Kräfte: $F_G = G\cdot\frac{mM}{r^2}$, $F_F = k\cdot(x-x_0)$, $F_A = \rho_{Fl}\, g\, V_K$, $F_R = \mu_R\cdot F_N$, $F_C = 2m\vec v\times\vec\omega$, $F = EA\cdot\frac{\Delta l}{l}$, $\boxed{\sum F = m\ddot x}$

Energien: $E_F = \frac12 k(x-x_0)^2$, $E_{Rot} = \frac12 I\omega^2$, $E_G = G\cdot\frac{mM}{r} = \int F(r)\,dr$, $W = \int F\,dr = F\,dr\cos(\alpha)$

Wurf / Fall: $t_F = \sqrt{\frac{2h}{g}}$, $v = \sqrt{2hg}$, $v_{Flucht} = \sqrt{2Rg}$, $p = m\cdot v = \sqrt{kmx^2}$, max. Höhe $r = \frac{R}{1-\frac{v^2}{2Rg}}$, $x_S = \frac{v_0^2}{2g}\sin(2\alpha)$

$\vec r(t) = \begin{pmatrix} v_0\cos(\alpha)t \\ v_0\sin(\alpha)t - \frac12 g t^2 + y_0 \end{pmatrix}$ Schiefe Ebene: $v = \sqrt{\frac{2gh}{1+x}}$ Brennvorgang: $v = v_e\ln\left(\frac{m_T+m_R}{m_R}\right) - gT$

Rotationsbewegung:
$\Delta S = r\cdot\varphi$
$v = r\cdot\dot\varphi = r\cdot\frac{2\pi}{T}$, $\omega = \frac{1}{r^2}\vec r\times\vec v$
$a = r\cdot\ddot\varphi = r\omega^2 = \frac{v^2}{r}$
$\sum M = I\cdot\ddot\varphi$ $M = R^2 m\ddot\varphi$
$M_D = D\cdot\varphi$
→ Direktionsmoment

Masse	m	$I = \rho\int r^2 d^3x = \int r^2\,dm$	Trägheitsmoment
Impuls	$p = m\cdot v$	$L = I\omega = r\times p$	Drehimpuls
Kraft	$F = \dot p$	$M = \dot L = I\ddot\varphi = r\times F$	Drehmoment
Energie	$E = \frac12 mv^2$	$E = \frac12 I\omega^2 = \frac12 L\omega$	Rot-energie
Leistung	$P = F\cdot v = \frac{W}{t}$	$P = D\cdot\omega$	Leistung

Tensor
$\begin{pmatrix} xx & xy & xz \\ xy & yy & yz \\ xz & yz & zz \end{pmatrix}$

Trägheitsmomente: Pkt/Hohlzyl: mr^2 Vollzyl: $\frac12 mr^2$ Kugel: $\frac25 mr^2$

Stoß: $\vec R_S = \frac1M\sum_i m_i r_i = \frac1M\int r\,dm = \frac1M\int_V r\rho(r)\,dV$
dezentral:
$p_{ges_x} = m_1v_1\cos\theta_1 + m_2v_2\cos\theta_2$
$p_{ges_y} = m_1v_1\sin\theta_1 + m_2v_2\sin\theta_2$
$M \gg m$: $v_1' = -v_1$, $v_2' \approx 0$

SP-System:
$R_S = \frac{m_1r_1+m_2r_2}{M}$
$P_S = Mv_S = m_1v_1 + m_2v_2$
$\vec r_{12} = \vec r_1 - \vec r_2$

Pendel: $\omega = \sqrt{\frac{g}{l}} \rightarrow T = 2\pi\sqrt{\frac{l}{g}} =$
$= \omega\sqrt{\frac{I}{D}} = 2\pi\cdot\sqrt{\frac{m}{k}}$
$m\ddot x = -mg\sin\varphi = ml\ddot\varphi$

Bewegungsglg:
$m\ddot x = \underbrace{-kx}_{\text{Kraft}}\ \underbrace{-b\dot x}_{\text{Reibung}} \rightarrow \ddot x + 2\gamma\dot x + \omega_0^2 x = 0;\ \omega^2 = \frac km$
Torsion: $M = -D\varphi = I\ddot\varphi \Rightarrow \ddot\varphi + \frac DI\varphi = 0,\ \omega^2 = \frac DI$

