

hangulmath

Hangul jamo as mathematical symbols

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訓民正號

훈민정호 — 백성을 가르치는 바른 기호

The Correct Symbols for the Instruction of the People

나랏 수식이 로마자와 희랍자에 머물러 그 수가 넉넉디 아니할쎄, 이런 전차로 어린 수학자가 쓰고저
홀 새 변수가 이셔도 마참내 제 뜨들 시러 퍼디 못할 노미 하니라.

내 이랄 어엿비 너겨 새로 마흔 기호를 맹가노니, 학자마다 수비 니겨 날로 레이텍에 쑤메 편안케
하고저 할 따라미니라.

$$\#\{\neg, \sqcup, \sqcap, \dots, \neg, \neg\} = 19 + 21 = 40$$

병오년(2026) 한글날

Whereas the symbols of our mathematics remain confined to the Roman and Greek letters, and their number is not sufficient, many a humble mathematician, though wishing to write a new variable, has in the end been unable to express his meaning.

Taking pity on them, I have newly made forty symbols, so that every scholar may learn them with ease and use them daily in $\text{\LaTeX}$; and this is all I desire.

$$\#\{\neg, \sqcup, \sqcap, \dots, \neg, \neg\} = 19 + 21 = 40$$

Given on Hangul Day, in the year 2026

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1 Introduction

Mathematical notation draws almost entirely on the Latin and Greek alphabets, and in a long paper one easily runs out of distinct letters. The Korean alphabet, Hangul, offers a clean supply of new symbols: its letters (*jamo*) are built from simple geometric strokes, are visually distinct from Latin and Greek, and each has a well-established name.

The `hangulmath` package makes the 40 jamo of modern Hangul available in mathematics: 14 basic consonants, 5 double consonants, 10 basic vowels and 11 compound vowels. Each symbol has a command named after the letter, so $\mathfrak{A}$ is `\giyeok`, much as α is `\alpha`. Consonants also have a four-letter alias that is easy to remember (`\giug`).

$$\sum_{k=1}^n \mathfrak{A}_k^2 \leq \left(\sum_{k=1}^n \mathfrak{A}_k \right)^2, \quad \square^2 \vec{A} = -\mu_0 \vec{J}, \quad \lim_{x \rightarrow \infty} f(x) = b.$$

The symbols are taken from a bundled subset of the Noto Sans CJK KR typeface, so no Korean font needs to be installed.

2 Requirements and installation

`hangulmath` works with **pdfLaTeX**, **XeLaTeX** and **LuaLaTeX**, and with `latex` followed by `dvips` or `dvipdfmx`. It needs a LaTeX kernel from 2022 or later.

- With **XeLaTeX** and **LuaLaTeX** the symbols come from the bundled OpenType fonts, loaded with `fontspec`.
- With **pdfLaTeX** (and the DVI route) they come from the same fonts converted to Type 1 (`.pfb` with `.tfm` metrics). The outlines and advance widths are identical, so the output is the same as with XeLaTeX. The symbols are given Unicode names, and the package switches on `\pdfgentounicode`, so they can be copied and searched in the PDF.

The options `font` and `opfont` and the commands `\hangulmathfont` and `\hangulmathopfont` load other OpenType fonts and therefore need XeLaTeX or LuaLaTeX; under pdfLaTeX they are ignored with a warning.

TeX Live and MiKTeX. Once the package is distributed via CTAN it is installed with the usual package manager (`tlmgr install hangulmath`, or automatically by MiKTeX).

Manual installation. The package consists of these files:

files	texmf directory	needed for
<code>.sty</code> <code>.def</code>	<code>tex/latex/hangulmath/</code>	all engines
<code>.otf</code> (2)	<code>fonts/opentype/public/hangulmath/</code>	XeLaTeX, LuaLaTeX
<code>.pfb</code> (2)	<code>fonts/type1/public/hangulmath/</code>	pdfLaTeX, DVI
<code>.tfm</code> (2)	<code>fonts/tfm/public/hangulmath/</code>	pdfLaTeX, DVI
<code>.map</code>	<code>fonts/map/dvips/hangulmath/</code>	DVI drivers

(The two fonts are `hangulmath-sans` and `hangulmath-sans-light`.) Next to the document, the files of the first four rows are enough: copy them into the directory of your document. In a local `texmf` tree, use the directories shown, then run `mktextlsr` and

`updmap-user --enable Map=hangulmath.map`

Under pdfLaTeX the package registers the font map itself (`\pdfmapline`), so the fonts work even without `updmap`. The DVI drivers need the enabled map, or it can be given on the command line, e.g. `dvips -u +hangulmath.map`.

Overleaf. Upload the eight files of the first four rows into your project. The default compiler, pdfLaTeX, works; so do XeLaTeX and LuaLaTeX.

3 Usage

`\usepackage{hangulmath}`

...

