalign	Takes the user temporarily out of an '\halign' table	64
\noalign{\hrule}	Provides horizontal rule that spans the entire width of an '\halign' table	71, 72
\noalign{\vskip_pt (or _in)}	Provides extra vertical skip inside an '\halign' table	64
\nofirstpagenum	Suppresses first page number; subsequent numbers appear centered at bottom if default page numbering scheme is used and centered at top if '\toppagenumbers' is used (available only with mmes)	20
\noindent	Suppresses paragraph indentation on the following paragraph	19, 23–25
\nopagenumbers	Suppresses all page numbers in the document	20
\normalbaselines	Ensures proper baselineskip inside a '\vtop' inside an '\halign' table	85–87
\note	Provides automatically numbered and positioned footnotes (available only with mmes)	31

Control sequence	Definition	Page
`\null`	Tricks TEX into thinking something is at the beginning of the line, paragraph, or page so that the extra space will not be ignored	17, 19
`\null{\hskip_pt (or _in)}`	Puts in extra horizontal space at the beginning of a line; both commands must be used together	19
`\numbereditems`	Used with '`\itm`' to produce sequentially numbered item list; no special reference is needed because this is the default for items (available only with `mmes`)	35
`\numberedsubitems`	Used with '`\sitm`' to produce sequentially numbered subitem list (available only with `mmes`)	35

`{\obeylines\obeyspaces`
`\let␣=\␣\parskip=0pt`
`\parindent=0pt`
 	
`\par}`
	Produces text exactly as it appears in the input when grouped together	29

`\oddpage`	Causes a page eject; if the current page is an odd-numbered page, leaves an extra blank page so that the following text is guaranteed to begin on an odd-numbered page (available only with `mmes`)	
`\offinterlineskip`	Used with '`\strut`' in an '`\halign`' ruled table to ensure correct baselineskip	71–88
`\omit`	Allows user to omit what is in the preamble of an '`\halign`' table and specify a different column arrangement	65, 67, 74, 75, 82, 83, 87

Control sequence	Definition	Page
`\over`	Used inside math to generate fractions `${a\over b}$` prints $\frac{a}{b}$	42
`\overbrace`	Used inside math to put a large horizontal brace over an expression `$\overbrace{a+b}$` prints $\overbrace{a+b}$	53
`\overline`	Used inside math to produce a horizontal line over an expression `$\overline{a+b}$` prints $\overline{a+b}$	41
`\page`	Generates an empty page in a document and continues page numbering (available only with `mmes`)	
`\pageno=_`	Invokes page to begin with specific page number	20
`\par`	Ends a paragraph; most often used inside grouping	18, 23–25, 29
`\parindent`	Specifies amount of paragraph indentation; default '`\parindent`' is 20pt	19, 25
`\parskip`	Specifies amount of vertical space between paragraphs; default '`\parskip`' is 0pt	19
`plus 1fil`	Used in conjunction with '`\tabskip`' in an '`\halign`' table with a specified width; allows TEX to stretch the space between columns as much as it needs to make the table the specified width	61

Control sequence	Definition	Page
\pmatrix	Used inside math to stack rows of entries on top of each other; automatically encloses those entries in parentheses `$a=\pmatrix{ 1& 1& 0\cr 0& 0& 0\cr }$` prints $a = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix}$	54
\quad	Produces empty horizontal space the width of the letter 'M' in the current font	58
\qquad	Produces empty horizontal space the width of two '\quad's	58
\raggedright	Generates ragged right text	19
\right	Used inside math when the user wants TEX to choose the size of right delimiter	51
\rightline	Generates right-justified line	14
\rightskip	Produces text that is indented a specified amount from the right margin	23, 24
\rlap	Used in an '\halign' table to put information to the right of a column without affecting the width of that column	67, 68
\rm	Gives roman (default) font	5, 19, 44
\romanitems	Used with '\itm' to produce item list with sequential lower-case roman numerals (available only with mmes)	35

Control sequence	Definition	Page
\romansubitems	Used with '\sitm' to produce subitem list with sequential lowercase roman numerals (available only with mmes)	35
\Romanitems	Used with '\itm' to produce item list with sequential uppercase roman numerals (available only with mmes)	35
\Romansubitems	Used with '\sitm' to produce subitem list with sequential uppercase roman numerals (available only with mmes)	35
\sbf	Gives **small boldface** font	5
\scriptstyle	Used inside math; style of type used for superscripts and subscripts	45
\scriptscriptstyle	Used inside math; style of type used for second-order superscripts and subscripts	45
\settabs	Produces a table that allows for specific placement of tab settings; user determines column width	57–59
\sit	Gives *small italic* font	5
\sitm	Produces an automatically lettered subitem list (available only with mmes)	33–35
\sl	Gives *slanted* font	5, 13
\specialdigit	Causes the '@' character to produce an empty space equal to the width of a digit; should be inserted before the beginning of an '\halign' table with decimal alignment (available only with mmes)	68

