

# <https://GitHub.Com/Nazgand/NazgandMathBook> Notation

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## 1 Substitution

This works similarly to Mathematica's Replace function. Example:

$$\frac{\partial}{\partial 3} 3^2 \neq \frac{\partial}{\partial x} x^2 \Big|_{x \rightarrow 3} = 2x \Big|_{x \rightarrow 3} = 6 \quad (1.1)$$

<https://reference.wolfram.com/language/ref/Replace.html>

## 2 Logic

And: Given statements  $A$  and  $B$ . The statement  $A \wedge B$  means that both statements  $A$  and  $B$  are true.

Or: Given statements  $A$  and  $B$ . The statement  $A \vee B$  means that at least 1 of the statements  $A$  or  $B$  is true.

Implies: The statement  $A \Rightarrow B$  is a conditional statement stating that if  $A$  is true, then  $B$  is true.

$A \Leftrightarrow B$  means  $[(A \Rightarrow B) \wedge (B \Rightarrow A)]$ .

Brackets: Normally, logic is read from left to right, yet sometimes brackets are used to change the order or add clarification.  
Example:  $A \vee [B \wedge C]$ .

Exists:  $\exists a$  means that some  $a$  exists.  $[\exists a, P(a)] \iff \{ \} \neq \{ a \mid P(a) \}$ .

[https://en.wikipedia.org/wiki/List\\_of\\_logic\\_symbols](https://en.wikipedia.org/wiki/List_of_logic_symbols)

Kronecker delta function:

$$\delta(0) = 1 \wedge [x \neq 0 \Rightarrow \delta(x) = 0] \quad (2.1)$$

[https://en.wikipedia.org/wiki/Kronecker\\_delta](https://en.wikipedia.org/wiki/Kronecker_delta)

## 3 Order and Equality

Equals:  $a = b$  means that  $a$  is equal to  $b$ .

[https://en.wikipedia.org/wiki/Equality\\_\(mathematics\)](https://en.wikipedia.org/wiki/Equality_(mathematics))

Greater than:  $a > b$  means that  $a$  is greater than  $b$ .  $a \geq b$  means that  $a$  is greater than or equal to  $b$ .

Less than:  $a < b$  means that  $a$  is less than  $b$ .  $a \leq b$  means that  $a$  is less than or equal to  $b$ .

[https://en.wikipedia.org/wiki/Inequality\\_\(mathematics\)](https://en.wikipedia.org/wiki/Inequality_(mathematics))

## 4 Sets

Sets: Sets either have an element or they do not have the element; no element is listed more than 1 time. Example sets are:  $\{1, 2, 3\}$ ,  $\{1, \{1, a, b\}\}$ .

Element of:  $\in$  means "is an element of". Examples:  $1 \in \{1, 2, 3\}$  and  $\{1, a, b\} \in \{1, \{1, a, b\}\}$ .

Subset:  $\subseteq$  means "is a subset of". Examples:  $\{1, 2, 3\} \subseteq \{1, 2, 3\}$  and  $\{3\} \subseteq \{1, 2, 3\}$  and  $\{ \} \subseteq \{1, 2, 3\}$ .

Union:  $A \cup B$  is the minimal set which contains all elements either  $A$  or  $B$  contain.

Intersection:  $A \cap B$  is the set which contains all elements both  $A$  and  $B$  contain.

[https://en.wikipedia.org/wiki/Set\\_\(mathematics\)](https://en.wikipedia.org/wiki/Set_(mathematics))

Set builder notation:

The set of all things  $a$  which satisfy the constraining statement  $P(a)$ :

$$\{ a \mid P(a) \} \quad (4.1)$$

The set of all things  $a$  in the set  $A$  which satisfy the statement  $P(a)$ :

$$\{ a \in A \mid P(a) \} \quad (4.2)$$

[https://en.wikipedia.org/wiki/Set-builder\\_notation](https://en.wikipedia.org/wiki/Set-builder_notation)