`\giyeok + \nieun = \digeut$` or, with aliases, `\giug + \niun = \diud$`

Every symbol command works in math mode and also in running text (it uses `\ensuremath`). The symbols are ordinary math symbols (`\mathord`): they take sub- and superscripts and scale correctly in script styles. They are always set upright, whatever the surrounding text font.

`\giug_{\ah}(x)$`, `\niun^{\ih j}$`, `\giug x\niun$` $\neg_l(x)$, $\perp^j$, $X\neg x\perp$

3.1 Package options

option	meaning
<code>font=\langle font \rangle</code>	Font for the symbols, given by name or file name (XeLaTeX and LuaLaTeX only). Default: the bundled <code>hangulmath-sans.otf</code> (HangulMath Sans DemiLight).
<code>opfont=\langle font \rangle</code>	(XeLaTeX and LuaLaTeX only.) Font for the large operator forms (Section 5). Default: the bundled, lighter <code>hangulmath-sans-light.otf</code> .
<code>metrics=\langle file \rangle</code>	Name (without <code>.def</code>) of the metrics file that describes the glyphs of <code>font</code> . Default: <code>hangulmath-metrics</code> , which matches the bundled font. See Section 7.
<code>scale=\langle number \rangle</code>	Scale factor for the symbol font. Default: taken from the metrics file (about 1.24 for the bundled font).
<code>sidebearing=\langle em \rangle</code>	Space, in em, added to the left and right of each glyph. Default: 0.06.

If a requested font is not installed, `hangulmath` issues a warning and uses the bundled font instead, so that documents always compile.

3.2 Using with kotex

`hangulmath` works together with the Korean typesetting package `kotex` (`xetexko` or `luatexko`), loaded before or after it. `kotex` normally sends every Hangul character to its own Korean text font; `hangulmath` switches this off locally inside its symbols, so they always come from the symbol font, with the same size and alignment as without `kotex`.

kotex already uses the command name `\rieul` (as a josa command), so `hangulmath` leaves that name untouched and prints a warning. Write ㄹ as `\liul` instead.

\hangulsym. More generally, if any command name is already taken by another package, `hangulmath` does not overwrite it but warns, naming the alternatives. Every symbol can always be reached by name:

`$\hangulsym{rieul} = \hangulsym{liul} = \liul$` $\text{ㄹ} = \text{ㄹ} = \text{ㄹ}$

4 The symbols

4.1 Naming rules

- **Official names** follow the Revised Romanization of Korean: `\giyeok`, `\nieun`, ..., `\ssanggiyeok`.
- **Consonant aliases** have four letters: the consonant, `iu`, and the consonant again, imitating the shape of the Korean letter names (기역 $\rightarrow$ `\giug`, 니은 $\rightarrow$ `\niun`). Their first letters are all different, so the first letter alone identifies the consonant. Two adjustments are needed: ㅇ has no initial sound and is `\iung`; ㄷ is written with `c` to keep four letters, `\ciuc`. ㄹ uses `l`, its sound at the end of a syllable.
- **Double consonants** double the first letter of the alias: `\ggiug`, `\ddiud`, `\bbiub`, `\ssius`, `\jjiuj`.
- **Vowels** are written as pronounced, followed by `h`: `\ah`, `\eoh`, `\ih`. The trailing `h` avoids clashes with existing commands such as `\a`, `\o`, `\u` and `\i`. In compound vowels the glide *w* is written `u` (`\uah` for ㅘ). ㅟ is `\euih` ($\text{ㅡ} + \text{ㅣ}$) to distinguish it from ㅜ , `\uih`.

4.2 Consonants

	official	alias	Unicode		official	alias	Unicode
ㄱ	<code>\giyeok</code>	<code>\giug</code>	U+3131	ㅇ	<code>\ieung</code>	<code>\iung</code>	U+3147
ㄴ	<code>\nieun</code>	<code>\niun</code>	U+3134	ㄷ	<code>\jieut</code>	<code>\jiuj</code>	U+3148
ㄷ	<code>\digeut</code>	<code>\diud</code>	U+3137	ㄸ	<code>\chieut</code>	<code>\ciuc</code>	U+314A
ㄹ	<code>\rieul</code>	<code>\liul</code>	U+3139	ㄱ	<code>\kieuk</code>	<code>\kiuk</code>	U+314B
ㅁ	<code>\mieum</code>	<code>\mium</code>	U+3141	ㅌ	<code>\tieut</code>	<code>\tiut</code>	U+314C
ㅂ	<code>\bieup</code>	<code>\biub</code>	U+3142	ㅍ	<code>\pieup</code>	<code>\piup</code>	U+314D
ㅅ	<code>\siot</code>	<code>\sius</code>	U+3145	ㅎ	<code>\hieut</code>	<code>\hiuh</code>	U+314E

