

ISO 31 conforming typesetting in L^AT_EX

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- 1 Introduction
- 2 The rules applied in \LaTeX
- 3 Some \LaTeX details and summary

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Why having rules and where do they come from

Like spelling rules they

- increase readability
- ease recognition
- often lead to better looking formulae

If breaking the rules increases readability you can do it, but first know them!

Different traditions different rules (Anglo-American, French, German, Russian...)

Today also an international standard: ISO-31 XI and rules for units from SI

My sources:

- Bureau international des poids et mesures (BIPM) “SI brochure”
- International Union of Pure and Applied Chemistry “Quantities, Units and Symbols in Physical Chemistry”

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Variables, parameters, functions

Variables, parameters and functions are to be set *italic* – easy: this is math mode's default. Examples:

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{and} \quad f(x) = x^2$$

Tip for symbols consisting of several letters like Reynolds number *Re* or Mach number *Ma*: use `\mathit` or even `\mathit` plus `\!`

$$Ma = F$$

$$Ma = 100 \quad \text{\mathit{M}\!a}$$

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This rule also applies to capital Greek letters! E.g use `\varPsi` instead of `\Psi` a.s.o. (amsmath). Example:

right: $\Psi(x, t) = \psi(x)\phi(t)$ wrong: $\Psi(x, t) = \psi(x)\phi(t)$

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Functions with fixed names

Mathematical functions with fixed names are to be set upright. Just use name of function `\exp (x)`, `\cos (x)`, `\sin (x)` etc.

$$\exp(x), \quad \sin(x), \quad \cos(x)$$

This also applies to Functions with fixed one letter names: $\Gamma(x)$
 If L^AT_EX doesn't know the function use e.g. `\operatorname{sgn}` for

$$\operatorname{sgn}(x) = \begin{cases} 1 & \text{if } x > 0 \\ -1 & \text{if } x < 0 \\ 0 & \text{if } x = 0 \end{cases}$$

If you often need `sgn` use `\DeclareMathOperator{\sgn}{sgn}` (amsmath). Now `\sgn` works like a “build in” function.

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Units

Units are to be set upright. Always! In all traditions! No excuses! This includes the SI-prefix for 10^{-6} μ (textcomp)

right: $r = 3 \mu\text{m}$ wrong: $r = 3\mu\text{m}$

Code of this example:

```
\text{right:} \quad r = 3 \text{ , } \text{\texttt{\textmu}\mathrm{m}}
\quad \text{\texttt{wrong:}} \quad r = 3\text{\texttt{\mu}} \text{m}
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To save time just use sistyle or siunitx: $r = \text{\texttt{\SI{30000}\{\micro m}}}$
 becomes $r = 30\,000 \mu\text{m}$

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Constants

Mathematical constants are to be set upright, physical or technical constants *italic*. Use `\mathrm`. Examples:

$$\text{right: } e^{i\pi} = -1 \quad \text{wrong: } e^{i\pi} = -1.$$

Nothing special for physical constants needed. Examples:

$$\epsilon_0 = \frac{1}{\mu_0 c_0^2} \approx 8.85 \times 10^{-12} \frac{\text{As}}{\text{Vm}}$$

Indices

Indices being variables are to be set *italic*, indices being text or abbreviation are to be set upright. Use `\mathrm`. Examples:

$$\mu_r, \quad \mu_B = \frac{e\hbar}{2m_e}, \quad T_{\text{hot}} > T_{\text{cold}}, \quad x_{\text{max}} = 7, \quad V_{\text{eff}}$$

$$a_n = \frac{1}{n^2}, \quad \sum_{i,j}^{\infty} m_{i,j}, \quad c_P > c_V$$

Matrices and vectors

No special rules for vectors. Just don't break the existing ones. → Don't use `\mathbf`, keep vectors italic. Examples:

$$Av_n = \lambda_n v_n \quad \text{with } A \in \mathbb{C}^{N \times N}, \quad v \in \mathbb{C}^N, \quad \lambda \in \mathbb{C}$$

or $\mathbf{A}v_n = \lambda_n v_n$ or $\vec{a} \cdot \vec{b} = |\vec{a}||\vec{b}| \cos \alpha$ but not $\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}||\mathbf{b}| \cos \alpha$

Create bold italic letters in math mode with `\bm` (bm)

Mathematical operators

Mathematical operators (like functions with fixed names) are to be set upright. Normally L^AT_EX knows them, like `+ \lim`, `\nabla`, `\det` etc.:

$$a + b, \quad \lim_{x \rightarrow \infty} f(x) = 0, \quad \mathbf{F} = -\nabla E_{\text{pot}}, \quad \det \mathbf{A} = 4$$

If L^AT_EX doesn't know use `\operatorname` or `\DeclareMathOperator` for multi-letter operators and `\mathrm` for single-letter operators:

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\DeclareMathOperator{\grad}{grad}
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$$\mathbf{F} = -\text{grad } E_{\text{pot}}, \quad z = x + iy \iff \text{Re } z = x \wedge \text{Im } z = y,$$

$$\mathbf{B} = \mathbf{A}^T, \quad \int x^2 dx = \frac{1}{3}x^3, \quad \frac{d^n}{dx^n} f(x)$$

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Elements and particles

Elements and particles are to be set upright. Examples:



This can be done with `\mathrm`:

```
2\mathrm H_2 + \mathrm O_2 \longrightarrow 2\mathrm{H_2 O}
```

but is *much* easier with `\ce` from mhchem:

```
\ce{2 H2 + O2 -> 2 H2O}
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Especially if it gets more complicated:

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\ce{ ^{238}U -> ^{234}Th + ^4He^{2+} + 2 e-}
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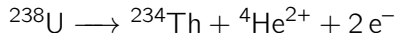
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Problems of L^AT_EX

- ① uses Anglo-American tradition: “wrong” treatment of Greek letters.
- ② Computer Modern and nearly all other free fonts don't have upright lower-case Greek letters (besides μ)
- ③ font selection and shape selection is a mess e.g.: `\mathrm` might not do what you want depending on document class and font (e.g.: beamer)
- ④ L^AT_EX is very old, development very slow: one only gets lots of important features with extra packages

Solutions to these Problems (sort of)

- ① force “correct” format: e.g.: `\varGamma` Γ instead of `\Gamma` Γ (not for $\Gamma(x)$)
- ② no good solution exists. You can
 - ignore it: $e^{i\pi} = -1 \quad \mu^- \longrightarrow e^- + \bar{\nu}_e + \nu_\mu$
 - use upgreek: $e^{i\pi} = -1 \quad \mu^- \longrightarrow e^- + \bar{\nu}_e + \nu_\mu$
 - use MinionPro
- ③ don't use `\mathrm` directly use `\newcommand{\mathup}{\mathrm}`. Replace `\mathrm` with `\textup` or `\mathsf` if necessary.
- ④ know and use the additional packages but beware of incompatibilities

Summary

In formulas **italic** are:

- variables and parameters e. g.: x or Re
- functions, e. g.: $f(x)$ or $\Psi(x)$
- physical constants, e. g.: c_0
- indices that are variables or physical quantities, e. g.: a_{ij} or c_V

and **upright** are:

- functions with fixed names, e. g.: $\sin(x)$ or $\Gamma(x)$
- mathematical constants, e. g.: π , i or e
- units and SI-prefixes, e. g.: $\lambda = 0.56 \mu\text{m}$
- indices, that are names or abbreviations, e. g.: x_{max} or μ_B
- chemical elements and particles, e. g.: H_2O or e^-
- mathematical operators, e. g.: $\mathbf{A}^T = \mathbf{B}$

The content of this talk as an article: moritz-nadler.de/formelsatz.pdf