

LaTeX Math Formatting

Variable Names, Subscripts, and Exponents

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Simple variables and subscripts

Let's play with LaTeX math syntax and learn some subtle things along the way.

There's a strong tradition in all fields that math variables are single uppercase or lowercase characters that are rendered in italic type. Except that uppercase Greek letters are set in upright type. That's the default in LaTeX and easy to write:

Example 1

LATEX INPUT

`g, G, \phi, \Phi`

RENDERED OUTPUT

g, G, ϕ, Φ

By *variable*, we mean symbols that represent values or quantities. A variable can be dimensionless like an index, or it can be a physical quantity with an assumed unit of measure like mass, energy, and time, or vectors, tensors, etc.

Subscripts that are variables are typically set in italic type, which is LaTeX's default:

Example 2

LATEX INPUT

`N_k`

RENDERED OUTPUT

N_k

Exponents

By tradition, variables used as exponents are set in italic type:

Example 3	
LATEX INPUT	N^k
RENDERED OUTPUT	N^k

If a term has both an exponent and subscript, they can be written in either order in LaTeX syntax:

Example 4	
LATEX INPUT	N^k_j , N_j^k
RENDERED OUTPUT	N_j^k, N_j^k

In that last example, notice how the exponent and subscript are aligned along the exact same slope as the italic letter of the base term. LaTeX consults the metadata in the math font to determine the slope of the italic base term.

Multi-letter variables

Some fields break tradition and use multi-letter variable names. These are discouraged by ISO 80000-2 and some publishers like IEEE and others.

However, most style guides allow multi-character names for everything else, such as unit symbols, numbers, function names, operators, acronyms, abbreviations, and descriptive labels used as sub-/superscripts. In those cases, there is a strong tradition to use upright (roman) type to distinguish them from variables.

For example, suppose we have a variable t or T for a time reference and we want to label the variable as the “starting” time. We can use the `\mathrm{}` command to tell LaTeX to consider the letters in the subscript as a single descriptor and render it in roman type:

Example 5

LATEX INPUT

 $T_\\mathrm{Start}$

RENDERED OUTPUT

 T_{Start}

(Note that it is traditional to use the quantity as the base of the term, not the descriptor, i.e., we say “ T_{Start} ” and not “ Start_T ”.)

Since they are somewhat non-traditional, house rules must determine whether multi-letter *variable* names are uppercase, lowercase, italic, or roman.

To write italic multi-letter variables, we could naively try this:

Example 6

LATEX INPUT

 $fgh=0, FGH=0$

RENDERED OUTPUT

 $fgh = 0, FGH = 0$

That caused odd spacing between the letters because LaTeX interpreted the formula as a product of the variables “f”, “g”, and “h” and added a teensy tiny sliver of a space between the letters. We can use the `\mathit{}` command to tell LaTeX that the letters form a single variable name that we want in italic type:

Example 7

LATEX INPUT

 $\mathit{fgh}=0, \mathit{FGH}=0$

RENDERED OUTPUT

 $fgh = 0, FGH = 0$

Now the letters are perfectly spaced.

To render the name in roman font, we can use the LaTeX `\mathrm{}` command:

Example 8**LATEX INPUT**

$$\mathrm{fgh}=0, \mathrm{FGH}=0$$
RENDERED OUTPUT

$$\mathrm{fgh} = 0, \mathrm{FGH} = 0$$
Multi-letter variable with exponent

There is one case that needs special attention. Suppose we want to put a variable exponent after an italic variable. It works if the base term is a single italic letter, but there's a spacing issue if the base term is multi-letter and italic. We might naively try this:

Example 9**LATEX INPUT**

$$H^k, \mathrm{FGH}^k$$
RENDERED OUTPUT

$$H^k, \mathrm{FGH}^k$$

It almost looks okay, but take a closer look at the exponent position:

After the single letter H , the exponent is positioned perfectly. But after FGH , the exponent is placed too high and with a slightly thinner horizontal spacing after the base term. LaTeX has no built-in recognition of variable exponents following a multi-letter variable name in italics. We can create a little command to fix this:

```
\newcommand*\mathitm[1]{%
  \vphantom{\mathit{#1}}%
  \smash[t]{\mathit{#1}}%
}
```

The “m” at the end of “`\mathit{m}`” stands for “multi-letter.” We can use it for multi-letter italic variable names with exponents like this:

Example 10**LATEX INPUT**

$$H^k, \mathit{FGH}^k$$
RENDERED OUTPUT

$$H^k, FGH^k$$

Now the exponents are positioned perfectly.

`\mathrm` vs `\text`

The commands `\mathrm` vs `\text` are often confused. The `\mathrm` command is used for text that is part of a formula. LaTeX will ignore spaces in the argument and render the text in a way that is consistent with the formula. The command `\text` is for text that is *not* part of a formula. LaTeX will respect spacing in the argument and adapt the text to the surrounding font style. Remember to include any necessary spaces in the argument to `\text`.

For example:

Example 11**LATEX INPUT**

$$\mathrm{timeout}=0 \text{ and } N=0$$
RENDERED OUTPUT

$$\text{timeout} = 0 \text{ and } N = 0$$