Winkelfunktionen

$\sin(x+y) = \sin x \cos y + \cos x \sin y$ | $\sin(z \pm \pi) = -\sin z$

$\sin(x-y) = \sin x \cos y - \cos x \sin y$ | $\cos(z \pm \pi) = -\cos z$

$\cos(x+y) = \cos x \cos y - \sin x \sin y$ | $\sin(\pi/2 - x) = \cos x$

$\cos(x-y) = \cos x \cos y + \sin x \sin y$ | $\cos(\pi/2 - x) = \sin x$

$\sin(nx) = 2\cos x \sin((n-1)x) - \sin((n-2)x)$ | $\sin(-z) = -\sin z$

$\cos(nx) = 2\cos x \cos((n-1)x) - \cos((n-2)x)$ | $\cos(-z) = \cos z$

$\cos^2 z + \sin^2 z = 1$ | $\cosh^2 z - \sinh^2 z = 1$ | $\cosh(\mathrm{i}z) = \cos z$

$\mathrm{e}^{\mathrm{i}z} = \cos z + \mathrm{i}\sin z$ | $\mathrm{e}^z = \cosh z + \sinh z$ | $\sinh(\mathrm{i}z) = \mathrm{i}\sin z$

$2\cos z = \mathrm{e}^{\mathrm{i}z} + \mathrm{e}^{-\mathrm{i}z}$ | $2\cosh z = \mathrm{e}^z + \mathrm{e}^{-z}$ | $\cos(\mathrm{i}z) = \cosh z$

$2\mathrm{i}\sin z = \mathrm{e}^{\mathrm{i}z} - \mathrm{e}^{-\mathrm{i}z}$ | $2\sinh z = \mathrm{e}^z - \mathrm{e}^{-z}$ | $\sin(\mathrm{i}z) = \mathrm{i}\sinh z$

Reihen

$\mathrm{e}^z = \sum_{k=0}^{\infty} \frac{z^k}{k!}$ | $\mathrm{e}^z = \lim_{n\to\infty}\left(1 + \frac{z}{n}\right)^n$ | $\ln z = \lim_{h\to 0} \frac{z^h - 1}{h}$

$\sin z = \sum_{k=0}^{\infty}(-1)^k \frac{z^{2k+1}}{(2k+1)!}$ | $\sinh z = \sum_{k=0}^{\infty} \frac{z^{2k+1}}{(2k+1)!}$

$\cos z = \sum_{k=0}^{\infty}(-1)^k \frac{z^{2k}}{(2k)!}$ | $\cosh z = \sum_{k=0}^{\infty} \frac{z^{2k}}{(2k)!}$

$\frac{z}{\mathrm{e}^z - 1} = \sum_{k=0}^{\infty} \overline{B}_k \frac{z^k}{k!}$ | $\ln(1-x) = (-1)\sum_{k=1}^{\infty}\frac{x^k}{k} \quad (-1 \le x < 1)$

$\frac{z}{1-\mathrm{e}^{-z}} = \sum_{k=0}^{\infty} B_k \frac{z^k}{k!}$ | $(z+1)^a = \sum_{k=0}^{\infty}\binom{a}{k} z^k \quad (a \in \mathbb{C}, |z|<1)$

$\frac{1}{1-z} = \sum_{k=0}^{\infty} z^k$ | $\frac{1}{(1-z)^n} = \sum_{k=0}^{\infty}\binom{n+k-1}{k} z^k \quad (|z|<1)$

$$f[a](z) := \mathrm{e}^{(z-a)D} f(a) = \sum_{k=0}^{\infty} \frac{f^{(k)}(a)}{k!}(z-a)^k$$

Differentialrechnung | $x_{n+1} = x_n - f(x_n)/f'(x_n)$

$f'(x) := \lim_{h\to 0} \frac{f(x+h)-f(x)}{h}$ | $T(x) = f(x_0) + f'(x_0)(x - x_0)$, $N(x) = f(x_0) - \frac{1}{f'(x_0)}(x - x_0)$