4.3 Double consonants

	official	alias	Unicode
ㄱ	<code>\ssanggiyeok</code>	<code>\ggiug</code>	U+3132
ㄷ	<code>\ssangdigeut</code>	<code>\ddiud</code>	U+3138
ㅂ	<code>\ssangbieup</code>	<code>\bbiub</code>	U+3143
ㅅ	<code>\ssangsiot</code>	<code>\ssius</code>	U+3146
ㄷ	<code>\ssangjieut</code>	<code>\jjiuj</code>	U+3149

4.4 Vowels and compound vowels

command	Unicode	command	Unicode
Ḥ	<code>\ah</code> U+314F	Ḥ	<code>\aeh</code> U+3150
Ḧ	<code>\yah</code> U+3151	Ḧ	<code>\yaeh</code> U+3152
Ḩ	<code>\eoh</code> U+3153	Ḩ	<code>\eh</code> U+3154
Ḫ	<code>\yeoh</code> U+3155	Ḫ	<code>\yeh</code> U+3156
Ḭ	<code>\oh</code> U+3157	Ḭ	<code>\uah</code> U+3158
Ḯ	<code>\yoh</code> U+315B	Ḯ	<code>\uaeh</code> U+3159
Ṁ	<code>\uh</code> U+315C	Ṁ	<code>\oeh</code> U+315A
Ṃ	<code>\yuh</code> U+3160	Ṁ	<code>\ueoh</code> U+315D
Ṅ	<code>\euh</code> U+3161	Ṃ	<code>\ueh</code> U+315E
Ṇ	<code>\ih</code> U+3163	Ṁ	<code>\uih</code> U+315F
		Ṇ	<code>\euih</code> U+3162

5 Operator forms

The symbol commands produce ordinary symbols. To use a symbol as an operator, wrap it in one of the following commands. They accept any math symbol, not only Hangul.

command	behaviour
<code>\hangulsum{<sym>}</code>	Large; in display style, limits below and above (like <code>\sum</code>).
<code>\hangulint{<sym>}</code>	Large; limits at the side (like <code>\int</code>).
<code>\hangullim{<sym>}</code>	Normal size; in display style, limits below (like <code>\lim</code>).
<code>\hangulopscale{<d>}{<t>}</code>	Sets the magnification of the large forms in display and text style (defaults 2.0 and 1.3).

The large forms are drawn with the lighter operator font (`opfont`), so that magnification does not make their strokes heavier than those of `\sum` and `\int`.

`\[ \hangulsum\tiut_{k=1}^n k^2 = \frac{n(n+1)(2n+1)}{6} \]`

$$\sum_{k=1}^n k^2 = \frac{n(n+1)(2n+1)}{6}, \quad \sum_{i=1}^m \sum_{j=1}^n a_{ij} \quad \text{vs.} \quad \sum_{i=1}^m \sum_{j=1}^n a_{ij}$$

Inline: `\sum_{k=1}^n \neg_k = \sum_{k=1}^n \neg_k`.

`\[ \hangulint\diud_{x=0}^{x=1} f(x) = a \quad \hangullim\liul_{x\to\infty} f(x) = b \]`

$$\lim_{x=0}^{x=1} f(x) = a \quad \lim_{x \rightarrow \infty} f(x) = b \quad \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n = e$$

6 More examples

Each example below shows the $\text{\LaTeX}$ input (shaded, labelled **LaTeX**) directly above its typeset result (labelled **Output**). Unless an example says otherwise, the input is math and is set in display style. The notations are suggestions, not standards; define them in your text before using them.

6.1 Vowels as brackets

The vowels $\lvert$ and $\rvert$ are mirror images, with a stroke pointing outwards like the angle brackets $\langle \rangle$. They give a Dirac notation in which a bra is $\lvert\psi\rvert$ and a ket is $\rvert\phi\rvert$. The vowels with two strokes, $\lvert\lvert$ and $\rvert\rvert$, give double brackets $\langle\!\langle \rangle\!\rangle$, as used for operators in Liouville space. Reversed pairs, with the strokes pointing inwards, make further kinds of bracket. Macros such as `\newcommand\ket[1]{\lvert\lvert\ah}` shorten the input.