Control sequence	Definition	Page
\splitpagenumbers	Centers first page number at bottom; subsequent numbers appear centered at top (available only with mmes)	20
\squareditems	Used with '\itm' to produce squared (■) item list (available only with mmes)	35
\squaredsubitems	Used with '\sitm' to produce squared (■) subitem list (available only with mmes)	35
\sqrt	Used inside math to produce square root sign over expression $\sqrt{a+b}$ prints $\sqrt{a+b}$	41
\srm	Gives small roman font	5
\ssl	Gives *small slanted* font	5
\strut	Produces vertical rule whose height and depth are equal to the default baselineskip and the width of 0pt; used in an '\halign' ruled table with '\offinterlineskip' to ensure correct vertical spacing	71
\strut#	Denotes first-column entry in an '\halign' ruled table	71–88
\strut#\strut	Ensures proper baselineskip inside a '\vtop' or a '\vcenter' inside an '\halign' table	85–88
\stt	Gives **small typewriter** font	5
\subitempar	Used to start new paragraphs within a subitem list using '\sitm' control sequence (available only with mmes)	34
\tabskip	Produces blank horizontal space between columns of an '\halign' table	61, 62

Control sequence	Definition	Page
\TeX	Produces the TEX logo (TEX)	3
\textstyle	Used inside math; style of type used in formulas within text	45
\today	Prints current date (available only with mmes)	
\toppagenumbers	Centers page numbers at top (available only with mmes)	20
true	Used in specifying '\hsize' and '\vsize' to prevent TEX from magnifying text off the page	39
\tt	Gives typewriter font	5
\underbar	Draws a line under some text	14
\underbrace	Used inside math to put a large horizontal brace under an expression $\underbrace{a+b}$ prints $\underbrace{a+b}$	53
\underline	Used inside math to produce a horizontal line under an expression $\underline{a+b}$ prints $\underline{a+b}$	41
\vbox	Used in an '\halign' table to temporarily take the table out of math mode and to prevent the table from splitting between pages	71–88
\vcenter	Allows user to center a column vertically in an '\halign' table; must appear inside math mode $\vcenter{...}$	86, 87

Control sequence	Definition	Page
\vfill	Pushes text vertically on either side of it as far as it can	17, 18
\vfill\eject	Ends current page	18
\vfill\eject\end	Ejects current page and document is ended; typing '\bye' at the end of the document produces the same result	18
\voffset	Shifts the output vertically on the page up or down from its normal position	20
\vrule#	Specifies vertical rules in the preamble of an '\halign' table	74–83
\vsize	Specifies the vertical length of pages; default '\vsize' is 9in	19, 39
\vskip_pt (or _in)	Puts in extra vertical space between lines	19
\vtop	Used in an '\halign' table when a column entry needs to be a sentence, a paragraph, or paragraphs	85–87

APPENDIX B

STANDARD NOTICES AVAILABLE WITH `mmes.tex`

The following standard Martin Marietta Energy Systems, Inc., notices are available with the mmes macro package. The control sequence, shown in typewriter font, is followed by the standard notice it generates.

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*Administrative Services, *Document Preparation Guide*, ORNL/IRO-1, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., September 1988.

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APPENDIX C

TABLE-SETTING EXERCISE

This exercise is designed as an aid for setting tables using TEX. The exercise builds on a sample table [*Bell Laboratories Computing Science Technical Report* 49 (1976)] to allow the user to see the change each added control sequence makes to the design of the table. Each page contains the input and the resulting table with comments to guide the user through formatting the sample table.