$(\mathrm{e}^x)' = \mathrm{e}^x$ | $(fg)' = f'g + g'f$

$\ln' x = 1/x$ | $(f/g)' = (f'g - g'f)/g^2$

$(a^x)' = a^x \ln a$ | $(g \circ f)' = (g' \circ f)f'$

$(x^n)' = nx^{n-1}$ | $(f^{-1})' = 1/(f' \circ f^{-1})$

$\sin' x = \cos x$ | $\tan' x = 1 + \tan^2 x = 1/\cos^2 x$

$\cos' x = -\sin x$ | $\cot' x = -1 - \cot^2 x = -1/\sin^2 x$

$\sinh' x = \cosh x$ | $\tanh' x = 1 - \tanh^2 x = 1/\cosh^2 x$

$\cosh' x = \sinh x$ | $\coth' x = 1 - \coth^2 x = -1/\sinh^2 x$

$\arcsin' x = 1/\sqrt{1-x^2}$ | $\arctan' x = 1/(1+x^2)$

$\arccos' x = -1/\sqrt{1-x^2}$ | $\mathrm{arccot}' x = -1/(1+x^2)$

$\mathrm{arsinh}' x = 1/\sqrt{x^2+1}$ | $\mathrm{artanh}' x = 1/(1-x^2)$

$\mathrm{arcosh}' x = 1/\sqrt{x^2-1}$ | $\mathrm{arcoth}' x = 1/(1-x^2)$

Integralrechnung

$\int_a^b f(x)\,\mathrm{d}x := \lim_{n\to\infty}\sum_{k=1}^{n} f\big(a + k\frac{b-a}{n}\big)\frac{b-a}{n} \quad (f \in C[a,b])$

$\int_a^b f'(x)\,\mathrm{d}x = [f(x)]_a^b := f(a) - f(b) \qquad (f \in C^1[a,b])$

$\int_a^b f(g(x))\,g'(x)\,\mathrm{d}x = \int_{g(a)}^{g(b)} f(u)\,\mathrm{d}u \quad \left(\begin{smallmatrix} f \in C(I,\mathbb{R}), \\ g \in C^1([a,b],I) \end{smallmatrix}\right)$

$\int_a^b f'(x)g(x)\,\mathrm{d}x = [f(x)g(x)]_a^b - \int_a^b f(x)g'(x)\,\mathrm{d}x \quad (f, g \in C^1)$

$t = \tan(\frac{x}{2}),\ \sin x = \frac{2t}{1+t^2},\ \cos x = \frac{1-t^2}{1+t^2},\ \mathrm{d}x = \frac{2\mathrm{d}t}{1+t^2}$

$L\{f(t)\} := \int_0^{\infty} f(t)\mathrm{e}^{-pt}\mathrm{d}t,\ F\{f(t)\} := \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(t)\mathrm{e}^{-\mathrm{i}\omega t}\mathrm{d}t$

$$\frac{\mathrm{d}}{\mathrm{d}x}\int_{a(x)}^{b(x)} f(x,t)\,\mathrm{d}t = \int_{a(x)}^{b(x)} \frac{\partial}{\partial x} f(x,t)\,\mathrm{d}t + g(x)$$

$g(x) = f(x, b(x))b'(x) - f(x, a(x))a'(x)$

Komplexe Zahlen

$z = r\mathrm{e}^{\mathrm{i}\varphi} = a + b\mathrm{i}$ | $|z| = r = \sqrt{a^2 + b^2}$

$\overline{z} = r\mathrm{e}^{-\mathrm{i}\varphi} = a - b\mathrm{i}$ | $\arg(z) = \varphi = \mathrm{sgn}(b)\arccos(a/r)$

$\operatorname{Re} z = a = r\cos\varphi$ | $z_1 + z_2 = (a_1 + a_2) + (b_1 + b_2)\mathrm{i}$

$\operatorname{Im} z = b = r\sin\varphi$ | $z_2 - z_2 = (a_1 - a_2) + (b_1 - b_2)\mathrm{i}$

$z_1 z_2 = r_1 r_2 \mathrm{e}^{\mathrm{i}(\varphi_1 + \varphi_2)} = (a_1 a_2 - b_1 b_2) + (a_1 b_2 + a_2 b_1)\mathrm{i}$

