# The cases package*

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## Description

The cases package provides a LaTeX environment `numcases` to produce multi-case equations with a separate equation number for each case. There is also `subnumcases` which numbers each case with the overall equation number plus a letter [8a, 8b, etc.]. The syntax is

`\begin{numcases}{` ⟨*left side*⟩ `}`
⟨*case 1*⟩ `&` ⟨*explanation 1*⟩ `\\`
⟨*case 2*⟩ `&` ⟨*explanation 2*⟩ `\\`
. . .
⟨*case n*⟩ `&` ⟨*explanation n*⟩
`\end{numcases}`

Each ⟨*case*⟩ is a math formula, to be typeset in display-math mode, like in a regular numbered equation. Each ⟨*explanation*⟩ is a piece of lr-mode text (which may contain math mode in `\(...\)` or `$...$`). The explanations are optional. Equation numbers are inserted automatically, just as for the `eqnarray` environment. In particular, the `\nonumber` command suppresses an equation number and the `\label` command allows reference to a particular case. In a `subnumcases` environment, a `\label` in the ⟨*left side*⟩ of the equation gives the overall equation number, without any letter.

To use this package, include `\usepackage{cases}` after `\documentclass`, and also after `\usepackage{amsmath}` if you are using that.

* This manual corresponds to cases v3.2, dated 2020/03/29.

*Question:* Is there a `numcases*` environment for unnumbered cases?
*Answer:* That would have the natural name `cases`, and it is provided by $\mathcal{AMS}$-LaTeX (amsmath package), or by this package given the `[cases]` option. It can also be achieved by using an ordinary LaTeX array between '`\left\lbrace\ `' and '`\right.`'.

Speaking of amsmath and package options, there are differences between the style used for this package and the cases done by amsmath (see below), but cases.sty has options to increase compatibility. Here is the full list of options for this package.

**`[subnum]`** Force all `numcases` environments to be treated as `subnumcases`.

**`[amsstyle]`** For compatibility with amsmath's `cases`, make `numcases` use cramped math style (`\textstyle`), and put explanations in the same math style.

**`[casesstyle]`** Change amsmath's `cases` environment to work in the text/math style of `numcases`.

**`[cases]`** Define a `cases` environment for use without amsmath. (This is actually the same as the `[casesstyle]` option.)

**`[fleqn]`** Flush-left equation alignment, indented by `\mathindent` or `\mathmargin`. (Usually inherited from the `\documentclass` options.)

**`[leqno]`** Left-side equation numbering (usually inherited from the `\documentclass` options). This looks silly with numbered cases!

## Examples

A simple example is:

```
\begin{numcases} {|x|=}
  x, & for $x \geq 0$\\
  -x, & for $x < 0$
\end{numcases}
```

Giving:

$$|x| = \begin{cases} x, & \text{for } x \geq 0 \quad (1) \\ -x, & \text{for } x < 0 \quad (2) \end{cases}$$

Another example, employing sub-numbering, is calculating the square root of a complex number $c + id$. First compute

$$w \equiv \begin{cases} 0 & \text{for } c = d = 0 \quad \text{(3a)} \\ \sqrt{|c|}\sqrt{\dfrac{1+\sqrt{1+(d/c)^2}}{2}} & \text{for } |c| \geq |d| \quad \text{(3b)} \\ \sqrt{|d|}\sqrt{\dfrac{|c/d|+\sqrt{1+(c/d)^2}}{2}} & \text{for } |c| < |d| \quad \text{(3c)} \end{cases}$$

Then, using $w$ from eq. (3), the square root is

$$\sqrt{c+id} = \begin{cases} 0\,, & w = 0 \text{ (case 3a)} \quad (4a) \\ w + i\dfrac{d}{2w}\,, & w \neq 0,\ c \geq 0 \quad (4b) \\ \dfrac{|d|}{2w} + iw\,, & w \neq 0,\ c < 0,\ d \geq 0 \quad (4c) \\ \dfrac{|d|}{2w} - iw\,, & w \neq 0,\ c < 0,\ d < 0 \quad (4d) \end{cases}$$

