The Correct Conventions
DRAFT

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0 Intro

This is the world of math and physics according to me, the author, Eric Toombs. This is mostly a personal reference to keep my own conventions straight. Maybe some day this will be a real math and physics textbook. Who knows?

Some really common stuff that everybody actually agrees on isn't in here. Other things that people do agree on are in here anyway, because the default presentation is always confusing. See for example Newtonian, Lagrangian, and Hamiltonian mechanics.

I try to choose conventions to make maximum sense, and for maximum convenience. Some conventions, though, are so widely agreed-upon, and so deeply-ingrained that they can't be changed, even if a different convention might make more sense. For example, postfix functions and postfix matrices might actually make more sense, because then the operators are in the same order that they are applied in. Changing *that*, though? No. Not this time.

Some conventions in here really are widely agreed-upon, but there are still so many opportunities for sign errors that they are in here anyway.

This is a draft. Almost everything is missing.

1 Natural numbers

The natural numbers, $\mathbb{N}$, always include 0. If you don't want the 0, use $\mathbb{N}_+ = \mathbb{N} \setminus \{0\}$.

2 τ

$$\tau = \frac{\text{circumference}}{\text{radius}} \tag{0}$$

You know it makes sense.

3 Functions

A function has a domain and an operation defining its action. The codomain is implied by the operation, or sometimes the operation is implied by the codomain.

Either way, suppose a function f agrees with g for values in the domains of both, but the domains aren't the same. Then, they are not the same functions. It is a mistake to have two such functions and give them the same label.

Similarly, a function's definition does not depend on the label used in its input. It is common, and stupid, in physics for $f(u)$ and $f(t)$ to be different functions. For example, $f(t)$ might equal $g \circ \Lambda(t)$, but physicists will give both the same label. This is a mistake.

Here is an anonymous function.

$$f = \mathbb{R}, x \mapsto x^2 \tag{1}$$

This is equivalent to

$$f \in \mathbb{R} \to \mathbb{R} \tag{2}$$
$$f(x) = x^2 \tag{3}$$

In computer science, they are called lambdas.

Sometimes, the domain is implied, in which case it can be left out of both forms of function definition. For example, in the following, $f \in \mathbb{R} \to \mathbb{R}$ is strongly implied:

$$f = x \mapsto e^x \tag{4}$$

4 Operators on functions

It happens often that one wants to apply an operator on an anonymous function. So, a shorthand was invented for that:

$$\sum \mathbb{N}, n \mapsto a^n = \sum_{n \in \mathbb{N}} a^n \tag{5}$$
$$= \sum_{n=0}^{\infty} a^n \tag{6}$$

This applies to summation, limits, differentiation, union, intersection, product, tensor product, and integration.

5 Integration

An integral is a Lebesgue integral by default. Integration happens over the function's entire domain by default. Thus the following is unambiguous:

$$\int f \tag{7}$$

6 Differentiation

7 Partial differentiation

Multi-input functions can have labelled inputs. Such a function is differentiated with respect to a label–not with respect to a number.

8 Complex differentiation

9 Complex contour integration

10 Complex area integration

11 Vectors

There is an extreme preference for column vectors. If you actually need a row vector, take a column vector and use a transpose:

$$v^\dagger H u \tag{8}$$

A row vector without such a transpose sign is a mistake.

12 Unitary generator conventions

There is the Hermitian convention H, and the antihermitian convention, A.

$$H^\dagger = H \tag{9}$$
$$A^\dagger = -A \tag{10}$$
$$H = iA \tag{11}$$
$$U(\alpha) = e^{A\alpha} = e^{-iH\alpha} \tag{12}$$

13 Laplace transform

The Laplace transform is over the entire real line.

14 Fourier transforms

There is a separate space and time Fourier transform standard, which unite to form the Minkowski space-time Fourier transform. These sign conventions then align with the sign conventions for complex space waves and time waves.

15 Units

Usually, time is measured in caesiums and $c = \hbar = e = 1$, making everything else measured in some kind of caesiums as well. Kilograms, metres, seconds, coulombs, etc. are kept, but only as unit conversions.

16 Minkowski space

The $(-,+,+,+)$ convention is used, period.

17 The EM field

18 The Klein-Gordon equation

19 The Dirac equation

20 QM polynomials

21 Newtonian, Lagrangian, and Hamiltonian mechanics

The usual way these are written is just awful, and confusing. Also, which way does the Poisson bracket go?

Example citation: [1]

References

[1] J. M. Leinaas and J. Myrheim. On the theory of identical particles. *Il Nuovo Cimento B (1971-1996)*, 37(1):1–23, Jan 1977.