LaTeX `\eoh\psi\rvert\phi\ah = \int \psi^*(x)\phi(x) dx`

Output $\lvert\psi\rvert\phi\rvert = \int \psi^*(x) \phi(x) dx$

LaTeX `\eoh\phi\rvert\psi\ah = \eoh\psi\rvert\phi\ah^*`

Output $\lvert\phi\rvert\psi\rvert = \lvert\psi\rvert\phi\rvert^*$

LaTeX `\lvert\psi\ah = \sum_n c_n\rvertn\ah, \quad c_n = \eoh n\rvert\psi\ah`

Output $\lvert\psi\rvert = \sum_n c_n \rvertn\rvert, \quad c_n = \lvertn\rvert\psi\rvert$

LaTeX `\sum_n \rvertn\ah\eoh n\rvert = \mathbf{1}`

Output $\sum_n \rvertn\rvert\lvertn\rvert = 1$

LaTeX `\eoh A\ah = \eoh\psi\rvertA\rvert\psi\ah, \quad (\Delta A)^2 = \eoh A^2\ah - \eoh A\ah^2`

Output $\lvert A\rvert = \lvert\psi\rvert A \rvert\psi\rvert, \quad (\Delta A)^2 = \lvert A^2\rvert - \lvert A\rvert^2$

LaTeX `\eoh x\rvertp\ah = \frac{1}{\sqrt{2\pi\hbar}} e^{ipx/\hbar}`

Output $\lvert x\rvert p\rvert = \frac{1}{\sqrt{2\pi\hbar}} e^{ipx/\hbar}$

LaTeX `\eoh x\rvertx'\ah = \delta(x - x')`

Output $\lvert x\rvert x'\rvert = \delta(x - x')$

LaTeX `\yeoh A\rvertB\yah = \operatorname{Tr}(A^\dagger B)`

Output $\lvert\lvert A\rvert\lvert B\rvert = \operatorname{Tr}(A^\dagger B)$

LaTeX `\frac{d}{dt}\lvert\rho\yah = \mathcal{L}\lvert\rho\yah`

Output $\frac{d}{dt}\lvert\rho\rvert = \mathcal{L}\lvert\rho\rvert$

LaTeX `\eoh A(t)\ah = \yeoh A\rverte^{\mathcal{L}t}\lvert\rho_0\yah`

Output $\lvert A(t)\rvert = \lvert A\rvert e^{\mathcal{L}t}\lvert\rho_0\rvert$

LaTeX `\ah A, B\eah = AB + BA, \quad \ah\psi(x), \psi^\dagger(y)\eah = \delta(x - y)`

Output $\vdash A, B \vdash = AB + BA, \quad \vdash \psi(x), \psi^\dagger(y) \vdash = \delta(x - y)$

LaTeX `\yah A|B\yeoh = \int_0^1 \operatorname{Tr}(A^\dagger \rho^s B \rho^{1-s}) ds`

Output $\vDash A|B \vDash = \int_0^1 \operatorname{Tr}(A^\dagger \rho^s B \rho^{1-s}) ds$

LaTeX `\aeh P, Q\eh = -(-1)^{(p-1)(q-1)}\aeh Q, P\eh, \quad \aeh\pi, \pi\eh = 0`

Output $\|P, Q\| = -(-1)^{(p-1)(q-1)} \|Q, P\|, \quad \|\pi, \pi\| = 0$

6.2 Consonants as function names

Followed by an argument, a consonant reads naturally as the name of a function. Some shapes suggest a meaning: $\daleth$ looks like a mirrored Γ , and makes a good name for the reciprocal gamma function; $\sqsubset$ is a box, the rectangle function; $\blacktriangle$ is a tent, the triangle function; and $\bigcirc$ is a disc, the circle function of optics.

LaTeX `\giug(x), \niun(x), \diud(x), \liul(x), \mium(x), \biub(x), \sius(x)`

Output $\daleth(x), \sqsubset(x), \sqsubset(x), \sqsubset(x), \sqsubset(x), \blacktriangle(x), \blacktriangle(x)$

LaTeX `\iung(x), \jiuj(x), \ciuc(x), \kiuk(x), \tiut(x), \piup(x), \hiuh(x)`

Output $\bigcirc(x), \blacktriangleright(x), \blacktriangleright(x), \blacktriangleright(x), \blacktriangleright(x), \blacktriangleright(x), \blacktriangleright(x)$

LaTeX `\ggiug(x), \ddiud(x), \bbiub(x), \ssius(x), \jjuij(x)`

Output $\daleth(x), \sqsubset(x), \sqsubset(x), \sqsubset(x), \sqsubset(x)$

LaTeX `\giug(z) = \frac{1}{\Gamma(z)}, \quad \giug(z), \giug(1-z) = \frac{\sin \pi z}{\pi}`

Output $\daleth(z) = \frac{1}{\Gamma(z)}, \quad \daleth(z) \daleth(1 - z) = \frac{\sin \pi z}{\pi}$

LaTeX `\giug(z) = z \backslash e^{\gamma z} \prod_{n=1}^{\infty} \Bigl(1 + \frac{z}{n} \Bigr) e^{-z/n}`

Output $\daleth(z) = z e^{\gamma z} \prod_{n=1}^{\infty} \left(1 + \frac{z}{n}\right) e^{-z/n}$

LaTeX `\mium(x) = \begin{cases} 1, & |x| < \frac{1}{2} \\ 0, & |x| > \frac{1}{2} \end{cases}`

