The mdwmath* package

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1 User guide

1.1 Square root typesetting

`\sqrt` The package supplies a star variant of the `\sqrt` command which omits the vinculum over the operand (the line over the top). While this is most useful in simple cases like $\sqrt{2}$ it works for any size of operand. The package also re-implements the standard square root command so that it positions the root number rather better.

[Note that omission of the vinculum was originally a cost-cutting exercise because the radical symbol can just fit in next to its operand and everything ends up being laid out along a line. However, I find that the square root without vinculum is less cluttered, so I tend to use it when it doesn't cause ambiguity.]

*The mdwmath package is currently at version 1.3, dated 25 August 2003.

Examples of the new square root command

$$\sqrt{2} \quad \text{rather than} \quad \sqrt{2}$$

$$\sqrt[3]{2} \quad \text{rather than} \quad \sqrt[3]{2}$$

$$\sqrt{x^3 + \sqrt[y]{\alpha}} - \sqrt[n+1]{a}$$

$$x = \sqrt[3]{\frac{3y}{7}}$$

$$q = \frac{2\sqrt{2}}{5} + \sqrt[\frac{n+1}{2}]{2x^2 + 3xy - y^2}$$

```
\[ \sqrt*{2} \quad \mbox{rather than} \quad \sqrt{2} \]
\[ \sqrt*[3]{2} \quad \mbox{ rather than } \quad \sqrt[3]{2} \]
\[ \sqrt{x^3 + \sqrt*[y]{\alpha}} - \sqrt*[n+1]{a} \]
\[ x = \sqrt*[3]{\frac{3y}{7}} \]
\[ q = \frac{2\sqrt*{2}}{5}+\sqrt[\frac{n+1}{2}]{2x^2+3xy-y^2} \]
```

1.2 Modular arithmetic

In standard maths mode, there's too much space before the parentheses in the output of the `\pmod` command. Suppose that $x \equiv y^2 \pmod{n}$: then the spacing looks awful. Go on, admit it.

It looks OK in a display. For example, if

$$c \equiv m^e \pmod{n}$$

then it's fine. The package redefines the `\pmod` command to do something more sensible. So now $c^d \equiv m^{ed} \equiv m \pmod{n}$ and all looks fine.

1.3 Some maths symbols you already have

`\bitor` `\bitand` `\dblor` `\dbland`

Having just tried to do some simple things, I've found that there are maths symbols missing. Here they are, in all their glory:

&	`\&`	|	`\bitor`	&&	`\dbland`
&	`\bitand`	||	`\dblor`		

`\xor` `\cat`

I also set up the `\xor` command to typeset '$\oplus$', which is commonly used to represent the bitsize exclusive-or operation among cryptographers. The command `\cat` typesets '$\|$', which is a common operator indicating concatenation of strings.

`\lsl` `\lsr` `\rol` `\ror`

The commands `\lsl` and `\lsr` typeset binary operators '$\ll$' and '$\gg$' respectively, and `\rol` and `\ror` typeset '$\lll$' and '$\ggg$'. Note that these are spaced as binary operators, rather than relations.

`\compose` `\implies` `\vect`

The `\compose` command typesets '$\circ$', which is usually used to denote function composition. The `\implies` command is made to typeset '$\Rightarrow$'. And `\vect{`$\langle x \rangle$`}` typesets '$\mathbf{x}$'.

`\statclose` `\compind`

The `\statclose` command typesets '$\stackrel{s}{=}$', which indicates 'statistical closeness'

of probability distributions; `\compind` typesets '$\overset{c}{\approx}$', which indicates computational indistinguishability.

1.4 Fractions

`\fracdef` We provide a general fraction system, a little tiny bit like `amsmath`'s `\genfrac`. Say `\fracdef{`⟨*name*⟩`}{`⟨*frac-params*⟩`}` to define a new `\frac`-like operator. The ⟨*frac-params*⟩ are a comma-separated list of parameters:

`line` Include a horizontal line between the top and bottom (like `\frac`).

`line=`⟨*length*⟩ Include a horizontal line with width ⟨*length*⟩.