The '$$' at the start and end of a table centers the table horizontally and vertically. Because '$$' puts the display in math mode, a '\vbox' follows the '$$' to temporarily take the table out of math mode. What is placed within the '\vbox' and the '\halign' is contained in braces. A three-column table has been specified with the first column right-justified, the second column centered, and the third column right-justified. A '\cr' ends each row of the table, and the '&' is the tab character that acts like the tab key on a typewriter. The '\llap' control sequence at the beginning of the table puts a '$' left of that column entry, and the '\rlap' control sequence on the last line of the table puts an asterisk to the right of the column. The table ends with '}}$$', which closes the '\vbox', the '\halign', and the math that was started at the very beginning of the table.

```
$$\vbox{
\halign{
     \hfil#&
     \hfil#\hfil&
     \hfil#
\cr
     1971&     41--54&     \llap{\$}2.60\cr
        2&     41--54&     2.70\cr
        3&     46--55&     2.87\cr
        4&     40--53&     3.24\cr
        5&     45--52&     3.40\cr
        6&     51--59&      .95\rlap{*}\cr
}}$$
```

$$\vbox{
\halign{
\hfil#&
\hfil#\hfil&
\hfil#
\cr
1971&41--54&\llap{\$}2.60\cr
2&41--54&2.70\cr
3&46--55&2.87\cr
4&40--53&3.24\cr
5&45--52&3.40\cr
6&51--59& .95\rlap{*}\cr
}}$$

The previous table appeared all crowded together, with no space between columns. To spread the table out, tabskip has been added. Here, the tabskip of '1em' puts space the size of one '\quad' in the current font between all the columns of the table. Tabskip amount is determined by the size of the table and the preference of the person setting the table.

```
$$\vbox{                        \tabskip=1em
\halign{
     \hfil#&
     \hfil#\hfil&
     \hfil#
\cr
     1971&     41--54&     \llap{\$}2.60\cr
        2&     41--54&     2.70\cr
        3&     46--55&     2.87\cr
        4&     40--53&     3.24\cr
        5&     45--52&     3.40\cr
        6&     51--59&      .95\rlap{*}\cr
}}$$
```

1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

Here the table is given the width of '\hsize', which is either the default of 6.5 inches or whatever the '\hsize' was set to at the beginning of the file. This manual uses an '\hsize' of 5.75 inches, so this sample table should measure 5.75 inches wide. The tabskip must have some degree of stretchability ('plus 1fil') when you are using '\halign' to '\hsize' or '\halign to *<dimension>*' so the table can stretch to the specified dimension.

```
$$\vbox{                        \tabskip=1em plus 1fil
\halign to \hsize{
     \hfil#&
     \hfil#\hfil&
     \hfil#
\cr
     1971&      41--54&      \llap{\$}2.60\cr
        2&      41--54&      2.70\cr
        3&      46--55&      2.87\cr
        4&      40--53&      3.24\cr
        5&      45--52&      3.40\cr
        6&      51--59&       .95\rlap{*}\cr
}}$$
```

1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

TEX put the same tabskip amount before the first column and after the last column in the previous table as it did between the column entries. That is why the table does not appear to be 5.75 inches wide. To take that extra tabskip space off the beginning and the end of the table, the tabskip is set to '0pt' before the first column of the table (on the line after the '$$\vbox{') and on the last line of the preamble before the '\cr'.

```
$$\vbox{                                \tabskip=0pt
\halign to \hsize{
     \hfil#                             \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#                             \tabskip=0pt
\cr
     1971&      41--54&      \llap{\$}2.60\cr
        2&      41--54&      2.70\cr
        3&      46--55&      2.87\cr
        4&      40--53&      3.24\cr
        5&      45--52&      3.40\cr
        6&      51--59&       .95\rlap{*}\cr
}}$$
```

1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

Here the horizontal size of the table is set to 2.5 inches inasmuch as this particular table would be easier to read if it were smaller than '\hsize'. Notice the tabskip still has stretchability ('plus 1fil') so the table can stretch to the specified 2.5 inches.

```
$$\vbox{                                \tabskip=0pt
\halign to 2.5in{
     \hfil#                             \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#                             \tabskip=0pt
\cr
     1971&      41--54&      \llap{\$}2.60\cr
        2&      41--54&      2.70\cr
        3&      46--55&      2.87\cr
        4&      40--53&      3.24\cr
        5&      45--52&      3.40\cr
        6&      51--59&       .95\rlap{*}\cr
}}$$
```

1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

To center the main heading of the table across the entire three columns of the table, use '`\multispan3`' along with the '`\hfil#\hfil`' specification for a centered column. For future reference, if a '`\multispan`' spans more than nine columns, the number of columns should appear in braces. For example, '`\multispan12`' would span only one column, whereas '`\multispan{12}`' would span 12 columns.

```
$$\vbox{                              \tabskip=0pt
\halign to 2.5in{
     \hfil#                           \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#                           \tabskip=0pt
\cr
     \multispan3\hfil{AT\&T Common Stock}\hfil\cr
     1971&     41--54&     \llap{\$}2.60\cr
        2&     41--54&     2.70\cr
        3&     46--55&     2.87\cr
        4&     40--53&     3.24\cr
        5&     45--52&     3.40\cr
        6&     51--59&      .95\rlap{*}\cr
}}$$
```

