$$\sin(a+b) = \sin a \cos b + \sin b \cos a$$
$$\cos(a+b) = \cos a \cos b - \sin a \sin b$$
$$\begin{array}{l|l} \sin(-x) = -\sin x & \sin(\pi/2 - x) = \cos x \\ \cos(-x) = \cos x & \cos(\pi/2 - x) = \sin x \end{array}$$
$$\begin{array}{l|l} \sin^2 x + \cos^2 x = 1 & 2i \sin x = e^{ix} - e^{-ix} \\ e^{ix} = \cos x + i \sin x & 2 \cos x = e^{ix} + e^{-ix} \end{array}$$
$$\begin{array}{l|l} \cosh^2 x - \sinh^2 x = 1 & 2 \sinh x = e^{x} - e^{-x} \\ e^{x} = \cosh x + \sinh x & 2 \cosh x = e^{x} + e^{-x} \end{array}$$
$$\cos(2x) = 1 - 2\sin^2 x = 2\cos^2 x - 1$$
$$\sin(nx) = 2\cos x \sin((n-1)x) - \sin((n-2)x)$$
$$\cos(nx) = 2\cos x \cos((n-1)x) - \cos((n-2)x)$$
$$s_n = a_1 + \ldots + a_n$$
$$\begin{array}{l|l} a_k = k & s_n = (n/2)(n+1) \\ a_k = k^2 & s_n = (n/6)(n+1)(2n+1) \\ a_k = k^3 & s_n = (n/2)^2(n+1)^2 \end{array}$$
$$\sum_{k=a}^{b-1} q^k = \frac{q^b - q^a}{q-1}, \quad \sum_{k=a}^{b-1} k^m q^k = \left(q \frac{\mathrm{d}}{\mathrm{d}q}\right)^m \frac{q^b - q^a}{q-1}$$
$$e^x = \sum_{k=0}^{\infty} \frac{x^k}{k!}, \quad \frac{x}{e^x - 1} = \sum_{k=0}^{\infty} \overline{B}_k \frac{x^k}{k!}, \quad \frac{1}{1-x} = \sum_{k=0}^{\infty} x^k$$
$$e^x = \lim_{n\to\infty} \left(1 + \frac{x}{n}\right)^n, \quad \ln x = \lim_{h \to 0} \frac{x^h - 1}{h}$$
$$\ln(1-x) = (-1) \sum_{k=1}^{\infty} \frac{x^k}{k} \quad (-1 \le x < 1)$$
$$\begin{array}{l|l} \sin x = \displaystyle\sum_{k=0}^{\infty} (-1)^k \frac{x^{2k+1}}{(2k+1)!} & \sinh x = \displaystyle\sum_{k=0}^{\infty} \frac{x^{2k+1}}{(2k+1)!} \\ \cos x = \displaystyle\sum_{k=0}^{\infty} (-1)^k \frac{x^{2k}}{(2k)!} & \cosh x = \displaystyle\sum_{k=0}^{\infty} \frac{x^{2k}}{(2k)!} \end{array}$$
$$(x+1)^n = \sum_{k=0}^{\infty} \binom{n}{k} x^k \quad (|x| < 1)$$
$$\frac{1}{(1-x)^n} = \sum_{k=0}^{\infty} \binom{n+k-1}{k} x^k \quad (|x| < 1)$$
$$x_{n+1} = \varphi(x_n), \quad \varphi(x) = x - f(x)/f'(x)$$
$$f(x+h) \overset{??}{=} \sum_{k=0}^{\infty} \frac{\langle h, \nabla \rangle^k}{k!} f(x) = e^{\langle h, \nabla \rangle} f(x)$$
$$n! \approx \sqrt{2\pi n}\,(n/e)^n$$
$$n! \approx \sqrt{2\pi n}\,n^n \exp\left(\frac{1}{12n} - n\right)$$
$$\begin{array}{l|l} \sin' x = \cos x & (fg)' = f'g + g'f \\ \cos' x = -\sin x & (f/g)' = (f'g - g'f)/g^2 \\ \tan' x = 1 + \tan^2 x & (1/g)' = -g'/g^2 \\ \cot' x = -1 - \cot^2 x & (f(g))' = f'(g)g' \\ \arcsin' x = 1/\sqrt{1-x^2} & (e^x)' = e^x \\ \arccos' x = -1/\sqrt{1-x^2} & \ln' x = 1/x \\ \arctan' x = 1/(x^2+1) & (x^n)' = nx^{n-1} \end{array}$$
$$\begin{array}{l|l} t = \tan(x/2) & \sin x = \dfrac{2t}{1+t^2} \\ \mathrm{d}x = \dfrac{2\,\mathrm{d}t}{1+t^2} & \cos x = \dfrac{1-t^2}{1+t^2} \end{array}$$
$f(x) = f(2a - x)$ (Achsensymmetrie)
$f(x) = 2b - f(2a - x)$ (Punktsymmetrie)
$$p(x) = y_0 + a_1(x - x_0) + a_2(x - x_0)(x - x_1)$$
$$a_1 = \frac{y_1 - y_0}{x_1 - x_0}, \quad a_2 = \frac{1}{x_2 - x_1}\left(\frac{y_2 - y_0}{x_2 - x_0} - a_1\right)$$