`noline` Don't include a line (like `\binom`).

`leftdelim=`⟨*delim*⟩ Use ⟨*delim*⟩ as the left-hand delimiter.

`rightdelim=`⟨*delim*⟩ Use ⟨*delim*⟩ as the right-hand delimiter.

`nodelims` Don't include delimiters.

`style=`⟨*style*⟩ Typeset the fraction in ⟨*style*⟩, which is one of `display`, `text`, `script` or `scriptscript`.

`style` Use the prevailing style for the fraction.

`innerstyle=`⟨*style*⟩ Typeset the *components* of the fraction in ⟨*style*⟩.

`innerstyle` Typeset the fraction components according to the prevailing style.

The commands created by `\fracdef` have the following syntax: ⟨*name*⟩`[`⟨*frac-params*⟩`]{`⟨*top*⟩`}{`⟨*bottom*⟩`}`. Thus, you can use the optional argument to 'tweak' the fraction if necessary. This isn't such a good idea to do often.

`\frac` `\binom` `\jacobi` The macros `\frac`, `\binom` and `\jacobi` are defined using `\fracdef`. They typset $\frac{x}{y}$, $\binom{n}{k}$ and $\left(\frac{x}{n}\right)$ respectively. (The last may be of use to number theorists talking about Jacobi or Lagrange symbols.)

By way of example, these commands were defined using

```
\fracdef\frac{nodelims, line}
\fracdef\binom{leftdelim = (, rightdelim = ), noline}
\fracdef\jacobi{leftdelim = (, rightdelim = ), line}
```

1.5 Rant about derivatives

`\d` There is a difference between UK and US typesetting of derivatives. Americans typeset

$$\frac{dy}{dx}$$

while the British want

$$\frac{\mathrm{d}y}{\mathrm{d}x}.$$

The command `\d` command is fixed to typeset a 'd'. (In text mode, `\d{x}` still typesets 'x̤'.)

1.6 New operator names

\keys \dom \ran \supp \lcm \ord \poly \negl

A few esoteric new operator names are supplied.

keys	`\keys`	dom	`\dom`	ran	`\ran`
supp	`\supp`	lcm	`\lcm`	ord	`\ord`
poly	`\poly`	negl	`\negl`		

I think `\lcm` ought to be self-explanatory. The `\dom` and `\ran` operators pick out the domain and range of a function, respectively; thus, if $F\colon X \to Y$ is a function, then $\operatorname{dom} F = X$ and $\operatorname{ran} F = Y$. The *support* of a probability distribution $\mathcal{D}$ is the set of objects with nonzero probability; i.e., $\operatorname{supp} D = \{\, x \in \operatorname{dom}\mathcal{D} \mid \mathcal{D}(x) > 0 \,\}$. If $g \in G$ is a group element then $\operatorname{ord} g$ is the *order* of g; i.e., the smallest positive integer i where g^i is the identity element, or 0 if there is no such i. $\operatorname{poly}(n)$ is some polynomial function of n. A function $\nu(\cdot)$ is *negligible* if, for every polynomial function $p(\cdot)$, there is an integer N such that $\nu(n) < 1/p(n)$ for all $n > N$; $\operatorname{negl}(n)$ is some negligible function of n.

1.7 Standard set names

\Z \Q \R \C \N \F \powerset \gf

If you have a `\mathbb` command defined, the following magic is revealed:

$\mathbb{Z}$	`\Z`	$\mathbb{Q}$	`\Q`	$\mathbb{R}$	`\R`
$\mathbb{N}$	`\N`	$\mathbb{F}$	`\F`	$\mathbb{C}$	`\C`

which are handy for various standard sets of things. Also the `\powerset` command typesets '$\mathbb{P}$', and `\gf{`$\langle q \rangle$`}`, which by default typesets $\mathbb{F}_{<q>}$ but you might choose to have it set $\mathrm{GF}(\langle q \rangle)$ intead.