$\frac{z_1}{z_2} = \frac{r_1}{r_2}\mathrm{e}^{\mathrm{i}(\varphi_1 - \varphi_2)} = \frac{a_1 a_2 + b_1 b_2}{a_2^2 + b_2^2} + \frac{a_2 b_1 - a_1 b_2}{a_2^2 + b_2^2}\mathrm{i}$

$\frac{1}{z} = \frac{1}{r}\mathrm{e}^{-\mathrm{i}\varphi} = \frac{a}{a^2+b^2} - \frac{b}{a^2+b^2}\mathrm{i}$

Algebra

$x^2 + px + q = 0{:}\ \ x = -\frac{p}{2} \pm \frac{1}{2}\sqrt{p^2 - 4q}$

$f(x) = f(2a - x)$ (Achsensymmetrie)

$f(x) = 2b - f(2a - x)$ (Punktsymmetrie)

Lineare Algebra

$\langle Av, w\rangle = \langle v, A^H w\rangle$ | $(AB)^H = B^H A^H$

$\langle v, w\rangle = |v||w|\cos\varphi$ | $(AB)^{-1} = B^{-1}A^{-1}$

$|v \times w| = |v||w|\sin\varphi$ | $\det(AB) = \det(A)\det(B)$

$\mathrm{proj}[w](v) = \frac{\langle v,w\rangle}{\langle w,w\rangle} w, \quad w_k := v_k - \sum_{i=1}^{k-1}\mathrm{proj}[w_i](v_k)$

$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} \times \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} = \begin{pmatrix} a_2 b_3 - a_3 b_2 \\ a_3 b_1 - a_1 b_3 \\ a_1 b_2 - a_2 b_1 \end{pmatrix}$

$\begin{pmatrix} a & b \\ c & d \end{pmatrix}^{-1} = \frac{1}{ad-bc}\begin{pmatrix} d & -b \\ -c & a \end{pmatrix}, \quad R(\varphi) = \begin{pmatrix} \cos\varphi & -\sin\varphi \\ \sin\varphi & \cos\varphi \end{pmatrix}$

Polarkoordinaten

$x = r\cos\varphi$

$y = r\sin\varphi$

$\varphi \in (-\pi, \pi]$

$\det J = r$

Zylinderkoordinaten

$x = r_{xy}\cos\varphi$

$y = r_{xy}\sin\varphi$

$z = z$

$\det J = r_{xy}$

Kugelkoordinaten

$x = r\sin\theta\,\cos\varphi$

$y = r\sin\theta\,\sin\varphi$

$z = r\cos\theta$

$\varphi \in (-\pi, \pi],\ \theta \in [0, \pi]$

$\det J = r^2\sin\theta$

$\theta = \beta - \pi/2$

$\beta \in [-\pi/2, \pi/2]$

$\cos\theta = \sin\beta$

$\sin\theta = \cos\beta$

Vektoranalysis

$\nabla(|\mathbf{x}|^2) = 2\mathbf{x}$ | $\nabla(fg) = g\nabla f + f\nabla g$

$\nabla|\mathbf{x}| = \mathbf{x}/|\mathbf{x}|$ | $\nabla\langle f, g\rangle = (Df)^T g + (Dg)^T f$

$\nabla(\frac{1}{g}) = -\frac{\nabla g}{g^2}$ | $\nabla(f/g) = (g\nabla f - f\nabla g)/g^2$

$\nabla \times \nabla f = 0$ | $\langle\nabla, f\mathbf{v}\rangle = \langle\nabla f, \mathbf{v}\rangle + f\langle\nabla, \mathbf{v}\rangle$

$\langle\nabla, \nabla \times \mathbf{v}\rangle = 0$ | $\nabla \times (f\mathbf{v}) = f(\nabla \times \mathbf{v}) - \mathbf{v} \times \nabla f$

$\nabla \times \nabla \times \mathbf{v} = \nabla\langle\nabla, \mathbf{v}\rangle - \Delta\mathbf{v}$

