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 젼차로 어린 수학자가 쓰고져 홀 새 변수가 이셔도 마참내 제 뜨들 시러 펴디 몯할 노미 하니라.

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

$$\#\{\text{ㄱ}, \text{ㄴ}, \text{ㄷ}, \ldots, \text{ㅟ}, \text{ㅢ}\} = 19 + 21 = 40$$

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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 LaTeX; and this is all I desire.

$$\#\{\text{ㄱ}, \text{ㄴ}, \text{ㄷ}, \ldots, \text{ㅟ}, \text{ㅢ}\} = 19 + 21 = 40$$

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 ㄱ is `\giyeok`, much as α is `\alpha`. Consonants also have a four-letter alias that is easy to remember (`\giug`).

$$ㄱㅏ(x) = \sum_{k} ㄴ_{k}\, x^{k}, \qquad □^{2}\vec{A} = -\mu_{0}\vec{J}, \qquad ㅣ\psi|\phi ㅏ = \int \psi^{*}\phi \, dx.$$

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 option `font` and the command `\hangulmathfont` load another OpenType font 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
`.sty .def`	`tex/latex/hangulmath/`	all engines
`.otf`	`fonts/opentype/public/hangulmath/`	XeLaTeX, LuaLaTeX
`.pfb`	`fonts/type1/public/hangulmath/`	pdfLaTeX, DVI
`.tfm`	`fonts/tfm/public/hangulmath/`	pdfLaTeX, DVI
`.map`	`fonts/map/dvips/hangulmath/`	DVI drivers

The font is `hangulmath-sans` in each format. To use the package without installing it (for example on Overleaf), copy these files into the directory of your document:

- pdfLaTeX (4 files): `hangulmath.sty`, `hangulmath-metrics.def`, `hangulmath-sans.pfb`, `hangulmath-sans.tfm`;

- XeLaTeX or LuaLaTeX (3 files): `hangulmath.sty`, `hangulmath-metrics.def`, `hangulmath-sans.otf`.

In a local `texmf` tree, use the directories shown, then run `mktexlsr` 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.

`$\giug_{\ah}(x)$, $\niun^{\ih j}$, $X\giug x\niun$` $\neg_{\vdash}(x)$, $\llcorner^{|j}$, $X\neg x\llcorner$

3.1 Package options

option	meaning
`font=`⟨*font*⟩	Font for the symbols, given by name or file name (XeLaTeX and LuaLaTeX only). Default: the bundled `hangulmath-sans.otf` (HangulMath Sans DemiLight).
`metrics=`⟨*file*⟩	Name (without `.def`) of the metrics file that describes the glyphs of `font`. Default: `hangulmath-metrics`, which matches the bundled font. See Section 6.
`scale=`⟨*number*⟩	Scale factor for the symbol font. Default: taken from the metrics file (about 1.24 for the bundled font).
`sidebearing=`⟨*em*⟩	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:

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

ㄹ = ㄹ = 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 → `\giug`, 니은 → `\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`; ㅊ 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). ㅢ is `\euih` (ㅡ + ㅣ) to distinguish it from ㅟ, `\uih`.

4.2 Consonants

	official	alias	Unicode
ㄱ	\giyeok	\giug	U+3131
ㄴ	\nieun	\niun	U+3134
ㄷ	\digeut	\diud	U+3137
ㄹ	\rieul	\liul	U+3139
ㅁ	\mieum	\mium	U+3141
ㅂ	\bieup	\biub	U+3142
ㅅ	\siot	\sius	U+3145

	official	alias	Unicode
ㅇ	\ieung	\iung	U+3147
ㅈ	\jieut	\jiuj	U+3148
ㅊ	\chieut	\ciuc	U+314A
ㅋ	\kieuk	\kiuk	U+314B
ㅌ	\tieut	\tiut	U+314C
ㅍ	\pieup	\piup	U+314D
ㅎ	\hieut	\hiuh	U+314E