1.8 Biggles

\bbigg \bbiggl \bbiggr \bbiggm

The `\bbigg` commands generalizes the Plain TEX `\bigg` family of macros. `\bbigg` produces an 'ordinary' symbol; `\bbiggl` and `\bbiggr` produce left and right delimiters; and `\bbiggm` produces a relation. They produce symbols whose size is related to the prevailing text size – so they adjust correctly in chapter headings, for example.

The syntax is straightforward: `\`$\langle$*bigop*$\rangle$`[`*a*`]{`*n*`}{`$\langle$*delim*$\rangle$`}`. Describing it is a bit trickier. The size is based on the current `\strut` height. If `\strut` has a height of h and a depth of d, then the delimiter produced has a height of $n \times (h + d + a)$.

The old `\big` commands have been redefined in terms of `\bbigg`.

1.9 The 'QED' symbol

\qed \qedrule

For use in proofs of theorems, we provide a 'QED' symbol which behaves well under bizarre line-splitting conditions. To use it, just say `\qed`. The little '∎' symbol is available on its own, by saying `\qedrule`. This also sets `\qedsymbol` if it's not set already. ∎

2 Implementation

This isn't really complicated (honest) although it is a lot hairier than I think it ought to be.

```
⟨*package⟩
\RequirePackage{amssymb}
\RequirePackage{mdwkey}
```

2.1 Square roots

2.1.1 Where is the square root sign?

LaTeX hides the square root sign away somewhere without telling anyone where it is. I extract it forcibly by peeking inside the `\sqrtsign` macro and scrutinising the contents. Here we go: prepare for yukkiness.

```
\newcount\sq@sqrt \begingroup \catcode`\|0 \catcode`\\12
|def|sq@readrad#1"#2\#3|relax{|global|sq@sqrt"#2|relax}
|expandafter|sq@readrad|meaning|sqrtsign|relax |endgroup
\def\sq@delim{\delimiter\sq@sqrt\relax}
```

2.1.2 Drawing fake square root signs

TeX absolutely insists on drawing square root signs with a vinculum over the top. In order to get the same effect, we have to attempt to emulate TeX's behaviour.

`\sqrtdel` This does the main job of typesetting a vinculum-free radical.[1] It's more or less a duplicate of what TeX does internally, so it might be a good plan to have a copy of Appendix G open while you examine this.

We start off by using `\mathpalette` to help decide how big things should be.

```
\def\sqrtdel{\mathpalette\sqrtdel@i}
```

Read the contents of the radical into a box, so we can measure it.

```
\def\sqrtdel@i#1#2{%
  \setbox\z@\hbox{$\m@th#1#2$}% %%% Bzzzt -- uncramps the mathstyle
```

Now try and sort out the values needed in this calculation. We'll assume that ξ_8 is 0.6 pt, the way it usually is. Next try to work out the value of φ.

```
  \ifx#1\displaystyle%
    \@tempdima1ex%
  \else%
    \@tempdima.6\p@%
  \fi%
```

That was easy. Now for ψ.

```
  \@tempdimb.6\p@%
  \advance\@tempdimb.25\@tempdima%
```

[1] Note for chemists: this is nothing to do with short-lived things which don't have their normal numbers of electrons. And it won't reduce the appearance of wrinkles either.

Build the 'delimiter' in a box of height $h(x) + d(x) + \psi + \xi_8$, as requested. Box 2 will do well for this purpose.

```
\dimen@.6\p@%
\advance\dimen@\@tempdimb%
\advance\dimen@\ht\z@%
\advance\dimen@\dp\z@%
\setbox\tw@\hbox{%
  $\left\sq@delim\vcenter to\dimen@{}\right.\n@space$%
}%
```

Now we need to do some more calculating (don't you hate it?). As far as Appendix G is concerned, $\theta = h(y) = 0$, because we want no rule over the top.

```
\@tempdima\ht\tw@%
\advance\@tempdima\dp\tw@%
\advance\@tempdima-\ht\z@%
\advance\@tempdima-\dp\z@%
\ifdim\@tempdima>\@tempdimb%
  \advance\@tempdima\@tempdimb%
  \@tempdimb.5\@tempdima%
\fi%
```