$\langle\nabla, v \times w\rangle = \langle\mathbf{w}, \nabla \times \mathbf{v}\rangle - \langle\mathbf{v}, \nabla \times \mathbf{w}\rangle$

$\int_\gamma f\,\mathrm{d}s := \int_a^b f(t)\,|\gamma'(t)|\,\mathrm{d}t,\ \int_\gamma \langle\mathbf{F}, \mathrm{d}\mathbf{x}\rangle := \int_a^b \langle\mathbf{F}(\mathbf{x}(t)), \mathbf{x}'(t)\rangle\,\mathrm{d}t$

$\int_{\varphi(U)} f(\mathbf{x})\,\mathrm{d}\mathbf{x} = \int_U f(\varphi(\mathbf{u}))\,|\det D\varphi(\mathbf{u})|\,\mathrm{d}\mathbf{u}$

Extremwerte

$f(x) = \text{extrem} \Rightarrow f'(x) = 0,\ f(p) = \text{extrem} \Rightarrow \mathrm{d}f_p = 0$

$f(x,y) = \text{extrem unter } g(x,y) = 0 \Rightarrow \mathrm{d}f = \lambda\mathrm{d}g$

$$J[\mathbf{x}] := \int_a^b L(t, \mathbf{x}(t), \mathbf{x}'(t))\,\mathrm{d}t = \text{extrem} \Rightarrow \frac{\partial L}{\partial x_k} = \frac{\mathrm{d}}{\mathrm{d}t}\frac{\partial L}{\partial x_k'}$$

Interpolation

Linear: $p(x) = y_1 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$

Quadratisch: $p(x) = y_0 + a_1(x - x_0) + a_2(x - x_0)(x - x_1)$

$a_1 = \frac{y_1 - y_0}{x_1 - x_0}, \quad a_2 = \frac{1}{x_2 - x_1}\left(\frac{y_2 - y_0}{x_2 - x_0} - a_1\right)$

Regression

$$y = \overline{y} + \frac{s_{xy}}{s_x}(x - \overline{x}),\ s_x = \sum_{k=1}^{n}(x_k - \overline{x})^2,\ s_{xy} = \sum_{k=1}^{n}(x_k - \overline{x})(y_k - \overline{y})$$

Logik

A	B	$A \land B$	$A \lor B$	$A \to B$	$A \leftrightarrow B$	$A \oplus B$	$A \uparrow B$
0	0	0	0	1	1	0	1
0	1	0	1	1	0	1	1
1	0	0	1	0	0	1	1
1	1	1	1	1	1	0	0

Disjunktion	**Konjunktion**	**Bezeichnung**
$A \lor A \equiv A$	$A \land A \equiv A$	Idempotenzgesetze
$A \lor 0 \equiv A$	$A \land 1 \equiv A$	Neutralitätsgesetze
$A \lor 1 \equiv 1$	$A \land 0 \equiv 0$	Extremalgesetze
$A \lor \overline{A} \equiv 1$	$A \land \overline{A} \equiv 0$	Komplementärgesetze
$A \lor B \equiv B \lor A$	$A \land B \equiv B \land A$	Kommutativgesetze
$(A \lor B) \lor C \equiv A \lor (B \lor C)$	$(A \land B) \land C \equiv A \land (B \land C)$	Assoziativgesetze
$\overline{A \lor B} \equiv \overline{A} \land \overline{B}$	$\overline{A \land B} \equiv \overline{A} \lor \overline{B}$	De Morgansche Regeln
$A \lor (A \land B) \equiv A$	$A \land (A \lor B) \equiv A$	Absorptionsgesetze

$(A \to B) \equiv \overline{A} \lor B$ | $(A \leftrightarrow B) \equiv (A \to B) \land (B \to A)$

$(A \to B) \equiv (\overline{B} \to \overline{A})$ | $(A \leftrightarrow B) \equiv (\overline{A} \lor B) \land (\overline{B} \lor A)$

$A \lor \forall_x P_x \equiv \forall_x (A \lor P_x)$ | $\forall_x (P_x \land Q_x) \equiv \forall_x P_x \land \forall_x Q_x$