4.3 Double consonants

	official	alias	Unicode
ㄲ	\ssanggiyeok	\ggiug	U+3132
ㄸ	\ssangdigeut	\ddiud	U+3138
ㅃ	\ssangbieup	\bbiub	U+3143
ㅆ	\ssangsiot	\ssius	U+3146
ㅉ	\ssangjieut	\jjiuj	U+3149

4.4 Vowels and compound vowels

	command	Unicode
ㅏ	\ah	U+314F
ㅑ	\yah	U+3151
ㅓ	\eoh	U+3153
ㅕ	\yeoh	U+3155
ㅗ	\oh	U+3157
ㅛ	\yoh	U+315B
ㅜ	\uh	U+315C
ㅠ	\yuh	U+3160
ㅡ	\euh	U+3161
ㅣ	\ih	U+3163

	command	Unicode
ㅐ	\aeh	U+3150
ㅒ	\yaeh	U+3152
ㅔ	\eh	U+3154
ㅖ	\yeh	U+3156
ㅘ	\uah	U+3158
ㅙ	\uaeh	U+3159
ㅚ	\oeh	U+315A
ㅝ	\ueoh	U+315D
ㅞ	\ueh	U+315E
ㅟ	\uih	U+315F
ㅢ	\euih	U+3162

5 More examples

Each example below shows the 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.

5.1 Vowels as brackets

The vowels ㅓ and ㅏ are mirror images, with a stroke pointing outwards like the angle brackets $\langle\ \rangle$. They give a Dirac notation in which a bra is ㅓψ| and a ket is |ϕㅏ. The vowels with two strokes, ㅕ and ㅑ, 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]{|#1\ah}` shorten the input.

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

Output

$$\text{ㅓ}\psi|\phi\text{ㅏ} = \int \psi^*(x)\,\phi(x)\,dx$$

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

Output

$$\text{ㅓ}\phi|\psi\text{ㅏ} = \text{ㅓ}\psi|\phi\text{ㅏ}^*$$

LaTeX
```
|\psi\ah = \sum_n c_n\,|n\ah, \qquad c_n = \eoh n|\psi\ah
```
Output
$$|\psi\rangle = \sum_n c_n\,|n\rangle, \qquad c_n = \langle n|\psi\rangle$$

LaTeX
```
\sum_n |n\ah\eoh n| = \mathbf{1}
```
Output
$$\sum_n |n\rangle\langle n| = \mathbf{1}$$

LaTeX
```
\eoh A\ah = \eoh\psi|A|\psi\ah, \qquad (\Delta A)^2 = \eoh A^2\ah - \eoh A\ah^2
```
Output
$$\langle A\rangle = \langle\psi|A|\psi\rangle, \qquad (\Delta A)^2 = \langle A^2\rangle - \langle A\rangle^2$$

LaTeX
```
\eoh x|p\ah = \frac{1}{\sqrt{2\pi\hbar}}\,e^{ipx/\hbar}
```
Output
$$\langle x|p\rangle = \frac{1}{\sqrt{2\pi\hbar}}\,e^{ipx/\hbar}$$

LaTeX
```
\eoh x|x'\ah = \delta(x - x')
```
Output
$$\langle x|x'\rangle = \delta(x - x')$$

LaTeX
```
\yeoh A|B\yah = \operatorname{Tr}(A^\dagger B)
```
Output
$$\langle\langle A|B\rangle\rangle = \mathrm{Tr}(A^\dagger B)$$

LaTeX
```
\frac{d}{dt}|\rho\yah = \mathcal{L}\,|\rho\yah
```
Output
$$\frac{d}{dt}|\rho\rangle\rangle = \mathcal{L}\,|\rho\rangle\rangle$$

LaTeX
```
\eoh A(t)\ah = \yeoh A|e^{\mathcal{L}t}|\rho_0\yah
```
Output
$$\langle A(t)\rangle = \langle\langle A|e^{\mathcal{L}t}|\rho_0\rangle\rangle$$

LaTeX
```
\ah A, B\eoh = AB + BA, \qquad \ah\psi(x), \psi^\dagger(y)\eoh = \delta(x - y)
```
Output
$$[A, B\} = AB + BA, \qquad [\psi(x), \psi^\dagger(y)\} = \delta(x - y)$$

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

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

5.2 Consonants as function names

Followed by an argument, a consonant reads naturally as the name of a function. Some shapes suggest a meaning: ㄱ looks like a mirrored Γ, and makes a good name for the reciprocal gamma function; ㅁ is a box, the rectangle function; ㅅ is a tent, the triangle function; and ㅇ is a disc, the circle function of optics.