$$\int_a^b f(x)\,\mathrm{d}x = \lim_{n\to\infty} \sum_{k=1}^{n} f\!\left(a + k\frac{b-a}{n}\right)\frac{b-a}{n}$$
$$\int_a^b f g'\,\mathrm{d}x = [fg]_a^b - \int_a^b f' g\,\mathrm{d}x$$
$$\int_a^b f(g) g'\,\mathrm{d}x = \int_{g(a)}^{g(b)} f(u)\,\mathrm{d}u$$
$$\frac{\mathrm{d}}{\mathrm{d}x} \int_{a(x)}^{b(x)} f(x,t)\,\mathrm{d}t = \int_{a(x)}^{b(x)} \frac{\partial}{\partial x} f(x,t)\,\mathrm{d}t + g(x)$$
$$g(x) = f(x, b(x)) b'(x) - f(x, a(x)) a'(x)$$
$$\int_{\varphi(U)} f(\underline{x})\mathrm{d}\underline{x} = \int_U f(\varphi(\underline{u}))|\det D\varphi(\underline{u})|\mathrm{d}\underline{u}$$
$$T(x) = f(x_0) + f'(x_0)(x - x_0)$$
$$N(x) = f(x_0) - \frac{1}{f'(x_0)}(x - x_0)$$
$$(n+1)! = (n+1)n!$$
$$\binom{n}{k} = \frac{n!}{k!\,(n-k)!}$$
$$n! = \Gamma(n+1)$$
$$\Gamma(x+1) = x\Gamma(x)$$
$$\Gamma(x)\Gamma(1-x) = \frac{\pi}{\sin(\pi x)}$$
$$\begin{array}{l|l} x = r\cos\varphi & r = \sqrt{x^2 + y^2} \\ y = r \sin\varphi & \varphi = \operatorname{sgn}(y) \arccos(x/r) \end{array}$$
$\det J = r$ (polar, Zylinder)
$\det J = r^2 \sin\theta$ (Kugel)
$$\operatorname{grad}(fg) = g \operatorname{grad} f + f \operatorname{grad} g$$
$$\operatorname{div}(fv) = v \operatorname{grad} f + f \operatorname{grad} v$$
$$\operatorname{rot}(fv) = f \operatorname{rot} v - v \times \operatorname{grad} f$$
$$\operatorname{rot}\operatorname{rot} v = \operatorname{grad}\operatorname{div} v - \Delta v$$
$$\operatorname{div}(v \times w) = w \operatorname{rot} v - v \operatorname{rot} w$$
$$\operatorname{rot}\operatorname{grad} f = 0$$
$$\operatorname{div}\operatorname{rot} v = 0$$
$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad - bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$
$$R(\varphi) = \begin{bmatrix} \cos\varphi & -\sin\varphi \\ \sin\varphi & \cos\varphi \end{bmatrix}$$
$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} \times \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} a_2 b_3 - a_3 b_2 \\ a_3 b_1 - a_1 b_3 \\ a_1 b_2 - a_2 b_1 \end{bmatrix}$$
$$L\{f(t)\} = \int_0^{\infty} f(t) e^{-pt}\mathrm{d}t$$
$$F\{f(t)\} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(t) e^{-i\omega t}\mathrm{d}t$$
$$Z\{a_n\} = \sum_{k=0}^{\infty} a_k z^{-k}$$
$$y = \overline{y} + \frac{s_{xy}}{s_x}(x - \overline{x})$$
$$\nabla f(x,y) + \lambda \nabla g(x,y) = 0$$
$$I[y] = \int_a^b F(x, y(x), y'(x))\,\mathrm{d}x$$
$$\frac{\partial F}{\partial y} = \frac{\mathrm{d}}{\mathrm{d}x}\frac{\partial F}{\partial y'}, \quad \frac{\partial L}{\partial q} = \frac{\mathrm{d}}{\mathrm{d}t}\frac{\partial L}{\partial \dot{q}}, \quad \frac{\partial \mathcal{L}}{\partial \varphi} = \partial_\mu \frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)}$$