$A \land \exists_x P_x \equiv \exists_x (A \land P_x)$ | $\exists_x (P_x \lor Q_x) \equiv \exists_x P_x \lor \exists_x Q_x$

$(I \models M) :\Leftrightarrow \forall \varphi \in M\colon I(\varphi)$

$(\models \varphi) :\Leftrightarrow \forall I\colon I(\varphi)$ | $(M \models \varphi) :\Leftrightarrow \forall I\colon ((I \models M) \Rightarrow I(\varphi))$

$\mathrm{erf}(\varphi) :\Leftrightarrow \exists I\colon I(\varphi)$ | $\mathrm{erf}(M) :\Leftrightarrow \exists I\colon (I \models M)$

$\mathrm{erf}(\{\varphi_1, \ldots, \varphi_n\}) \Leftrightarrow \mathrm{erf}(\varphi_1 \land \ldots \land \varphi_n)$

$\mathrm{erf}(\varphi_1 \lor \ldots \lor \varphi_n) \Leftrightarrow \mathrm{erf}(\varphi_1) \lor \ldots \lor \mathrm{erf}(\varphi_n)$

$(M \vdash \varphi) \Rightarrow (M \models \varphi)$ (Korrektheit)

$(M \models \varphi) \Rightarrow (M \vdash \varphi)$ (Vollständigkeit)

$(M \cup \{\varphi\} \vdash \psi) \Leftrightarrow (M \vdash \varphi \to \psi)$

$(M \cup \{\varphi\} \models \psi) \Leftrightarrow (M \models \varphi \to \psi)$

Mengenlehre

$A \cap B := \{x \mid x \in A \land x \in B\}$ | $A \subseteq B :\Leftrightarrow \forall_x (x \in A \Rightarrow x \in B)$

$A \cup B := \{x \mid x \in A \lor x \in B\}$ | $A = B :\Leftrightarrow \forall_x (x \in A \Leftrightarrow x \in B)$

$A \setminus B := \{x \mid x \in A \land x \notin B\}$ | $A = B :\Leftrightarrow A \subseteq B \land B \subseteq A$

$\bigcap_{i \in I} A_i := \{x \mid \forall i \in I\colon x \in A_i\}$ | $f(M) := \{y \mid \exists x \in M\colon y = f(x)\}$

$\bigcup_{i \in I} A_i := \{x \mid \exists i \in I\colon x \in A_i\}$ | $f^{-1}(N) := \{x \mid f(x) \in N\}$

$A \times B := \{t \mid \exists x \in A\colon \exists y \in B\colon t = (x, y)\}$

$A \subseteq B \Leftrightarrow A \cup B = B \Leftrightarrow A \cap B = A$

$f(M \cup N) = f(M) \cup f(N)$ | $f^{-1}(M \cup N) = f^{-1}(M) \cup f^{-1}(N)$

$f(M \cap N) \subseteq f(M) \cap f(N)$ | $f^{-1}(M \cap N) = f^{-1}(M) \cap f^{-1}(N)$

$M \subseteq N \Rightarrow f(M) \subseteq f(N)$ | $M \subseteq N \Rightarrow f^{-1}(M) \subseteq f^{-1}(N)$

$(g \circ f)(M) = g(f(M))$ | $(g \circ f)^{-1}(M) = f^{-1}(g^{-1}(M))$

Kombinatorik

$$\sum_{k=m}^{n-1} q^k = \frac{q^m - q^n}{q - 1}, \quad \sum_{k=m}^{n-1} k^p q^k = \left(q \frac{\mathrm{d}}{\mathrm{d}q}\right)^p \frac{q^m - q^n}{q - 1}$$