These equations, eq. (3) and (4), were produced by:

```
Another example, employing sub-numbering, is calculating the square root
of a complex number $c+id$. First compute
\begin{subnumcases} {\label{weqn} w\equiv}
  0       & for $c = d = 0$\label{wzero}\\
  \sqrt{|c|}\,\sqrt{\frac{1 + \sqrt{1+(d/c)^2}}{2}} & for $|c| \geq |d|$ \\
  \sqrt{|d|}\,\sqrt{\frac{|c/d| + \sqrt{1+(c/d)^2}}{2}} & for $|c| < |d|$
\end{subnumcases}
Then, using $w$ from eq.~(\ref{weqn}), the square root is
\begin{subnumcases}{\label{sqrteqn} \sqrt{c+id}=}
  0\,,                  & $w=0$ (case \ref{wzero})\\
  w+i\frac{d}{2w}\,,    & $w \neq 0$, $c \geq 0$ \\
  \frac{|d|}{2w} + iw\,, & $w \neq 0$, $c < 0$, $d \geq 0$ \\
  \frac{|d|}{2w} - iw\,, & $w \neq 0$, $c < 0$, $d < 0$
\end{subnumcases}
```

## Compatibilibility with amsmath

When used in conjunction with amsmath.sty, the cases package will obey the the variant commands `\tag`, `\notag`, and `\mathmargin`, however the formatting details differ between amsmath's `cases` environment and `numcases`. For comparison, equation (3) formatted by amsmath and its `cases` environment may be entered as

```
\begin{equation}
\label{wams} w \equiv
\begin{cases}
 0    & \text{for}\ c = d = 0\\
 \sqrt{|c|}\,\sqrt{\frac{1+\sqrt{1+(d/c)^2}}{2}} &\text{for}\ |c| \geq |d|\\
 \sqrt{|d|}\,\sqrt{\frac{|c/d| + \sqrt{1+(c/d)^2}}{2}} &\text{for}\ |c|<|d|
\end{cases}
\end{equation}
```

which produces

$$w \equiv \begin{cases} 0 & \text{for } c = d = 0 \\ \sqrt{|c|}\sqrt{\frac{1+\sqrt{1+(d/c)^2}}{2}} & \text{for } |c| \geq |d| \\ \sqrt{|d|}\sqrt{\frac{|c/d|+\sqrt{1+(c/d)^2}}{2}} & \text{for } |c| < |d| \end{cases} \tag{5}$$

To get this more compact layout with `numcases` you can insert `\textstyle` at the beginning of each case, as needed, or use the cases package option `[amsstyle]`. To have the (unnumbered) `cases` environment give the more open layout of eq. (3) you can put `\displaystyle` at the beginning of each case, or use the option `[casesstyle]` for the cases package. (Yes these go with the cases package, they are not options for amsmath.)

Another slight difference is that the cases within `numcases` can be right-justified by inserting `\hfill` at the beginning of each, which might be desired in rare situations, like maybe the absolute value example numbered (1) and (2) above.

For full disclosure, even without any relevant package options, cases.sty will slightly adjust the `cases` environment from amsmath, by adding a little space after the left brace.

## Sub-numbering

For control of the sub-equation-numbering style, see the $\mathcal{AMS}$-LaTeX documentation for `subequations`, currently in section 3.11.3. If you are not using amsmath, that documentation still mostly applies, except the name for regular equation numbers is then 'mainequation' instead of 'parentequation'. Also, the sub-numbering style can be controlled more easily by defining `\thesubequation`. An example for capitalized letters is

```
\renewcommand\thesubequation{\themainequation.\Alph{equation}} % 13.C
```

(noting that the counter to reference is 'equation' not 'subequation').