ISO 31 conforming typesetting in LaTeX

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Outline

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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 `\!`

$$Ma = F$$

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

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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 LaTeX 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: $r = 3\,\mu\mathrm{m}$ wrong: $r = 3\mu m$

Code of this example:

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

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Constants

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

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

Nothing special for physical constants needed. Examples:

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

Indices

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

$$\mu_\mathrm{r}, \quad \mu_\mathrm{B} = \frac{e\hbar}{2m_\mathrm{e}}, \quad T_\mathrm{hot} > T_\mathrm{cold}, \quad x_\mathrm{max} = 7, \quad V_\mathrm{eff}$$

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

Matrices and vectors

Not special rules for vectors. Just don't break the existing ones. $\rightarrow$
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 $\boldsymbol{A}\boldsymbol{v}_n = \lambda_n \boldsymbol{v}_n$ 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 bolt italic letters in math mode with `\bm` (bm)

Mathematical operators

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

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

If LaTeX 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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$$\boldsymbol{F} = -\operatorname{grad} E_{\mathrm{pot}}, \quad z = x + \mathrm{i}y \Longleftrightarrow \operatorname{Re} z = x \wedge \operatorname{Im} z = y,$$

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

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Elements and particles

Elements and particles are to be set upright. Examples:

$$2\,H_2 + O_2 \longrightarrow 2\,H_2O \qquad \mu^- \longrightarrow e^- + \bar{\nu}_e + \nu_\mu$$

This can be done with `\mathrm`:

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2\mathrm H_2 + \mathrm O_2 \longrightarrow 2\mathrm{H_2 O}
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but is *much* easier with `\ce` from mhchem:

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\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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Problems of LaTeX

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. LaTeX 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` $\varGamma$ 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: $e^{i\pi} = -1 \quad \mu^- \longrightarrow e^- + \bar{\nu}_e + \upnu_\upmu$
   - 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.: $a_{i,j}$ 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.: $\lambda = 0.56\,\mu\mathrm{m}$
- indices, that are names or abbreviations, e. g.: x_{max} or μ_{B}
- chemical elements and particles, e. g.: $\mathrm{H_2O}$ or $\mathrm{e^-}$
- mathematical operators, e. g.: $\boldsymbol{A}^{\mathrm{T}} = \boldsymbol{B}$

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