$\sum_{k=1}^{n} k = (n/2)(n+1)$ | $\sum_{k=m}^{n-1} (\Delta a)_k = a_n - a_m$

$\sum_{k=1}^{n} k^2 = (n/6)(n+1)(2n+1)$ | $(\Delta a)_k := a_{k+1} - a_k$

$\sum_{k=1}^{n} k^3 = (n/2)^2 (n+1)^2$ | $n! = n \cdot (n-1)!$

$$(a+b)^n = \sum_{k=0}^{n} \binom{n}{k} a^{n-k} b^k, \quad \binom{n}{k} := \frac{1}{k!} n^{\underline{k}} = \frac{n!}{k!(n-k)!}$$

$$n! = \Gamma(n+1), \quad \Gamma(z+1) = z\Gamma(z), \quad \Gamma(z)\Gamma(1-z) = \frac{\pi}{\sin(\pi z)}$$

$$\binom{n+1}{k+1} = \binom{n}{k} + \binom{n+1}{k}, \quad \binom{n}{k} = \binom{n}{n-k}, \quad \binom{n}{0} = \binom{n}{n} = 1$$

$$n! \approx \sqrt{2\pi n}\, n^n \exp\left(\frac{1}{12n} - n\right) \approx \sqrt{2\pi n}\,(n/e)^n$$

Mechanik

$$\begin{array}{l|l} v = s'(t) & \omega = \varphi'(t) \\ a = v'(t) & \alpha = \omega'(t) \\ F = p'(t) & M = L'(t) \\ p = mv & L = J\omega \\ F = ma & M = J\alpha \\ E_{\text{kin}} = \frac{1}{2}mv^2 & E_{\text{rot}} = \frac{1}{2}J\omega^2 \end{array}$$

$$\begin{array}{l|l|l} s = \varphi r & M = rF & E_{\text{pot}} = mgh \\ v = \omega r & M = r \times F & E_{\text{kin}} + E_{\text{pot}} = \text{const.} \\ a = \alpha r & L = r \times p & F = Ds \quad \text{(Feder)} \end{array}$$

Gleichstrom

$$\begin{array}{l|l|l} U = RI & Q = It & GR = 1 \\ I = GU & W = Pt & \\ P = UI & W = QU & \end{array}$$

Wechselstrom

$$\begin{array}{l|l|l} \underline{U} = \underline{ZI} & \underline{Z} = R + jX & Z^2 = R^2 + X^2 \\ \underline{I} = \underline{YU} & \underline{Y} = G + jQ & R = Z\cos\varphi \\ \underline{S} = \underline{UI} & \underline{S} = P + jB & X = Z\sin\varphi \end{array}$$

$$\begin{array}{l|l|l} \underline{Z} = R & \text{Widerstand} & \omega = 2\pi f \\ \underline{Z} = jX_C & \text{Kondensator} & X_C = -1/(\omega C) \\ \underline{Z} = jX_L & \text{Spule} & X_L = \omega L \end{array}$$

$$\begin{array}{l|l} u_s = \sqrt{2}\,U_{\text{eff}} & u = u_s \sin(\omega t + \varphi_0) \\ i_s = \sqrt{2}\,I_{\text{eff}} & i = i_s \sin(\omega t + \varphi_0) \end{array}$$

Allgemeine Gleichungen

$$\begin{array}{l|l} u = Ri & p = ui \\ i = Cu'(t) & \\ u = Li'(t) & \end{array}$$

Elektrostatisches Feld

$$\begin{array}{l|l} F = \dfrac{1}{4\pi\varepsilon}\dfrac{Q_1Q_2}{r^2} & \vec{F}_1 = \dfrac{1}{4\pi\varepsilon}Q_1Q_2\dfrac{\underline{x}_1 - \underline{x}_2}{|\underline{x}_1 - \underline{x}_2|^3} \end{array}$$

$$\begin{array}{l|l|l} \vec{F} = q\underline{E} & Q = CU & U = \varphi(B) - \varphi(A) \\ \underline{D} = \varepsilon\underline{E} & \varepsilon = \varepsilon_0\varepsilon_r & W = QU \end{array}$$

$\underline{E} = -\operatorname{grad}\varphi$

$\varepsilon_0 E^2 = 2w_e$

Plattenkondensator

$U = Ed \mid C = \varepsilon A/d$

Homogenes Feld in der Spule

$Hl = NI \mid Bl = \mu NI \mid \Theta = NI$

Magnetostatisches Feld

$$\begin{array}{l|l} \vec{F} = q\underline{v} \times \underline{B} & \Phi = BA \\ F = qvB & \underline{B} = \mu\underline{H} \\ F = BIl & \mu = \mu_0\mu_r \end{array}$$