Integers:

$$0 \in \mathbb{Z} \wedge [a \in \mathbb{Z} \Leftrightarrow (a + 1) \in \mathbb{Z}] \tag{4.3}$$

$$\mathbb{Z}_{>0} = \{n \in \mathbb{Z} \mid n > 0\} \tag{4.4}$$

$$\mathbb{Z}_{\geq 0} = \{n \in \mathbb{Z} \mid n \geq 0\} \tag{4.5}$$

<https://en.wikipedia.org/wiki/Integer>

[https://en.wikipedia.org/wiki/Natural\\_number#Notation](https://en.wikipedia.org/wiki/Natural_number#Notation)

Rational numbers:

$$\mathbb{Q} = \left\{ \frac{a}{b} \mid a \in \mathbb{Z} \wedge b \in \mathbb{Z}_{>0} \right\} \tag{4.6}$$

$$\mathbb{Q}^+ = \{q \in \mathbb{Q} \mid q > 0\} \tag{4.7}$$

$$\mathbb{Q}^{\geq 0} = \{q \in \mathbb{Q} \mid q \geq 0\} \tag{4.8}$$

[https://en.wikipedia.org/wiki/Rational\\_number](https://en.wikipedia.org/wiki/Rational_number)

Real numbers:

$$\mathbb{R}^{\geq 0} = \{ \inf A \mid A \subseteq \mathbb{Q}^+ \wedge A \neq \{\} \} \tag{4.9}$$

$$\mathbb{R} = \{a - b \mid \{a, b\} \subseteq \mathbb{R}^{\geq 0}\} \tag{4.10}$$

$$\mathbb{R}^+ = \{a \in \mathbb{R}^{\geq 0} \mid a > 0\} \tag{4.11}$$

[https://en.wikipedia.org/wiki/Real\\_number](https://en.wikipedia.org/wiki/Real_number)

## 5 Sigma summation

$$\sum_{k \in \{ \}} f(k) = 0 \tag{5.1}$$

$$\sum_{k \in \{a\}} f(k) = f(a) \tag{5.2}$$

$$\sum_{k \in (S_1 \cup S_2)} f(k) = \left( \sum_{k \in S_1} f(k) \right) + \left( \sum_{k \in S_2} f(k) \right) - \left( \sum_{k \in (S_1 \cap S_2)} f(k) \right) \tag{5.3}$$

Shorthand

$$\sum_{k=a}^{a-1} f(k) = 0 \tag{5.4}$$

$$\sum_{k=a}^{b+1} f(k) = \left( \sum_{k=a}^b f(k) \right) + f(b+1) = f(a) + \sum_{k=a+1}^{b+1} f(k) \tag{5.5}$$

## 6 Calculus

A limit  $\lim_{a \rightarrow b} f(a)$  is the value usually approaching  $f(b)$

$n$ th derivative, not to be confused with  $f^n(x)$ :

$$f^{(n)}(x) = \frac{\partial^n}{\partial x^n} f(x) \tag{6.1}$$

[https://en.wikipedia.org/wiki/Derivative#Leibniz's\\_notation](https://en.wikipedia.org/wiki/Derivative#Leibniz's_notation)

Integrals can be thought as the area under a curve. The integral from  $a$  to  $b$  of function  $f(x)$  with respect to  $x$  is:

$$\int_a^b f(x) \, \mathrm{d}x \tag{6.2}$$

Laplace transform:

$$\mathcal{L}\{f(t)\}(s) = \int_0^\infty f(t)e^{-st} \, \mathrm{d}t \tag{6.3}$$

Laplace transform inverse:

$$\mathcal{L}^{-1}\{\mathcal{L}\{f(t)\}(s)\}(t) = f(t) \tag{6.4}$$

[https://en.wikipedia.org/wiki/Laplace\\_transform#Formal\\_definition](https://en.wikipedia.org/wiki/Laplace_transform#Formal_definition)

Modular arithmetic function,  $\text{Mod} : (\mathbb{C}, \mathbb{C}) \rightarrow \mathbb{C}$

$$0 \leq \text{Re} \left( \frac{\text{Mod}(a,b)}{b} \right) < 1 \wedge \text{Mod}(a,b) = \text{Mod}(a+b,b) \tag{6.5}$$