LaTeX
```
\giug(x),\ \niun(x),\ \diud(x),\ \liul(x),\ \mium(x),\ \biub(x),\ \sius(x)
```
Output
$$\text{ㄱ}(x),\ \text{ㄴ}(x),\ \text{ㄷ}(x),\ \text{ㄹ}(x),\ \text{ㅁ}(x),\ \text{ㅂ}(x),\ \text{ㅅ}(x)$$

LaTeX
```
\iung(x),\ \jiuj(x),\ \ciuc(x),\ \kiuk(x),\ \tiut(x),\ \piup(x),\ \hiuh(x)
```
Output
$$\text{ㅇ}(x),\ \text{ㅈ}(x),\ \text{ㅊ}(x),\ \text{ㅋ}(x),\ \text{ㅌ}(x),\ \text{ㅍ}(x),\ \text{ㅎ}(x)$$

LaTeX
```
\ggiug(x),\ \ddiud(x),\ \bbiub(x),\ \ssius(x),\ \jjiuj(x)
```
Output
$$\text{ㄲ}(x),\ \text{ㄸ}(x),\ \text{ㅃ}(x),\ \text{ㅆ}(x),\ \text{ㅉ}(x)$$

LaTeX
```
\giug(z) = \frac{1}{\Gamma(z)}, \qquad \giug(z)\,\giug(1-z) = \frac{\sin\pi z}{\pi}
```
Output
$$\text{ㄱ}(z) = \frac{1}{\Gamma(z)}, \qquad \text{ㄱ}(z)\,\text{ㄱ}(1-z) = \frac{\sin \pi z}{\pi}$$

LaTeX
```
\giug(z) = z\,e^{\gamma z}\prod_{n=1}^{\infty}\Bigl(1 + \frac{z}{n}\Bigr)e^{-z/n}
```
Output
$$\text{ㄱ}(z) = z\,e^{\gamma z}\prod_{n=1}^{\infty}\Bigl(1+\frac{z}{n}\Bigr)e^{-z/n}$$

LaTeX
```
\mium(x) = \begin{cases} 1, & |x| < \frac12 \\ 0, & |x| > \frac12 \end{cases}
```
Output
$$\text{ㅁ}(x) = \begin{cases} 1, & |x| < \frac{1}{2} \\ 0, & |x| > \frac{1}{2} \end{cases}$$

LaTeX
```
\sius(x) = \max(1 - |x|, 0)
```
Output
$$\text{ㅅ}(x) = \max(1 - |x|, 0)$$

LaTeX
```
\mium * \mium = \sius, \qquad \hat{\mium}(k) = \operatorname{sinc}\frac{k}{2}
```
Output
$$\text{ㅁ} * \text{ㅁ} = \text{ㅅ}, \qquad \hat{\text{ㅁ}}(k) = \operatorname{sinc}\frac{k}{2}$$

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

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

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

Output

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

5.3 ㅍ the Hamiltonian, ㄹ the Lagrangian

With its two horizontal bars and two posts, ㅍ is a sturdy letter for the Hamiltonian; ㄹ is the first consonant of 라그랑지안.