$H = I/(2\pi r)$ (Feld um einen geraden Leiter)

$B^2 = 2\mu_0 w_m$

Elektrodynamik

$E = -\nabla\varphi$

$\varepsilon\Delta\varphi = -\rho(x)$

$\varepsilon_0 E^2 = 2w_e$

$B^2 = 2\mu_0 w_m$

Maxwell-Gleichungen

$$\begin{array}{l|l} \langle\nabla, D\rangle = \rho_f(x) & \langle\nabla, \varepsilon_0 E\rangle = \rho(x) \\ \langle\nabla, B\rangle = 0 & \langle\nabla, B\rangle = 0 \\ \nabla \times E = -D_t B & \nabla \times E = -D_t B \\ \nabla \times H = J_f + D_t D & \nabla \times B = \mu_0(J + \varepsilon_0 D_t E) \end{array}$$

Spezielle Relativitätstheorie

$\gamma = \dfrac{1}{\sqrt{1-\beta^2}}, \quad \beta = v/c$

$\gamma = \cosh\varphi, \quad \beta\gamma = \sinh\varphi, \quad \beta = \tanh\varphi$

$ct' = \gamma(ct - \beta x), \quad x' = \gamma(x - vt), \quad (y,z)' = (y,z)$

$$\begin{array}{l|l} t = \gamma\tau & E_{\text{kin}} = E - E_0 \\ p = \gamma mv & E_{\text{kin}} = \gamma mc^2 - mc^2 \\ E = \gamma mc^2 & E^2 = (pc)^2 + (mc^2)^2 \end{array}$$

$$\Lambda_v = \begin{bmatrix} \gamma & -\beta\gamma & 0 & 0 \\ -\beta\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$g = \operatorname{diag}(1, -1, -1, -1)$

$(D_\mu) = (D_{ct}, D_x, D_y, D_z)$

$(D^\mu) = (D_{ct}, -D_x, -D_y, -D_z)$

Optik

$\dfrac{1}{f} = \dfrac{1}{g} + \dfrac{1}{b}, \quad A = \dfrac{B}{G} = \dfrac{b}{g}$

$n_1 \sin(\varphi_1) = n_2 \sin(\varphi_2)$

$c_0 = nc$

Thermodynamik

$$\begin{array}{l|l|l} R = N_A k_B & m = nM & V = nV_m \\ R = R_s M & m = Nm_T & N = nN_A \end{array}$$

$pV = nRT$

$\dfrac{p_1V_1}{T_1} = \dfrac{p_2V_2}{T_2}$

$Q = mc\Delta T$

Konstanten

$\varepsilon_0 = 8.8542 \times 10^{-12}\ \mathrm{C/(V\,m)}$

$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H/m}$

$c_0 = 2.9979 \times 10^{8}\ \mathrm{m/s}$

$e = 1.6022 \times 10^{-19}\ \mathrm{C}$

$G = 6.674 \times 10^{-11}\ \mathrm{m^3/(kg\,s^2)}$

$N_A = 6.0221 \times 10^{23}\ \mathrm{mol^{-1}}$

$k_B = 1.3806 \times 10^{-23}\ \mathrm{J/K}$

$R = 8.3145\ \mathrm{J/(mol\,K)}$

$0\ \mathrm{K} = -273.15\ {}^\circ\mathrm{C}$

$u = 1.6605 \times 10^{-27}\ \mathrm{kg}$

$h = 6.6261 \times 10^{-34}\ \mathrm{Js}$

$\hbar = 1.0546 \times 10^{-34}\ \mathrm{Js}$

$\sigma = 5.6704 \times 10^{-8}\ \mathrm{W/(m^2K^4)}$

$m_e = 9.1094 \times 10^{-31}\ \mathrm{kg}$

$m_p = 1.6726 \times 10^{-27}\ \mathrm{kg}$

$m_n = 1.6749 \times 10^{-27}\ \mathrm{kg}$

$m_\alpha = 6.6447 \times 10^{-27}\ \mathrm{kg}$