Schwingungen: $x(t) = A\cos(\omega t+\varphi)$
$= \frac12|c|\left(e^{i(\omega t+\varphi)} + e^{-i(\omega t+\varphi)}\right)$
$= Ae^{-\gamma t}\cos(\omega' t)$
$E_{pot} = \frac12 kx^2 = \frac12 kA^2\cos^2(\omega t+\varphi)$
$E_{kin} = \frac12 mA^2\omega^2\sin^2(\omega t+\varphi)$

erzw. Schwingungen:
1) $\omega \ll \omega_0 = \sqrt{\frac km}$ Rückstellterm
$x(t) = \frac{F_0}{k}\cos(\omega t)$, $\delta = 0$
2) $\omega \gg \omega_0$, $\omega \gg \frac kb$
$-x(t) = \frac{F_0}{m\omega^2}\cos(\omega t)$, $\delta = -\pi$
3) $\omega = \omega_0$
$-b\omega_0 A\sin(\omega_0 t+\delta) = F_0(\omega_0 t)$, $\delta = \frac\pi2$
$A = \frac{F_0}{b\omega_0}$

gekoppelt:
$m_1\ddot x_1 = -kx_1 - q(x_1-x_2)$
$m_2\ddot x_2 = -k_2x_2 + q(x_1-x_2)$

Überlagerung:
$f = \frac{f_1+f_2}{2}$, $A = 2a\cos\left(\frac{\omega_1-\omega_2}{2}t\right)$
$x(t) = A\cos\left(\frac{\omega_1+\omega_2}{2}t\right)$

Elastizität
$\sigma = \frac FA = E\cdot\frac{\Delta L}{L}$ Zugspannung
$\frac{\Delta V}{V} = 2\cdot\frac{\Delta w}{w} + \frac{\Delta L}{L} = \varepsilon(1-2\nu)$ Querkontraktion
$\nu = -\frac{\Delta w/w}{\Delta V/V}$
$\tau = \frac FA = G\cdot\alpha$ Scherspannung

$v(r) = \frac{p_1-p_2}{4\eta l}(R^2-r^2)$
$p(h) = p_0\exp\left(-\frac{\rho_0 g h}{p_0}\right)$

Hydr. Presse: $\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow A_1\cdot S_1 = A_2\cdot S_2$
$V_{verdr} = \frac{\rho_K}{\rho_{Fl}}\cdot V_K$
Hydrostat. Druck: $p = \rho_{Fl}\cdot g\cdot h$, $p = \frac FA$
$\Delta E = \sigma\cdot\Delta A = \sigma\cdot 2l\Delta x$ $\dot V = A\cdot v$
Kontinuitätsglg: $A_1v_1 = A_2v_2$
Bernoulliglg: $p_0 = p + \frac12\rho v^2 + \rho g h = const$

Wellen: $v = \lambda\cdot f = \frac\omega k$, $k = \frac{2\pi}{\lambda}$
Wellenglg: $\frac{\partial^2 D}{\partial t^2} = \frac{1}{v^2}\frac{\partial^2 D}{\partial t^2}$
$D(x,t) = A\cdot\sin(\omega t - kx)$
Schallpegel: $L = 10\log\frac{I}{I_0}$, $I_0 = 10^{-12}\frac{W}{m^2}$

einseitig: $l = (2n+1)\frac\lambda4$, $f_k = \frac14(2k+1)\frac cl$
beids.: $l = (n+1)\frac\lambda2$, $f_k = \frac12(k+1)\frac cl$
Knoten: $x = \frac{\lambda}{4\pi}((2n+1)\pi+\varphi)$
Bauch: $x = \frac{\lambda}{4\pi}(2n\pi+\varphi)$

L in Festk: $v = \sqrt{E/\rho}$
L in Fluid: $v = \sqrt{K/\rho}$
T in Festk: $v = \sqrt{G/\rho}$
T Seil: $v = \sqrt{\sigma/\rho}$

T Saite/Kabel: $v = \sqrt{F/\mu}$, $\mu = \frac mL$
Schall: $\sqrt{p/\rho}$

Maxwell'sches Rad:
$m\ddot x = F_G - F_F = mg - I\cdot\frac{a}{r^2}$
$\rightarrow a = \frac{g}{1+\frac{I}{mr^2}}$