AT&T Common Stock

1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

The headings above each column needed to be centered over each column. Because the first column is right-justified and the title of that column is smaller in width than the column entries it is above, an '\omit' is used at the beginning of the first column to omit what was in the preamble. The '\hfil#\hfil' specification is then used to center the heading above the column. The template for the second column is for a centered column, so the title will automatically be centered above the column, eliminating the need for using an '\omit'. In the third column the title is wider than the column entries it is to be centered above, so '\hidewidth#\hidewidth' is used to prevent the widths of the title from being used to determine column width.

```
$$\vbox{                                \tabskip=0pt
\halign to 2.5in{
     \hfil#                             \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#                             \tabskip=0pt
\cr
     \multispan3\hfil{AT\&T Common Stock}\hfil\cr
     \omit\hfil{Year}\hfil&
     Price&
     \hidewidth{Dividend}\hidewidth\cr
     1971&     41--54&     \llap{\$}2.60\cr
        2&     41--54&     2.70\cr
        3&     46--55&     2.87\cr
        4&     40--53&     3.24\cr
        5&     45--52&     3.40\cr
        6&     51--59&      .95\rlap{*}\cr
}}$$
```

AT&T Common Stock

Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

Use a '\noalign{\hrule}' specification for each row you want followed by a horizontal rule. A '\noalign{}' is used in a table to exit the table temporarily and do a '\vskip' or '\hrule', for example.

Notice: TEX does not put interline space between rule boxes and their neighbors in a vertical list. That is the reason for the lack of extra vertical space between the rows of the table.

```
$$\vbox{                                \tabskip=0pt
\halign to 2.5in{
     \hfil#                             \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#                             \tabskip=0pt
\cr
     \noalign{\hrule}
     \multispan3\hfil{AT\&T Common Stock}\hfil\cr
     \noalign{\hrule}
     \omit\hfil{Year}\hfil&
     Price&
     \hidewidth{Dividend}\hidewidth\cr
     \noalign{\hrule}
     1971&     41--54&     \llap{\$}2.60\cr
     \noalign{\hrule}
        2&     41--54&     2.70\cr
     \noalign{\hrule}
        3&     46--55&     2.87\cr
     \noalign{\hrule}
        4&     40--53&     3.24\cr
     \noalign{\hrule}
        5&     45--52&     3.40\cr
     \noalign{\hrule}
        6&     51--59&      .95\rlap{*}\cr
     \noalign{\hrule}
}}$$
```

AT&T Common Stock		
Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

When creating a table containing horizontal or vertical rules or a combination of both, the command '\offinterlineskip' should be inserted on the line after '$$\vbox{'. Because TEX does not put interline space between rules and their neighbors in a vertical list, a '\strut', which is a zero-width invisible rule of the correct height and depth for the current font, is added as a first-column entry in the preamble along with a '#' sign and an '&' sign after it. The '\strut#' fixes the vertical space allowed for the entire table. If your '\baselineskip' differs from the default of 12 points, a '\makestrut' command should appear at the top of your file after the specification for '\baselineskip'. The '\makestrut' will adjust the size of the '\strut' to fit the current amount of '\baselineskip'. The initial '&' in the listings of the row data that follow the preamble is all that is necessary to cause the '\strut' to apply to the entries in each row.

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign to 2.5in{
     \strut#                            \tabskip=1em plus 1fil&
     \hfil#&
     \hfil#\hfil&
     \hfil#                             \tabskip=0pt
\cr
     \noalign{\hrule}
     &     \multispan3\hfil{AT\&T Common Stock}\hfil\cr
     \noalign{\hrule}
     &      \omit\hfil{Year}\hfil&
            Price&
            \hidewidth{Dividend}\hidewidth\cr
            \noalign{\hrule}
     &      1971&     41--54&     \llap{\$}2.60\cr
     \noalign{\hrule}
     &         2&     41--54&     2.70\cr
     \noalign{\hrule}
     &         3&     46--55&     2.87\cr
     \noalign{\hrule}
     &         4&     40--53&     3.24\cr
     \noalign{\hrule}
     &         5&     45--52&     3.40\cr
     \noalign{\hrule}
     &         6&     51--59&      .95\rlap{*}\cr
     \noalign{\hrule}
}}$$
```

AT&T Common Stock		
Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

Although the '\strut#' in the first column entry is an invisible dimension, TEX still treats it as a separate column and puts tabskip space between it and the next column. That is what caused the horizontal rules to extend beyond the left-hand side of the table the exact amount of '\tabskip'. To take that extra space out put in by the '\strut#&', the '\tabskip=1em plus 1fil' needs to be moved to the next column entry for text in the preamble before the '&'.

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign to 2.5in{
     \strut#&
     \hfil#                             \tabskip=1em plus 1fil&
     \hfil#\hfil&
     \hfil#                             \tabskip=0pt
\cr
     \noalign{\hrule}
     &     \multispan3\hfil{AT\&T Common Stock}\hfil\cr
     \noalign{\hrule}
     &      \omit\hfil{Year}\hfil&
            Price&
            \hidewidth{Dividend}\hidewidth\cr
            \noalign{\hrule}
     &      1971&     41--54&     \llap{\$}2.60\cr
     \noalign{\hrule}
     &         2&     41--54&     2.70\cr
     \noalign{\hrule}
     &         3&     46--55&     2.87\cr
     \noalign{\hrule}
     &         4&     40--53&     3.24\cr
     \noalign{\hrule}
     &         5&     45--52&     3.40\cr
     \noalign{\hrule}
     &         6&     51--59&      .95\rlap{*}\cr
     \noalign{\hrule}
}}$$
```