Output $\sqsubset(x) = \begin{cases} 1, & |x| < \frac{1}{2} \\ 0, & |x| > \frac{1}{2} \end{cases}$

LaTeX `\sius(x) = \max(1 - |x|, 0)`

Output $\blacktriangle(x) = \max(1 - |x|, 0)$

LaTeX `\mium * \mium = \sius, \qquad \hat{\mium}(k) = \operatorname{sinc}\frac{k}{2}`

Output $\square * \square = \text{人}, \quad \hat{\square}(k) = \operatorname{sinc} \frac{k}{2}$

LaTeX `\hat{\sius}(k) = \operatorname{sinc}^2\frac{k}{2}`

Output $\hat{\lambda}(k) = \operatorname{sinc}^2 \frac{k}{2}$

LaTeX `\iung(r) = \begin{cases} 1, & r < 1 \\ 0, & r > 1 \end{cases}`

Output $\mathcal{O}(r) = \begin{cases} 1, & r < 1 \\ 0, & r > 1 \end{cases}$

LaTeX `\hat{\iung}(\rho) = \frac{J_1(2\pi\rho)}{\rho}`

Output $\hat{\mathcal{O}}(\rho) = \frac{J_1(2\pi\rho)}{\rho}$

6.3 $\mathbb{H}$ the Hamiltonian, Ξ the Lagrangian

With its two horizontal bars and two posts, $\mathbb{H}$ is a sturdy letter for the Hamiltonian; Ξ is the first consonant of 라그랑지안.

LaTeX `\piup\,,|\psi\ah = E\,,|\psi\ah`

Output $\mathbb{H} |\psi\rangle = E |\psi\rangle$

LaTeX `i\hbar\,,\frac{\partial}{\partial t}|\psi(t)\ah = \piup\,,|\psi(t)\ah`

Output $i\hbar \frac{\partial}{\partial t} |\psi(t)\rangle = \mathbb{H} |\psi(t)\rangle$

LaTeX `\piup = \frac{p^2}{2m} + V(x), \quad E_n = \langle n|\piup|n\ah`

Output $\mathbb{H} = \frac{p^2}{2m} + V(x), \quad E_n = \langle n|\mathbb{H}|n\rangle$

LaTeX `\frac{dA}{dt} = \frac{i}{\hbar}[\piup, A] + \frac{\partial A}{\partial t}`

Output $\frac{dA}{dt} = \frac{i}{\hbar} [\mathbb{H}, A] + \frac{\partial A}{\partial t}$

LaTeX `\frac{df}{dt} = \{f, \piup\}`

Output $\frac{df}{dt} = \{f, \mathbb{H}\}$

LaTeX `Z = \operatorname{Tr} e^{-\beta\piup}, \quad \rho = \frac{e^{-\beta\piup}}{Z}`

Output $Z = \operatorname{Tr} e^{-\beta\mathbb{H}}, \quad \rho = \frac{e^{-\beta\mathbb{H}}}{Z}$

LaTeX `F = -\frac{1}{\beta}\ln Z`

Output
$$F = -\frac{1}{\beta} \ln Z$$

LaTeX `\eoh q_f|e^{-i\piup t/\hbar}|q_i\ah = \int \mathcal{D}q\; e^{iS[q]/\hbar}`

Output
$$\langle q_f | e^{-i\Pi t/\hbar} | q_i \rangle = \int \mathcal{D}q \, e^{iS[q]/\hbar}$$

LaTeX `S[q] = \int \liul\,dt`

Output
$$S[q] = \int \varpi \, dt$$

LaTeX `\frac{d}{dt}\frac{\partial \liul}{\partial \dot q} = \frac{\partial \varpi}{\partial q}`

Output
$$\frac{d}{dt} \frac{\partial \varpi}{\partial \dot{q}} = \frac{\partial \varpi}{\partial q}$$

LaTeX `\piup = p\,\dot q - \liul`

Output
$$\Pi = p \dot{q} - \varpi$$

LaTeX `\dot q = \frac{\partial \piup}{\partial p}`

Output
$$\dot{q} = \frac{\partial \Pi}{\partial p}$$

LaTeX `\dot p = -\frac{\partial \piup}{\partial q}`

Output
$$\dot{p} = -\frac{\partial \Pi}{\partial q}$$

LaTeX `\liul = -\tfrac{1}{4} F_{\mu\nu} F^{\mu\nu} + \bar{\psi} \gamma^\mu D_\mu \psi - m \bar{\psi} \psi`

Output
$$\varpi = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + \bar{\psi} (i\gamma^\mu D_\mu - m) \psi$$

6.4 大 as a superscript mark

Set as a superscript, 大 joins the prime, the asterisk and the dagger as a mark for a new kind of conjugate, dual or distinguished point.