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

Output

$$\text{ㅍ}\,|\psi\rangle = E\,|\psi\rangle$$

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

Output

$$i\hbar\,\frac{\partial}{\partial t}|\psi(t)\rangle = \text{ㅍ}\,|\psi(t)\rangle$$

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

Output

$$\text{ㅍ} = \frac{p^2}{2m} + V(x), \qquad E_n = \langle n|\text{ㅍ}|n\rangle$$

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

Output

$$\frac{dA}{dt} = \frac{i}{\hbar}[\text{ㅍ}, A] + \frac{\partial A}{\partial t}$$

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

Output

$$\frac{df}{dt} = \{f, \text{ㅍ}\}$$

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

Output

$$Z = \operatorname{Tr} e^{-\beta\text{ㅍ}}, \qquad \rho = \frac{e^{-\beta\text{ㅍ}}}{Z}$$

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

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

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

Output

$$S[q] = \int \text{ㄹ}\,dt$$

LaTeX
```
\frac{d}{dt}\frac{\partial\liul}{\partial\dot q}=\frac{\partial\liul}{\partial q}
```
Output
$$\frac{d}{dt}\frac{\partial \text{ㄹ}}{\partial \dot{q}} = \frac{\partial \text{ㄹ}}{\partial q}$$

LaTeX
```
\piup = p\,\dot q - \liul
```
Output
$$\text{ㅍ} = p\,\dot{q} - \text{ㄹ}$$

LaTeX
```
\dot q = \frac{\partial\piup}{\partial p}
```
Output
$$\dot{q} = \frac{\partial \text{ㅍ}}{\partial p}$$

LaTeX
```
\dot p = -\frac{\partial\piup}{\partial q}
```
Output
$$\dot{p} = -\frac{\partial \text{ㅍ}}{\partial q}$$

LaTeX
```
\liul = -\tfrac14 F_{\mu\nu}F^{\mu\nu} + \bar\psi\,(i\gamma^\mu D_\mu - m)\,\psi
```
Output
$$\text{ㄹ} = -\tfrac{1}{4}F_{\mu\nu}F^{\mu\nu} + \bar{\psi}\,(i\gamma^{\mu}D_{\mu} - m)\,\psi$$