AT&T Common Stock		
Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

Vertical rules are added to this table by using '\vrule#' in the preamble everywhere a vertical rule is needed. Each vertical rule is treated as a separate column, and as such each '\vrule#' has a corresponding '&' in the preamble as well as in the table itself. The main title that previously spanned three columns must now span five columns to accommodate the columns that were added with the vertical rules.

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign to 2.5in{
     \strut#&
     \vrule#                            \tabskip=1em plus 1fil&
     \hfil#&
     \vrule#&
     \hfil#\hfil&
     \vrule#&
     \hfil#&
     \vrule#                             \tabskip=0pt
\cr
     \noalign{\hrule}
     &&      \multispan5\hfil{AT\&T Common Stock}\hfil&\cr
     \noalign{\hrule}
     &&      \omit\hfil{Year}\hfil&&
             Price&&
             \hidewidth{Dividend}\hidewidth&\cr
     \noalign{\hrule}
     &&      1971&&     41--54&&     \llap{\$}2.60&\cr
     \noalign{\hrule}
     &&         2&&     41--54&&     2.70&\cr
     \noalign{\hrule}
     &&         3&&     46--55&&     2.87&\cr
     \noalign{\hrule}
     &&         4&&     40--53&&     3.24&\cr
     \noalign{\hrule}
     &&         5&&     45--52&&     3.40&\cr
     \noalign{\hrule}
     &&         6&&     51--59&&      .95\rlap{*}&\cr
     \noalign{\hrule}
}}$$
```

AT&T Common Stock		
Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

The footnote, like the main heading, should be spanned across the entire table. The first '&' that ensures the strut should still be inserted at the beginning of the footnote row, leaving columns to be spanned. Because the footnote is to be left-justified, the column specification should be '`\multispan7{*(first quarter only)}\hfil`'.

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign to 2.5in{
     \strut#&
     \vrule#                            \tabskip=1em plus 1fil&
     \hfil#&
     \vrule#&
     \hfil#\hfil&
     \vrule#&
     \hfil#&
     \vrule#                             \tabskip=0pt
\cr
     \noalign{\hrule}
     &&      \multispan5\hfil{AT\&T Common Stock}\hfil&\cr
     \noalign{\hrule}
     &&      \omit\hfil{Year}\hfil&&
             Price&&
             \hidewidth{Dividend}\hidewidth&\cr
     \noalign{\hrule}
     &&      1971&&     41--54&&     \llap{\$}2.60&\cr
     \noalign{\hrule}
     &&         2&&     41--54&&     2.70&\cr
     \noalign{\hrule}
     &&         3&&     46--55&&     2.87&\cr
     \noalign{\hrule}
     &&         4&&     40--53&&     3.24&\cr
     \noalign{\hrule}
     &&         5&&     45--52&&     3.40&\cr
     \noalign{\hrule}
     &&         6&&     51--59&&      .95\rlap{*}&\cr
     \noalign{\hrule}
     &       \multispan7{*(first quarter only)}\hfil\cr
}}$$
```

AT&T Common Stock		
Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

*(first quarter only)