Work out how high to raise the radical symbol. Remember that Appendix G thinks that the box has a very small height, although this is untrue here.

```
\@tempdima\ht\z@%
\advance\@tempdima\@tempdimb%
\advance\@tempdima-\ht\tw@%
```

Build the output (finally). The brace group is there to turn the output into a mathord, one of the few times that this is actually desirable.

```
{\raise\@tempdima\box\tw@\vbox{\kern\@tempdimb\box\z@}}%
}
```

2.1.3 The new square root command

This is where we reimplement all the square root stuff. Most of this stuff comes from the PLAIN TEX macros, although some is influenced by $\mathcal{AMS}$-TEX and LATEX 2_ε, and some is original. I've tried to make the spacing vaguely automatic, so although it's not configurable like $\mathcal{AMS}$-TEX's version, the output should look nice more of the time. Maybe.

`\sqrt` LATEX says this must be robust, so we make it robust. The first thing to do is to see if there's a star and pass the appropriate squareroot-drawing command on to the rest of the code.

```
\DeclareRobustCommand\sqrt{\@ifstar{\sqrt@i\sqrtdel}{\sqrt@i\sqrtsign}}
```

Now we can sort out an optional argument to be displayed on the root.

```
\def\sqrt@i#1{\@ifnextchar[{\sqrt@ii{#1}}{\sqrt@iv{#1}}}
```

Stages 2 and 3 below are essentially equivalents of PLAIN TEX's `\root`...`\of` and `\r@@t`. Here we also find the first wrinkle: the `\rootbox` used to store the number is spaced out on the left if necessary. There's a backspace after the end so that the root can slip underneath, and everything works out nicely. Unfortunately size is fixed here, although doesn't actually seem to matter.

```
\def\sqrt@ii#1[#2]{%
  \setbox\rootbox\hbox{$\m@th\scriptscriptstyle{#2}$}%
  \ifdim\wd\rootbox<6\p@%
    \setbox\rootbox\hb@xt@6\p@{\hfil\unhbox\rootbox}%
  \fi%
  \mathpalette{\sqrt@iii{#1}}%
}
```

Now we can actually build everything. Note that the root is raised by its depth – this prevents a common problem with letters with descenders.

```
\def\sqrt@iii#1#2#3{%
  \setbox\z@\hbox{$\m@th#2#1{#3}$}%
  \dimen@\ht\z@%
  \advance\dimen@-\dp\z@%
  \dimen@.6\dimen@%
  \advance\dimen@\dp\rootbox%
  \mkern-3mu%
  \raise\dimen@\copy\rootbox%
  \mkern-10mu%
  \box\z@%
}
```

Finally handle a non-numbered root. We read the rooted text in as an argument, to stop problems when people omit the braces. (AMS-TEX does this too.)

```
\def\sqrt@iv#1#2{#1{#2}}
```

`\root` We also re-implement Plain TEX's `\root` command, just in case someone uses it, and supply a star-variant. This is all very trivial.

```
\def\root{\@ifstar{\root@i\sqrtdel}{\root@i\sqrtsign}}
\def\root@i#1#2\of{\sqrt@ii{#1}[#2]}
```

2.2 Modular programming

`\pmod` Do some hacking if not `\ifouter`.

```
\def\pmod#1{%
  \ifinner\;\else\allowbreak\mkern18mu\fi%
  ({\operator@font mod}\,\,#1)%
}
```

2.3 Some magic new maths characters

`\bitor` `\bitand` `\dblor` `\dbland` `\xor` `\lor` `\ror` `\lsl` `\lsr` The new boolean operators.

```
\DeclareMathSymbol{&}{\mathbin}{operators}{`\&}
\DeclareMathSymbol{\bitand}{\mathbin}{operators}{`\&}
\def\bitor{\mathbin\mid}
\def\dblor{\mathbin{\mid\mid}}
\def\dbland{\mathbin{\mathrel\bitand\mathrel\bitand}}
\let\xor\oplus
\def\lsl{\mathbin{<\!\!<}}
\def\lsr{\mathbin{>\!\!>}}
\def\rol{\mathbin{<\!\!<\!\!<}}
```

```
\def\ror{\mathbin{>\!\!>\!\!>}}
\AtBeginDocument{\ifx\lll\@@undefined\else
  \def\lsl{\mathbin{\ll}}
  \def\lsr{\mathbin{\gg}}
  \def\rol{\mathbin{\lll}}
  \def\ror{\mathbin{\ggg}}
\fi}
```