5.4 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',\qquad A^*,\qquad A^\dagger,\qquad A^{\ciuc}
```
Output
$$A',\qquad A^{*},\qquad A^{\dagger},\qquad A^{\text{大}}$$

LaTeX
```
(AB)^{\ciuc} = B^{\ciuc}A^{\ciuc}, \qquad (A^{\ciuc})^{\ciuc} = A
```
Output
$$(AB)^{\text{大}} = B^{\text{大}}A^{\text{大}}, \qquad (A^{\text{大}})^{\text{大}} = A$$

LaTeX
```
\eoh\psi|A\phi\ah = \eoh A^{\ciuc}\psi|\phi\ah
```
Output
$$\text{┤}\psi|A\phi\text{├} = \text{┤}A^{\text{大}}\psi|\phi\text{├}$$

LaTeX
```
f^{\ciuc}(y) = \sup_x\bigl(xy - f(x)\bigr)
```
Output
$$f^{\text{大}}(y) = \sup_{x}\bigl(xy - f(x)\bigr)$$

LaTeX
```
f^{\ciuc\ciuc} = f \quad\text{($f$ convex)}
```
Output
$$f^{\text{大大}} = f \quad (f \text{ convex})$$

LaTeX
```
\piup(q,p) = \liul^{\ciuc} = \sup_{\dot q}\bigl(p\,\dot q - \liul(q,\dot q)\bigr)
```
Output
$$\text{ㅍ}(q,p) = \text{ㄹ}^{\text{大}} = \sup_{\dot{q}}\bigl(p\,\dot{q} - \text{ㄹ}(q,\dot{q})\bigr)$$

LaTeX
```
x^{\ciuc} = \operatorname*{arg\,min}_x f(x), \qquad \nabla f(x^{\ciuc}) = 0
```
Output

$$x^{\perp\!\!\!\perp} = \operatorname*{arg\,min}_x f(x), \qquad \nabla f(x^{\perp\!\!\!\perp}) = 0$$

LaTeX
```
T^{\ciuc},\ p^{\ciuc},\ V^{\ciuc}
```
Output

$$T^{\perp\!\!\!\perp},\ p^{\perp\!\!\!\perp},\ V^{\perp\!\!\!\perp}$$

5.5 ⊥, ⫫, ⊤, ⫪ as arrows

The stroke of ⊥ points up and that of ⊤ points down; ⫫ and ⫪ 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
```
\sigma_z|\oh\ah = +|\oh\ah, \qquad \sigma_z|\uh\ah = -|\uh\ah
```
Output

$$\sigma_z|\perp\!\!\!\perp\rangle = +|\perp\!\!\!\perp\rangle, \qquad \sigma_z|\top\rangle = -|\top\rangle$$

LaTeX
```
S_+|\uh\ah = \hbar\,|\oh\ah
```
Output

$$S_+|\top\rangle = \hbar\,|\perp\!\!\!\perp\rangle$$

LaTeX
```
|\psi^-\ah = \frac{1}{\sqrt{2}}\bigl(|\oh\uh\ah - |\uh\oh\ah\bigr)
```
Output

$$|\psi^-\rangle = \frac{1}{\sqrt{2}}\bigl(|\perp\top\rangle - |\top\perp\rangle\bigr)$$

LaTeX
```
|\yoh\ah = |\oh\oh\ah,\quad |\yuh\ah = |\uh\uh\ah
```
Output

$$|\barwedge\rangle = |\perp\perp\rangle, \quad |\veebar\rangle = |\top\top\rangle$$

LaTeX
```
1s\boxed{\oh\uh}\;\; 2s\boxed{\oh\uh}\;\; 2p\boxed{\oh\uh}\boxed{\oh}\boxed{\oh}
```
Output

$$1s\boxed{\perp\top}\ \ 2s\boxed{\perp\top}\ \ 2p\boxed{\perp\top}\boxed{\perp}\boxed{\perp}$$

LaTeX
```
\mathrm{CaCO_3 + 2HCl \to CaCl_2 + H_2O + CO_2}\,\oh
```
Output

$$\mathrm{CaCO_3 + 2HCl \to CaCl_2 + H_2O + CO_2}\,\perp$$

LaTeX
```
\mathrm{Ag^+} + \mathrm{Cl^-} \to \mathrm{AgCl}\,\uh
```
Output

$$\mathrm{Ag^+ + Cl^- \to AgCl}\,\top$$

LaTeX
```
\mathrm{Ba^{2+}} + \mathrm{SO_4^{2-}} \to \mathrm{BaSO_4}\,\uh
```
Output

$$\mathrm{Ba^{2+} + SO_4^{2-} \to BaSO_4}\,\top$$

LaTeX
```
x \mathrel{\uh} 0 \quad (x \downarrow 0)
```
Output

$$x\ \top\ 0 \quad (x \downarrow 0)$$

LaTeX
```
f_n \mathrel{\oh} f \implies \int f_n\,d\mu \mathrel{\oh} \int f\,d\mu
```

Output

$$f_n \perp f \implies \int f_n \, d\mu \perp \int f \, d\mu$$

LaTeX
```
a \mathbin{\oh} b = a^b, \qquad 2 \mathbin{\yoh} 4 = 2^{2^{2^{2}}} = 65536
```

Output

$$a \perp b = a^b, \qquad 2 \perp\!\!\!\perp 4 = 2^{2^{2^2}} = 65536$$

5.6 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
```
{}^{298}_{120}\giug \to {}^{294}_{118}\niun + {}^{4}_{2}\mathrm{He}
```

Output

$${}^{298}_{120}\text{ㄱ} \to {}^{294}_{118}\text{ㄴ} + {}^{4}_{2}\mathrm{He}$$

LaTeX
```
{}^{14}_{6}\ciuc \to {}^{14}_{7}\diud + e^- + \bar\nu_e
```

Output