If you need to add vertical skip in a vertically ruled table, insert an additional blank row the height of the desired vertical skip. Use an '\omit' to omit the vertical rules in the multispanned heading.

```
$$\vbox{                                \tabskip=0pt
\offinterlineskip
\halign to 2.5in{
     \strut#&
     \vrule#                            \tabskip=1em plus 1fil&
     \hfil#&
     \vrule#&
     \hfil#\hfil&
     \vrule#&
     \hfil#&
     \vrule#                             \tabskip=0pt
\cr
     \noalign{\hrule}
     height 2pt
     &&      &\omit&    &\omit&      &\cr
     &&      \multispan5\hfil{AT\&T Common Stock}\hfil&\cr
     height 2pt
     &&      &\omit&    &\omit&      &\cr
     \noalign{\hrule}
     height 2pt
     &&      &&         &&          &\cr
     &&      \omit\hfil{Year}\hfil&&
             Price&&
             \hidewidth{Dividend}\hidewidth&\cr
     height 2pt
     &&      &&         &&          &\cr
     \noalign{\hrule}
     &&      1971&&     41--54&&     \llap{\$}2.60&\cr
     \noalign{\hrule}
     &&         2&&     41--54&&     2.70&\cr
     \noalign{\hrule}
     &&         3&&     46--55&&     2.87&\cr
     \noalign{\hrule}
     &&         4&&     40--53&&     3.24&\cr
     \noalign{\hrule}
     &&         5&&     45--52&&     3.40&\cr
     \noalign{\hrule}
     &&         6&&     51--59&&      .95\rlap{*}&\cr
     \noalign{\hrule}
     &       \multispan7{*(first quarter only)}\hfil\cr
}}$$
```

AT&T Common Stock		
Year	Price	Dividend
1971	41–54	$2.60
2	41–54	2.70
3	46–55	2.87
4	40–53	3.24
5	45–52	3.40
6	51–59	.95*

*(first quarter only)

APPENDIX D

EXTERNAL CORRESPONDENCE MACRO PACKAGE

PERSONAL

MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 21, 1989

TeX Users, All Divisions of ORNL
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831

Dear TeX Users:

TeX Macro Package for Generating External Correspondence

Enclosed is the input for this sample letter which demonstrates all the capabilities of the TeX macro package for generating external correspondence. Many features are included, some of which you may not need. If a particular feature is not required, it may be left out of the input. **It is important to note that one blank line should precede and follow each change of section in the letter.**

Also enclosed is another sample external letter and input which illustrate the most commonly used features of this macro package.

The first paragraph of this letter will be repeated so that the automatic page headings and numbers can be illustrated.

Enclosed is the input for this sample letter which demonstrates all the capabilities of the TeX macro package for generating external correspondence. Many features are included, some of which you may not need. If a particular feature is not required, it may be left out of the input.

Enclosed is the input for this sample letter which demonstrates all the capabilities of the TeX macro package for generating external correspondence. Many features are included, some of which you may not need. If a particular feature is not required, it may be left out of the input.

Enclosed is the input for this sample letter which demonstrates all the capabilities of the TeX macro package for generating external correspondence. Many features are included, some of which you may not need. If a particular feature is not required, it may be left out of the input.

Enclosed is the input for this sample letter which demonstrates all the capabilities of the TeX macro package for generating external correspondence. Many features are included, some of which you may not need. If a particular feature is not required, it may be left out of the input.

PERSONAL

PERSONAL

TEX Users 2 February 21, 1989

Enclosed is the input for this sample letter which demonstrates all the capabilities of the TEX macro package for generating external correspondence. Many features are included, some of which you may not need. If a particular feature is not required, it may be left out of the input.

Sincerely,

K. T. Barry

S. P. Ketterer
Publications Division

SPK:sk

Enclosures
1. Sample Input
2. More Sample Input

Separate Cover: Input for the Macro Package—Fourth-Class Mail

Special Delivery

cc: J. M. Dole
D. S. Griffith
P. L. Kienlen

cc/enc: K. M. Dobbs
R. W. McGaffey

bc: T. D. Anderson
J. D. Mason

P.S. If you like, you can add a *postscript* to your letter in this section.