LaTeX `A', \quad A^*, \quad A^\dagger, \quad A^\text{大}`

Output
$$A', \quad A^*, \quad A^\dagger, \quad A^\text{大}$$

LaTeX `(AB)^\text{大} = B^\text{大} A^\text{大}, \quad (A^\text{大})^\text{大} = A`

Output
$$(AB)^\text{大} = B^\text{大} A^\text{大}, \quad (A^\text{大})^\text{大} = A$$

LaTeX `\eoh\psi|A\phi\ah = \eoh A^\text{大}\psi|\phi\ah`

Output
$$\langle \psi | A \phi \rangle = \langle A^\text{大} \psi | \phi \rangle$$

LaTeX	<code>f^{\ciuc}(y) = \sup_x \bigr(xy - f(x)\bigr)</code>
Output	$f^\star(y) = \sup_x (xy - f(x))$
LaTeX	<code>f^{\ciuc\ciuc} = f \quad \text{(\\$f\\$ convex)}</code>
Output	$f^{\star\star} = f \quad (f \text{ convex})$
LaTeX	<code>\piup(q,p) = \liul^{\ciuc} = \sup_{\dot q} \bigr(p\dot q - \liul(q,\dot q)\bigr)</code>
Output	$\Pi(q,p) = \varpi^\star = \sup_{\dot q} (p\dot q - \varpi(q,\dot q))$
LaTeX	<code>x^{\ciuc} = \operatorname*{arg\,min}_x f(x), \quad \qquad \nabla f(x^{\ciuc}) = 0</code>
Output	$x^\star = \operatorname*{arg\,min}_x f(x), \quad \nabla f(x^\star) = 0$
LaTeX	<code>T^{\ciuc}, \ p^{\ciuc}, \ V^{\ciuc}</code>
Output	$T^\star, \ p^\star, \ V^\star$

6.5 $\perp$, $\ll$, $\top$, π as arrows

The stroke of $\perp$ points up and that of $\top$ points down; $\ll$ and π have two strokes. They serve as arrows: spins up and down, the electrons of an oxygen atom in its orbitals, gas evolved and precipitate formed, monotone limits, and Knuth's arrow notation. Wrap them in `\mathrel` or `\mathbin` where they act as relations or operations, so that they get the right spacing.

LaTeX	<code>\sigma_z \oh\ah = + \oh\ah, \quad \sigma_z \uh\ah = - \uh\ah</code>
Output	$\sigma_z \perp\rangle = + \perp\rangle, \quad \sigma_z \top\rangle = - \top\rangle$
LaTeX	<code>S_+ \uh\ah = \hbar\, \oh\ah</code>
Output	$S_+ \top\rangle = \hbar \perp\rangle$
LaTeX	<code> \psi^- \rangle = \frac{1}{\sqrt{2}} \bigr(\oh\uh\ah - \uh\oh\ah\bigr)</code>
Output	$ \psi^-\rangle = \frac{1}{\sqrt{2}} (\perp\top\rangle - \top\perp\rangle)$
LaTeX	<code> \yoh\ah = \oh\oh\ah, \quad \yuh\ah = \uh\uh\ah</code>
Output	$ \ll\rangle = \perp\perp\rangle, \quad \pi\rangle = \top\top\rangle$
LaTeX	<code>1s\boxed{\oh\uh}\;;\; 2s\boxed{\oh\uh}\;;\; 2p\boxed{\oh\uh}\boxed{\oh}\boxed{\oh}</code>
Output	$1s\boxed{\perp\top} \quad 2s\boxed{\perp\top} \quad 2p\boxed{\perp\top}\boxed{\perp}\boxed{\perp}$

LaTeX	<code>\mathrm{CaCO_3} + 2\mathrm{HCl} \rightarrow \mathrm{CaCl_2} + \mathrm{H_2O} + \mathrm{CO_2}</code>
Output	$\mathrm{CaCO_3} + 2\mathrm{HCl} \rightarrow \mathrm{CaCl_2} + \mathrm{H_2O} + \mathrm{CO_2}$
LaTeX	<code>\mathrm{Ag^+} + \mathrm{Cl^-} \rightarrow \mathrm{AgCl}</code>
Output	$\mathrm{Ag^+} + \mathrm{Cl^-} \rightarrow \mathrm{AgCl}$
LaTeX	<code>\mathrm{Ba^{2+}} + \mathrm{SO_4^{2-}} \rightarrow \mathrm{BaSO_4}</code>
Output	$\mathrm{Ba^{2+}} + \mathrm{SO_4^{2-}} \rightarrow \mathrm{BaSO_4}$
LaTeX	<code>x \relax 0 \quad (x \downarrow 0)</code>
Output	$x \top 0 \quad (x \downarrow 0)$
LaTeX	<code>f_n \relax f \implies \int f_n d\mu \relax \int f d\mu</code>
Output	$f_n \perp f \implies \int f_n d\mu \perp \int f d\mu$
LaTeX	<code>a \mathbin{b} = a^b, \quad 2 \mathbin{4} = 2^{2^2} = 65536</code>
Output	$a \perp b = a^b, \quad 2 \mathbin{4} = 2^{2^2} = 65536$

6.6 Consonants as element symbols

With pre-scripts for mass and atomic numbers, consonants become the symbols of imaginary elements, and enter formulas, equations and equilibrium constants like real ones.