\cat \compose \implies \vect \d \jacobi

A mixed bag of stuff.

```
\def\cat{\mathbin{\|}}
\let\compose\circ
\def\implies{\Rightarrow}
\def\vect#1{\mathord{\mathbf{#1}}}
\def\d{%
  \ifmmode\mathord{\operator@font d}%
  \else\expandafter\a\expandafter d\fi%
}
\def\jacobi#1#2{{{#1}\overwithdelims()#2}}
```

\statclose \compind

Fancy new relations for probability distributions.

```
\def\statclose{\mathrel{\mathop{=}\limits^{\scriptscriptstyle s}}}
\def\compind{\mathrel{\mathop{\approx}\limits^{\scriptscriptstyle c}}}
```

\keys \dom \ran \supp \lcm \poly \negl \ord

And the new operator names.

```
\def\keys{\mathop{\operator@font keys}\nolimits}
\def\dom{\mathop{\operator@font dom}\nolimits}
\def\ran{\mathop{\operator@font ran}\nolimits}
\def\supp{\mathop{\operator@font supp}\nolimits}
\def\lcm{\mathop{\operator@font lcm}\nolimits}
\def\poly{\mathop{\operator@font poly}\nolimits}
\def\negl{\mathop{\operator@font negl}\nolimits}
\def\ord{\mathop{\operator@font ord}\nolimits}
```

2.4 Fractions

\@frac@parse

`\@frac@parse{`⟨*stuff*⟩`}{`⟨*frac-params*⟩`}` – run ⟨*stuff*⟩ passing it three arguments: an infix fraction-making command, the 'outer' style, and the 'inner' style.

This is rather tricky. We clear a load of parameters, parse the parameter list, and then build a token list containing the right stuff. Without the token list fiddling, we end up expanding things at the wrong times – for example, `\{` expands to something terribly unpleasant in a document preamble.

All of the nastiness is contained in a group.

```
\def\@frac@parse#1#2{%
  \begingroup%
  \let\@wd\@empty\def\@ldel{.}\def\@rdel{.}%
  \def\@op{over}\let\@dim\@empty\@tempswafalse%
  \let\@is\@empty\let\@os\@empty%
  \mkparse{mdwmath:frac}{#2}%
  \toks\tw@{\endgroup#1}%
  \toks@\expandafter{\csname @@\@op\@wd\endcsname}%
  \if@tempswa%
    \toks@\expandafter{\the\expandafter\toks@\@ldel}%
```

```
    \toks@\expandafter{\the\expandafter\toks@\@rdel}%
  \fi%
  \expandafter\toks@\expandafter{\the\expandafter\toks@\@dim}%
  \toks@\expandafter{\the\toks\expandafter\tw@\expandafter{\the\toks@}}
  \toks@\expandafter{\the\expandafter\toks@\expandafter{\@os}}
  \toks@\expandafter{\the\expandafter\toks@\expandafter{\@is}}
  \the\toks@%
}
```