$${}^{14}_{6}\text{大} \to {}^{14}_{7}\text{ㄷ} + e^- + \bar{\nu}_e$$

LaTeX
```
2\,\giug_2 + \iung_2 \rightleftharpoons 2\,\giug_2\iung
```

Output

$$2\,\text{ㄱ}_2 + \text{ㅇ}_2 \rightleftharpoons 2\,\text{ㄱ}_2\text{ㅇ}$$

LaTeX
```
K = \frac{[\giug_2\iung]^2}{[\giug_2]^2\,[\iung_2]}
```

Output

$$K = \frac{[\text{ㄱ}_2\text{ㅇ}]^2}{[\text{ㄱ}_2]^2\,[\text{ㅇ}_2]}$$

LaTeX
```
\ssius^{2+} + 2\,\diud^- \to \ssius\diud_2\,\uh
```

Output

$$\text{ㅅ}^{2+} + 2\,\text{ㄷ}^- \to \text{ㅅㄷ}_2\,\text{ㅜ}$$

LaTeX
```
\biub\liul_3 + 3\,\mathrm{H_2O} \to \biub(\mathrm{OH})_3 + 3\,\mathrm{H}\liul
```

Output

$$\text{ㅂㄹ}_3 + 3\,\mathrm{H_2O} \to \text{ㅂ}(\mathrm{OH})_3 + 3\,\mathrm{H}\text{ㄹ}$$

LaTeX
```
\mathrm{C_6H_{12}O_6} + 6\,\iung_2 \to 6\,\mathrm{C}\iung_2 + 6\,\mathrm{H_2}\iung
```

Output

$$\mathrm{C_6H_{12}O_6} + 6\,\text{ㅇ}_2 \to 6\,\mathrm{C}\text{ㅇ}_2 + 6\,\mathrm{H_2}\text{ㅇ}$$

5.7 Operators

The shape of $\square$ suggests the d'Alembertian (box) operator. A symbol can also take limits like lim, using the standard LaTeX commands `\mathop` and `\limits`; no extra command is needed.

LaTeX
```
\mium^2 \equiv \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}
```
Output
$$\square^2 \equiv \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$$

LaTeX
```
\mium^2 A^\mu = -\mu_0 J^\mu, \qquad (\mium^2 - m^2)\,\phi = 0
```
Output
$$\square^2 A^\mu = -\mu_0 J^\mu, \qquad (\square^2 - m^2)\,\phi = 0$$

LaTeX
```
\mathop{\liul}\limits_{n\to\infty}\Bigl(1 + \frac{1}{n}\Bigr)^{n} = e
```
Output
$$\operatorname*{⊒}_{n\to\infty}\left(1 + \frac{1}{n}\right)^{n} = e$$

LaTeX
```
{}_2\biub_1(a,b;c;z) = \sum_{n\ge0}\frac{(a)_n(b)_n}{(c)_n\,n!}\,z^n
```
Output
$${}_2⊟_1(a,b;c;z) = \sum_{n\ge0}\frac{(a)_n(b)_n}{(c)_n\,n!}\,z^n$$

5.8 In running text

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

LaTeX
```
Spin up is $|\oh\ah$, spin down $|\uh\ah$; also in plain text: \oh{} and \uh{}.
```
Output
Spin up is $|ㅗㅏ$, spin down $|ㅜㅏ$; also in plain text: ㅗ and ㅜ.

6 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*⟩`}` changes the font later in the preamble.

7 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.

8 Korean summary (한국어 요약)

hangulmath는 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 h를 붙입니다(`\ah`, `\uah`).

모음은 괄호로도 쓸 수 있습니다. 예컨대 디랙 표기 $\langle\psi|\phi\rangle$를 $\langle\psi\vert\phi\rangle$로 씁니다. 5절에 예제가 더 있습니다.

9 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 LaTeX Project Public License, version 1.3c or (at your option) any later version.

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

10 Change history

v0.9 (2026/10/21) The operator commands `\hangulsum`, `\hangulint`, `\hangullim` and `\hangulopscale` have been removed, together with the lighter operator font, the option `opfont` and `\hangulmathopfont`. The package now consists of a single font, so four

files are enough under pdfLaTeX and three under XeLaTeX. A symbol can still be used with limits through standard LaTeX: `\mathop{\liul}\limits_{x\to\infty}`. The option `opfont` is accepted with a warning so that old documents still compile.

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 5 greatly expanded, with each example shown as LaTeX input and typeset output: vowels as brackets, consonants as function names, ㅍ as the Hamiltonian, ㅈ as a superscript mark, ㅗ and ㅜ 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.