LaTeX	<code>{ }^{298}_{120}\mathrm{giug} \rightarrow { }^{294}_{118}\mathrm{niun} + { }^4_2\mathrm{He}</code>
Output	${}^{298}_{120}\top \rightarrow {}^{294}_{118}\sqsubset + {}^4_2\mathrm{He}$
LaTeX	<code>{ }^{14}_6\mathrm{ciuc} \rightarrow { }^{14}_7\mathrm{diud} + \mathrm{e^-} + \mathrm{\bar{\nu}_e}</code>
Output	${}^{14}_6\text{大} \rightarrow {}^{14}_7\sqsubset + e^- + \bar{\nu}_e$
LaTeX	<code>2\mathrm{giug_2} + \mathrm{iung_2} \rightleftharpoons 2\mathrm{giug_2iung}</code>
Output	$2\top_2 + \mathrm{O_2} \rightleftharpoons 2\top_2\mathrm{O}$
LaTeX	<code>K = \frac{[\mathrm{giug_2iung}]^2}{[\mathrm{giug_2}]^2[\mathrm{iung_2}]}</code>
Output	$K = \frac{[\top_2\mathrm{O}]^2}{[\top_2]^2[\mathrm{O_2}]}$
LaTeX	<code>\mathrm{ssius^{2+}} + 2\mathrm{diud^-} \rightarrow \mathrm{ssiusdiud_2}</code>
Output	$\mathbb{M}^{2+} + 2\sqsubset^- \rightarrow \mathbb{M}\sqsubset_2 \top$
LaTeX	<code>\mathrm{biubliul_3} + 3\mathrm{H_2O} \rightarrow \mathrm{biub(OH)_3} + 3\mathrm{Hliul}</code>
Output	$\mathbb{B}\Xi_3 + 3\mathrm{H_2O} \rightarrow \mathbb{B}(\mathrm{OH})_3 + 3\mathrm{H}\Xi$

LaTeX	<code>\mathrm{C_6H_{12}O_6} + 6\,\iung_2 \to 6\,\mathrm{C}\iung_2 + 6\,\mathrm{H_2}\iung</code>
Output	$\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$

6.7 Operators

The shape of $\square$ suggests the d'Alembertian (box) operator, and the operator forms of Section 5 give sums, products, integrals and limits. A large $\prod$, the first consonant of $\boxtimes$ (product), stands in for $\prod$ (here over primes p).

LaTeX	<code>\mum^2 \equiv \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}</code>
Output	$\square^2 \equiv \nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2}$

LaTeX	<code>\mum^2 A^\mu = -\mu_0 J^\mu, \quad \qqquad (\square^2 - m^2)\phi = 0</code>
Output	$\square^2 A^\mu = -\mu_0 J^\mu, \quad (\square^2 - m^2) \phi = 0$

LaTeX	<code>\zeta(s) = \hangelsum\tiut_{n\ge 1} n^{-s} = \hangelsum\giug_{p\,} (1 - p^{-s})^{-1}</code>
Output	$\zeta(s) = \sum_{n \geq 1} n^{-s} = \prod_p (1 - p^{-s})^{-1}$

LaTeX	<code>\hangelint\diud_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}</code>
Output	$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$

LaTeX	<code>\hangellim\liul_{n\to\infty} \Bigl(1 + \frac{1}{n}\Bigr)^n = e</code>
Output	$\lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n = e$

LaTeX	<code>{_2\biub_1(a,b;c;z) = \hangelsum\tiut_{n\ge 0} \frac{(a)_n(b)_n}{(c)_n n!} z^n</code>
Output	${}_2\mathsf{H}_1(a,b;c;z) = \sum_{n \geq 0} \frac{(a)_n (b)_n}{(c)_n n!} z^n$

6.8 In running text

The symbol commands also work outside math mode. This input is text, not math.

LaTeX	<code>Spin up is \$\iuh\$, spin down \$\iuh\$; also in plain text: \oh and \uh.</code>
Output	Spin up is $\uparrow$, spin down $\downarrow$; also in plain text: $\uparrow$ and $\downarrow$.

7 Using other fonts

This section applies to XeLaTeX and LuaLaTeX; pdfLaTeX always uses the bundled font. Hangul compatibility jamo are drawn small and high in the em square of most Korean fonts, with large side bearings. `hangulmath` therefore scales all glyphs by a common factor, lowers

them by a common amount so that consonants sit on the baseline, and trims each glyph to its ink. These values depend on the font and are stored in a metrics file.