Galileo:
$s' = s - v\cdot t + s_0$
$s = \frac12 at^2 = \omega r t^2 = \omega D t$
$t = \frac{s}{\omega D} \rightarrow v = \frac{\omega D^2}{s}$

Kepler:
$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
$e = \sqrt{a^2-b^2}$, $\varepsilon = \frac ea$
$\frac{T_1^2}{a_1^3} = \frac{T_2^2}{a_2^3}$

$v_{1\,end} = \frac{1}{m_1+m_2}\left[(m_1-m_2)v_{1\,anf} + 2m_2v_{2\,anf}\right]$

Math. Erg.:

Zylinder:

$$\begin{pmatrix} r\cos\varphi \\ r\sin\varphi \\ z \end{pmatrix}$$

$r\,dr\,d\varphi\,dz$

Kugel:

$$\begin{pmatrix} r\cos\varphi\sin\Theta \\ r\sin\varphi\sin\Theta \\ r\cos\Theta \end{pmatrix}$$

$r^2\sin\Theta\,dr\,d\varphi\,d\Theta$

Feder:

$$\begin{pmatrix} -2k & k \\ k & -2k \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

$$\cos\varphi = \frac{\vec{v}\circ\vec{w}}{\|\vec{v}\|\cdot\|\vec{w}\|}$$

$$\sin\varphi = \frac{|\vec{v}\times\vec{w}|}{|\vec{v}|\cdot|\vec{w}|}$$

Part. Integration:

$$\int_a^b f'(x)g(x)dx = f(x)g(x)\Big|_a^b - \int_a^b f(x)g'(x)dx$$

Partialbruchzerlegung:

$$\frac{f(x)}{g(x)} = \sum_i \left(\frac{A_i^{(1)}}{(x-a_i)} + \dots + \frac{A_i^{(k)}}{(x-a_i)^k}\right)$$

Trennung d. Variablen:

$$\frac{dy}{dt} = f(t)g(y) \Rightarrow \int \frac{1}{g(y)}dy = \int f(t)dt$$

Variation d. Konstanten:

$$\dot{x} = a(t)x + b(t)$$

$$\Rightarrow x_p(t) = e^{A(t)}\int_{t_0}^{t} b(t)\,e^{-A(t)}dt$$

$$x_h(t) = Ce^{A(t)}$$

$$\left.\begin{aligned} R_{SP} &= \frac{1}{V}\int_V z\,d^3x \\ M &= \rho\int_V d^3x \\ I &= \rho\int_V r_\perp^2\,d^3x \end{aligned}\right\}$$ Korrektur-faktoren nicht vergessen

höhere Ordnung:

$$\left.\begin{aligned} \ddot{x} &= -kx \\ \Rightarrow u &:= \dot{x} \end{aligned}\right\} \quad \dot{u} = -kx \Rightarrow \dot{\vec{u}} = A\vec{u} \text{ mit } \vec{u} = \begin{pmatrix} x \\ u \end{pmatrix}$$

$$V_{Kegel} = \frac{1}{3}\pi r^2 h$$

$$V_{Kugel} = \frac{4}{3}\pi r^3$$

$$T(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(x)}{n!}(x-x_0)^n$$

Skalarprodukt: $\langle\vec{v}|\vec{w}\rangle = \sum_{i=1}^{n} \bar{v}_i w_i$, $\|\vec{v}\| = \sqrt{\langle v|v\rangle}$

$$\langle f|g\rangle = \int_0^c \overline{f(x)}g(x)dx$$

Spatprodukt: $\vec{u}\circ(\vec{v}\times\vec{w}) = -\vec{u}\circ(\vec{w}\times\vec{v}) = \vec{w}\circ(\vec{u}\times\vec{v}) = -\vec{v}\circ(\vec{w}\times\vec{u})$

Kreuzprodukt: $\vec{v}\times\vec{w} = \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix}\times\begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} = \begin{pmatrix} v_2w_3 - v_3w_2 \\ v_3w_1 - v_1w_3 \\ v_1w_2 - v_2w_1 \end{pmatrix}$