PERSONAL

```
\input mmes

     %Macro package for external correspondence.

\input external

     %The '\mm' notation positions the letter for use with
     %Martin Marietta letterhead. If you are using ORNL
     %letterhead, no notation is required here because ORNL
     %letterhead is the default.

\mm

     %If a sensitivity notation is specified, it will appear
     %at the top and bottom of the first page and the other
     %subsequent pages.

\sensitivity{PERSONAL}

     %The \date{\today} notation produces the current date.
     %If you want to supply a different date, put the date you
     %want to use in the braces (e.g., \date{February 21, 1989}).

\date{\today}

     %When the first line of the inside address is long, for
     %example, a person's name and title, a '|' can be placed
     %where the line should be truncated (in this case before
     %the ',') for use in the running head of subsequent pages.

\address
\TeX\ Users|, All Divisions of ORNL
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831
```

```
     %The \body contains the greeting, the \subject (if needed),
     %and body of the letter.

\body
Dear \TeX\ Users:

     %The \subject must come after the \body and be enclosed
     %in braces.

\subject
{\TeX\ Macro Package for Generating External Correspondence}

Enclosed is the input for this sample letter that demonstrates
all the capabilities of the \TeX\ macro package for generating
external correspondence.  Many features are included, some of
which you may not need.  If a particular feature is not required,
it may be left out of the input.  {\bf It is important to note
that one blank line should precede and follow each change of
section in the letter}.

Also enclosed is another sample external letter and input that
illustrate the most commonly used features of this macro package.

The first paragraph of this letter will be repeated so that the
automatic page headings and numbers can be illustrated.

Enclosed is the input for this sample letter that demonstrates
all the capabilities of the \TeX\ macro package for generating
external correspondence.  Many features are included, some of
which you may not need.  If a particular feature is not required,
it may be left out of the input.  {\bf It is important to note
that one blank line should precede and follow each change of
section in the letter}.

Enclosed is the input for this sample letter that demonstrates
all the capabilities of the \TeX\ macro package for generating
external correspondence.  Many features are included, some of
which you may not need.  If a particular feature is not required,
it may be left out of the input.  {\bf It is important to note
that one blank line should precede and follow each change of
section in the letter}.
```

```
Enclosed is the input for this sample letter that demonstrates
all the capabilities of the \TeX\ macro package for generating
external correspondence. Many features are included, some of
which you may not need. If a particular feature is not required,
it may be left out of the input. {\bf It is important to note
that one blank line should precede and follow each change of
section in the letter}.

Enclosed is the input for this sample letter that demonstrates
all the capabilities of the \TeX\ macro package for generating
external correspondence. Many features are included, some of
which you may not need. If a particular feature is not required,
it may be left out of the input. {\bf It is important to note
that one blank line should precede and follow each change of
section in the letter}.

Enclosed is the input for this sample letter that demonstrates
all the capabilities of the \TeX\ macro package for generating
external correspondence. Many features are included, some of
which you may not need. If a particular feature is not required,
it may be left out of the input. {\bf It is important to note
that one blank line should precede and follow each change of
section in the letter}.

    %The \closing includes the complimentary close, space
    %for the signature, name, and title. This is an example of
    %how to input multiple authors.

\closing
Sincerely,
K. T. Barry
\vskip3\baselineskip
S. P. Ketterer
Publications Division

\initials
SPK:sk
```

```
%Enclosures can be designated in one of three methods.

%     A single enclosure is generated with
%          \enclosure
%
%     Multiple enclosures are generated with
%          \enclosures
%
%     Automatically numbered multiple enclosures are
%     generated with
%          \enclosures
%          Description of First Enclosure
%          Description of Second Enclosure

\enclosures
Sample Input
More Sample Input

\separatecover
Input for the Macro Package---Fourth-Class Mail

\mailrate
Special Delivery

\cc
J. M. Dole
D. S. Griffith
P. L. Kienlen

\ccenc
K. M. Dobbs
R. W. \Mc Gaffey

\bc
T. D. Anderson
J. D. Mason

\ps
P.S. If you like, you can add a {\sl postscript} to
your letter in this section.

\endletter

\bye
```

MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

February 21, 1989

TEX Users
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831

Dear TEX Users:

This sample letter and input illustrate the most commonly used features of TEX's external correspondence macro package.

Sincerely,

J. B. Goode
One Division

SPK:sk

Enclosures

cc: D. S. Griffith
P. L. Kienlen
R. W. McGaffey

```
\input mmes

\input external

\mm

\date{\today}

\address
\TeX\ Users
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831

\body
Dear \TeX\ Users:

This sample letter and input illustrate the most commonly used
features of \TeX 's external correspondence macro package.

\closing
Sincerely,
J. B. Goode
One Division

\initials
SPK:sk

\enclosures

\cc
D. S. Griffith
P. L. Kienlen
R. W. \Mc Gaffey

\endletter

\bye
```

APPENDIX E

INTERNAL CORRESPONDENCE MACRO PACKAGE

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

February 21, 1989

A. B. Able, K-1007, MS-7329, K-25

TEX Macro Package for Generating Internal Correspondence

Enclosed is the input for this sample internal memo that demonstrates all the capabilities of the TEX macro package for generating internal correspondence.