The keyword definitions are relatively straightforward now. The error handling for style and innerstyle could do with improvement.

```
\def\@frac@del#1#2{\def\@wd{withdelims}\@tempswatrue\def#1{#2}}
\mkdef{mdwmath:frac}{leftdelim}{\@frac@del\@ldel{#1}}
\mkdef{mdwmath:frac}{rightdelim}{\@frac@del\@rdel{#1}}
\mkdef{mdwmath:frac}{nodelims}*{\let\@wd\@empty\@tempswafalse}
\mkdef{mdwmath:frac}{line}{%
  \def\@op{above}\setlength\dimen@{#1}\edef\@dim{\the\dimen@\space}%
}
\mkdef{mdwmath:frac}{line}*{\def\@op{over}\let\@dim\@empty}
\mkdef{mdwmath:frac}{noline}*{\def\@op{atop}\let\@dim\@empty}
\def\@frac@style#1#2{%
  \ifx\q@delim#2\q@delim\let#1\@empty%
  \else%
    \expandafter\ifx\csname #2style\endcsname\relax%
      \PackageError{mdwmath}{Bad maths style `#2'}\@ehc%
    \else%
      \edef#1{\csname#2style\endcsname}%
    \fi%
  \fi%
}
\mkdef{mdwmath:frac}{style}[]{\@frac@style\@os{#1}}
\mkdef{mdwmath:frac}{innerstyle}[]{\@frac@style\@is{#1}}
```

\fracdef

Here's where the rest of the pain is. We do a preliminary parse of the parameters and 'compile' the result into the output macro. If there's no optional argument, then we don't need to do any really tedious formatting at the point of use.

```
\def\fracdef#1#2{\@frac@parse{\fracdef@i{#1}{#2}}{#2}}
\def\fracdef@i#1#2#3#4#5{\def#1{\@frac@do{#2}{#3}{#4}{#5}}}
\def\@frac@do#1#2#3#4{%
  \@ifnextchar[{\@frac@complex{#1}}{\@frac@simple{#2}{#3}{#4}}%
}
\def\@frac@complex#1[#2]{\@frac@parse\@frac@simple{#1,#2}}
\def\@frac@simple#1#2#3#4#5{{#2{{#3#4}#1{#3#5}}}}
```

\frac@fix
\@@over
\@@atop
\@@above
\@@overwithdelims
\@@atopwithdelims
\@@abovewithdelims

Finally, we need to fix up \@@over and friends. Maybe amsmath has hidden the commands away somewhere unhelpful. If not, we make the requisite copies.

```
\def\q@delim{\q@delim}
\def\frac@fix#1{\expandafter\frac@fix@i\string#1\q@delim}
\def\frac@fix@i#1#2\q@delim{\frac@fix@ii{#2}\frac@fix@ii{#2withdelims}}
\def\frac@fix@ii#1{%
  \expandafter\ifx\csname @@#1\endcsname\relax%
    \expandafter\let\csname @@#1\expandafter\endcsname\csname#1\endcsname%
  \fi%
```

```
}
\frac@fix\over \frac@fix\atop \frac@fix\above
```

\frac
\binom
\jacobi

And finally, we define the fraction-making commands.

```
\fracdef\frac{nodelims, line}
\fracdef\binom{leftdelim = (, rightdelim = ), noline}
\fracdef\jacobi{leftdelim = (, rightdelim = ), line}
```

2.5 Blackboard bold stuff

\Z
\Q
\R
\C
\N
\F
\powerset
\gf

First of all, the signs.

```
\def\Z{\mathbb{Z}}
\def\Q{\mathbb{Q}}
\def\R{\mathbb{R}}
\def\C{\mathbb{C}}
\def\N{\mathbb{N}}
\def\F{\mathbb{F}}
\def\powerset{\mathbb{P}}
\def\gf#1{\F_{#1}}
%\def\gf#1{\mathrm{GF}({#1})}
```

And now, define `\mathbb` if it's not there already.

```
\AtBeginDocument{\ifx\mathbb\@@undefined\let\mathbb\mathbf\fi}
```

2.6 Biggles

Now for some user-controlled delimiter sizing. The standard bigness of plain TEX's delimiters are all right, but it's a little limiting.

The biggness of delimiters is based on the size of the current `\strut`, which LATEX keeps up to date all the time. This will make the various delimiters grow in proportion when the text gets bigger. Actually, I'm not sure that this is exactly right – maybe it should be nonlinear,

\bbigg
\bbiggl
\bbiggr
\bbiggm

This is where the bigness is done. This is more similar to the plain TEX big delimiter stuff than to the amsmath stuff, although there's not really a lot of difference.