## 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

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

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

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

## allgemeine Gleichungen

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

## elektrostatisches Feld

$$F = \frac{1}{4\pi\varepsilon}\frac{Q_1Q_2}{r^2} \quad \Big| \quad \vec{F}_1 = \frac{1}{4\pi\varepsilon}Q_1Q_2\frac{\underline{x}_1 - \underline{x}_2}{|\underline{x}_1 - \underline{x}_2|^3}$$

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

$\underline{E} = -\operatorname{grad}\varphi$
$\varepsilon_0 E^2 = 2w_e$

## Plattenkondensator

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

## homogenes Feld in der Spule

$H\,l = NI \mid B\,l = \mu NI \mid \Theta = NI$

## 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

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

## SRT

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

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

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

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

$g = \operatorname{diag}(1, -1, -1, -1)$
$(D_\mu) = (D_{ct}, D_x, D_y, D_z)$
$(D^\mu) = (D_{ct}, -D_x, -D_y, -D_z)$

## Optik

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

$n_1\sin(\varphi_1) = n_2\sin(\varphi_2)$
$c_0 = nc$

## Thermodynamik

$$\begin{array}{l|l|l} R = N_Ak_B & m = nM & V = nV_m \\ R = R_sM & m = Nm_T & N = nN_A \end{array}$$

$pV = nRT$

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

$Q = mc\Delta T$

## Konstanten

$\varepsilon_0 = 8.8542 \times 10^{-12}\,\mathrm{C/(V\,m)}$
$\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H/m}$
$c_0 = 2.9979 \times 10^{8}\,\mathrm{m/s}$
$e = 1.6022 \times 10^{-19}\,\mathrm{C}$
$G = 6.674 \times 10^{-11}\,\mathrm{m^3/(kg\,s^2)}$

$N_A = 6.0221 \times 10^{23}\,\mathrm{mol^{-1}}$
$k_B = 1.3806 \times 10^{-23}\,\mathrm{J/K}$
$R = 8.3145\,\mathrm{J/(mol\,K)}$

$0\,\mathrm{K} = -273.15\,^\circ\mathrm{C}$
$u = 1.6605 \times 10^{-27}\,\mathrm{kg}$
$h = 6.6261 \times 10^{-34}\,\mathrm{Js}$
$\hbar = 1.0546 \times 10^{-34}\,\mathrm{Js}$
$\sigma = 5.6704 \times 10^{-8}\,\mathrm{W/(m^2K^4)}$

$m_e = 9.1094 \times 10^{-31}\,\mathrm{kg}$
$m_p = 1.6726 \times 10^{-27}\,\mathrm{kg}$
$m_n = 1.6749 \times 10^{-27}\,\mathrm{kg}$
$m_\alpha = 6.6447 \times 10^{-27}\,\mathrm{kg}$