To use another font, generate a metrics file with the Python script `hangulmath-metrics.py` (Python 3.10+, `pip install fonttools`):

```
python3 hangulmath-metrics.py "Nanum Gothic" -o nanum.def
```

and load it together with the font:

```
\usepackage[font={Nanum Gothic}, metrics=nanum]{hangulmath}
```

`\hangulmathfont{<font>}` and `\hangulmathopfont{<font>}` change the fonts later in the preamble.

8 Caveats

- **Look-alikes.** — resembles a minus sign and | a vertical bar. Use them with care, and say in the text which letter you mean.
- **Submissions.** Since version 0.8 the package works with pdfLaTeX, so documents using it can be compiled by arXiv and by the usual journal systems. Include the font files (`.pfb`, `.tfm`) with your sources if the server's TeX installation does not have `hangulmath` yet.
- **Name clashes.** If another package defines a command with the same name as a symbol, the other package wins and `hangulmath` warns; use the alias or `\hangulsym` (Section 3.2).
- **Searchability.** The symbols are real Unicode characters in the PDF, so they can be copied and searched.

9 Korean summary (한국어 요약)

`hangulmath`는 현대 한글 자모 40자(기본 자음 14, 쌍자음 5, 기본 모음 10, 복모음 11)를 수식 기호로 쓸 수 있게 하는 패키지입니다. pdfLaTeX, XeLaTeX, LuaLaTeX에서 모두 동작하며, 기호용 고딕체 글꼴이 OpenType과 Type 1 두 형식으로 함께 들어 있어 따로 한글 글꼴을 설치할 필요가 없습니다. 다른 글꼴을 기호로 쓰는 `font` 옵션은 XeLaTeX와 LuaLaTeX에서만 쓸 수 있습니다.

명령어는 로마자 표기법에 따른 공식 이름(`\giyeok`)과 외우기 쉬운 네 글자 약어(`\giug`)가 있습니다. 약어는 자음, `iu`, 자음의 순서이며, 쌍자음은 첫 글자를 두 번 씁니다(`\ggiug`). 모음은 소리 나는 대로 쓰고 끝에 `h`를 붙입니다(`\ah`, `\uah`).

합, 적분, 극한처럼 쓰려면 `\hangulsum`, `\hangulint`, `\hangullim`으로 감쌉니다. 모음은 괄호로도 쓸 수 있습니다. 예컨대 디랙 표기 $\langle\psi|\phi\rangle$ 를 $\langle\psi|\phi\rangle$ 로 씁니다. 6절에 예제가 더 있습니다.

$$\text{\hangulsum\texttiut}_{k=1}^n a_k \Rightarrow \sum_{k=1}^n a_k$$

10 License

Copyright © 2026 Inkyu Park. Source code and issue tracker: <https://github.com/krunyx/hangulmath>.

The package files may be distributed and/or modified under the conditions of the L^AT_EX Project Public License, version 1.3c or (at your option) any later version.

The bundled fonts `hangulmath-sans.otf` and `hangulmath-sans-light.otf` are modified (subset and renamed) versions of Noto Sans CJK KR, copyright 2014–2021 Adobe, and are distributed under the SIL Open Font License 1.1; see `OFL.txt`. They are rebuilt with `hangulmath-fonts.py`. Their Type 1 versions (`.pfb`, `.tfm`) and `hangulmath.map` are made from them with `hangulmath-type1.py` and are under the same license.

11 Change history

- v0.8 (2026/10/21)** Works with **pdfLaTeX** and with `latex + dvips/dvipdfmx`: the bundled fonts are also shipped as Type 1 fonts with TFM metrics and a map file, built by the new script `hangulmath-type1.py`. The output matches XeLaTeX, and the symbols can be copied from the PDF. Under pdfLaTeX the options `font` and `opfont` are ignored with a warning.
- v0.7 (2026/10/15)** Works with `kotex` (`xetexko` and `luatexko`) in either loading order: the symbols no longer fall into `kotex`'s Korean text font. Command names already defined by another package (such as `kotex`'s `\rieul`) are left alone with a warning instead of causing an error. New command `\hangulsym{⟨name⟩}`. New one-page example `hangulmath-minimal.tex`.
- v0.6 (2026/10/11)** Documentation: Section 6 greatly expanded, with each example shown as L^AT_EX input and typeset output: vowels as brackets, consonants as function names, Π as the Hamiltonian, ㅈ as a superscript mark, $\perp$ and $\top$ as arrows, consonants as element symbols. No change to the package code. The preface (Korean and English) rewritten as a closer parody of the Hunminjeongeum; the document preamble offers commented-out lines for choosing another Korean font.
- v0.5 (2026/10/10)** First public release.