The following are several repeated paragraphs that are supplied to demonstrate the automatic running head capabilities of multiple-page internal memos.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

A. B. Able
Page 2
February 21, 1989

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

S. S. Simon, 4500S, MS-6144, ORNL (4-0000)

SPK:sss

Enclosure

Separate Cover: Input for the Macro Package

cc: B. A. Friend
N. E. Thing

cc/enc: C. I. Knew
N. E. Thing

I just wanted to add a little more here.

Distribution

G. N. Erosity
O. K. Fine
I. C. Yu

```
\input mmes

    %Macro package for internal correspondence.

\input internal

    %Date can be specified or can use '\today'. For example,
    %'\date{February 21, 1989}' or '\date{\today}'. If '\date'
    %is omitted, '\today' is used as the default.

\date{\today}

    %The recipient of the memo is specified with '\to'.

\to
A. B. Able, K-1007, MS-7329, K-25

    %If the memo extends beyond one page, a page header is
    %automatically generated according to the following
    %criteria:
    %
    %     The first line following the '\to' command is used to
    %     determine the running head.
    %
    %     If there is a name only, for example,
    %          \to
    %          A. B. Able
    %     TeX will take the name and produce a second-page
    %     header like this:
    %          A. B. Able
    %          Date given in '\date'
    %          Page 2
    %
    %     If the '\to' line is
    %          A. B. Able, K-1007, MS-7329, K-25
    %     TeX will delete everything past the first comma and
    %     generate the header
    %          A. B. Able
    %          Date given in '\date'
    %          Page 2
    %
    %     If there are multiple addressees, each addressee is
    %     input on a separate line.
    %          \to
    %          A. B. Able, K-1007, MS-7329, K-25
    %          B. F. Brooks, 4500S, MS-633, ORNL
```

```
%     TeX then generates this heading:
%          A. B. Able et al.
%          Date given in '\date'
%          Page 2
%
%Thus, MOST running headings are automatically generated
%correctly, with the following two exceptions.
%          \to
%          A. B. Able, Jr., K-1007, MS-7329, K-25
%     generates the following running head
%          A. B. Able
%          Date given in '\date'
%          Page 2
%     because the first comma normally flags the beginning
%     of the address;
%
%     and
%
%          \to
%          A. B. Able and B. F. Brooks
%     generates the following running head
%          A. B. Able and B. F. Brooks
%          Date given in '\date'
%          Page 2
%     when you probably want
%          A. B. Able et al.
%          Date given in '\date'
%          Page 2
%
%     If the automatic running head is unacceptable, you can
%     specify what you want with the command
%          \runhead{A. B. Able, Jr.}
%     which should be input following the addressee
%          \to
%          A. B. Able, Jr., K-1007, MS-7329, K-25
%
%          \runhead{A. B. Able, Jr.}
%
%The '\to' block MUST be followed by a blank line
```


When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format

```
    %The subject is automatically flush left and underlined.

\subject
\TeX\ Macro Package for Generating Internal Correspondence

    %The body of the memo is begun with the command '\body'.

\body
```

Enclosed is the input for this sample internal memo that demonstrates all the capabilities of the \TeX\ macro package for generating internal correspondence.

The following are several repeated paragraphs that are supplied to demonstrate \TeX 's capabilities to generate automatic running heads in multiple-page internal memos.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

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Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

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When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

Break paragraphs for the body of the letter at changes in thought, remembering that short paragraphs are easiest to read. Reference all correspondence in the introductory paragraph.

When letters require continuation pages, the format to be used is presented on the following page.

Headings on continuation pages should follow the format described.

Enclosures should be referenced in the text of the memo.

```
     %The sender of the memo is specified with '\from'.

\from
S. S. Simon, 4500S, MS-6144, ORNL (4-0000)

     %The concluding annotations are the same as for the external
     %macro package.

\initials
SPK:sss
```

```
%Enclosures can be designated in one of three methods.
%
%     A single enclosure is generated with
%         \enclosure
%
%     Multiple enclosures are generated with
%          \enclosures
%
%     Automatically numbered multiple enclosures are
%     generated with
%          \enclosures
%          Description of First Enclosure
%          Description of Second Enclosure

\enclosure

\separatecover
Input for the Macro Package

\cc
B. A. Friend
L. A. Law

\ccenc
C. I. Knew
N. E. Thing

\ps
I just wanted to add a little more here.

     %A heading for a distribution list can be generated.

\distribution
G. N. Erosity
O. K. Fine
I. C. Yu

     %If an attachment separate from the memo is to be added
     %to the end of the memo, text can be included after
     %'\endmemo'. Text added after '\endmemo' will not contain
     %the running head or page numbering of the memo.

\endmemo

\bye
```

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