The two arguments are a multiplier for the delimiter size, and a small increment applied *before* the multiplication (which is optional).

This is actually a front for a low-level interface which can be called directly for efficiency.

```
\def\bbigg{\@bbigg\mathord} \def\bbiggl{\@bbigg\mathopen}
\def\bbiggr{\@bbigg\mathclose} \def\bbiggm{\@bbigg\mathrel}
```

\@bbigg

This is an optional argument parser providing a front end for the main macro `\bbigg@`.

```
\def\@bbigg#1{\@ifnextchar[{\@bigg@i{#1}}{\@bigg@i{#1}[\z@]}}
\def\@bigg@i#1[#2]#3#4{#1{\bbigg@{#2}{#3}{#4}}}
```

\bbigg@

This is it, at last. The arguments are as described above: an addition to be made to the strut height, and a multiplier. Oh, and the delimiter, of course.

This is a bit messy. The smallest 'big' delimiter, `\big`, is the same height as the current strut box. Other delimiters are $1\frac{1}{2}$, 2 and $2\frac{1}{2}$ times this height. I'll set the height of the delimiter by putting in a `\vcenter` of the appropriate size.

Given an extra height x, a multiplication factor f and a strut height h and depth d, I'll create a vcenter with total height $f(h+d+x)$. Easy, isn't it?

```
\def\bbigg@#1#2#3{%
  {\hbox{$%
    \dimen@\ht\strutbox\advance\dimen@\dp\strutbox%
    \advance\dimen@#1%
    \dimen@#2\dimen@%
    \left#3\vcenter to\dimen@{}\right.\n@space%
  $}}%
}
```

`\big` `\Big` `\bigg` `\Bigg` Now for the easy macros.

```
\def\big{\bbigg@\z@\@ne}
\def\Big{\bbigg@\z@{1.5}}
\def\bigg{\bbigg@\z@\tw@}
\def\Bigg{\bbigg@\z@{2.5}}
```

2.7 The 'QED' symbol

`\qed` `\qedrule` `\qedsymbol` This is fairly simple. Just be careful will the glue and penalties. The size of the little box is based on the current font size.

The horizontal list constructed by the macro is like this:

- A `\quad` of space. This might get eaten if there's a break here or before. That's OK, though.
- An empty box, to break a run of discardable items.
- A `\penalty 10000` to ensure that the spacing glue isn't discarded.
- `\hfill` glue to push the little rule to the end of the line.
- A little square rule '■', with some small kerns around it.
- A glue item to counter the effect of glue added at the paragraph boundary.

The vertical mode case is simpler, but less universal. It copes with relatively simple cases only.

A `\qed` commend ends the paragraph.

```
\def\qed{%
  \ifvmode%
    \unskip%
    \setbox\z@\hb@xt@\linewidth{\hfil\strut\qedsymbol}%
    \prevdepth-\@m\p@%
    \ifdim\prevdepth>\dp\strutbox%
      \dimen@\prevdepth\advance\dimen@-\dp\strutbox%
      \kern-\dimen@%
    \fi%
    \penalty\@M\vskip-\baselineskip\box\z@%
  \else%
```

```
    \unskip%
    \penalty\@M\hfill%
    \hbox{}\penalty200\quad%
    \hbox{}\penalty\@M\hfill\qedsymbol\hskip-\parfillskip\par%
  \fi%
}
\def\qedrule{{%
  \dimen@\ht\strutbox%
  \advance\dimen@\dp\strutbox%
  \dimen@ii1ex%
  \advance\dimen@-\dimen@ii%
  \divide\dimen@\tw@%
  \advance\dimen@-\dp\strutbox%
  \advance\dimen@\dimen@ii%
  \advance\dimen@ii-\dimen@%
  \kern\p@%
  \vrule\@width1ex\@height\dimen@\@depth\dimen@ii%
  \kern\p@%
}}
\providecommand\qedsymbol{\qedrule}
```

That's all there is. Byebye.

⟨/package⟩

Mark Wooding, 25 August 2003

Appendix

A The GNU General Public License

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