Costanti

$R = 8.314\ J/mol \cdot K$
Coulomb constant $K = 8.988 \times 10^9\ Nm^2C^{-2}$
$k_B = 1.381 \times 10^{-23}\ m^2kg \cdot s^{-2}K^{-1}$
$N_A = 6.022 \times 10^{23}$
$G = 6.6741 \times 10^{-11}\ m^3kg^{-1}s^{-2}$
$e = 1.602 \times 10^{-19}\ C$
$\epsilon_0 = 8.8542 \times 10^{-12}\ F \cdot m^{-1}$
$\mu_0 = 4\pi \times 10^{-7}\ \frac{T \cdot m}{A}$
$c^2 = \frac{1}{\epsilon_0 \mu_0}$
$c = 299.8 \times 10^6\ m/s$
$e = 1.602 \times 10^{-19}\ C\ m_p = 1.673 \times 10^{-27}\ kg$
$m_e = 9.109 \times 10^{-31}\ kg$

Units conversion

$1\ amu = 1,66 \times 10^{-27}\ kg$
$1\ cal = 4.186\ J$
$1\ yd = 3\ ft$
$1\ m = 3.281\ ft$

Formule trigonometriche

$\sin(\alpha) + \sin(\beta) = 2\sin\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha-\beta}{2}\right)$
$\sin(\alpha) - \sin(\beta) = 2\cos\left(\frac{\alpha+\beta}{2}\right)\sin\left(\frac{\alpha-\beta}{2}\right)$
$\cos(\alpha) + \cos(\beta) = 2\cos\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha-\beta}{2}\right)$
$\cos(\alpha) - \cos(\beta) = -2\sin\left(\frac{\alpha+\beta}{2}\right)\sin\left(\frac{\alpha-\beta}{2}\right)$
$\cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$
$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$
$\tan(2\alpha) = \frac{2\tan(\alpha)}{1-\tan^2(\alpha)}$
$\cot(2\alpha) = \frac{\cot^2(\alpha)-1}{2\cot(\alpha)}$
$\cos(\alpha+\beta) = \cos(\alpha)\cos(\beta) - \sin(\alpha)\sin(\beta)$
$\cos(\alpha-\beta) = \cos(\alpha)\cos(\beta) + \sin(\alpha)\sin(\beta)$

Equazioni differenziali

$\frac{df}{dx} = A \overset{f(0)=B}{\longrightarrow} f(x) = B + Ax$
$\frac{df}{dx} = -kf(x) \overset{f(0)=A}{\longrightarrow} f(x) = Ae^{-kx}$
$\frac{df}{dx} = A + Bf(x) \overset{f(0)=C}{\longrightarrow} f(x) = -\frac{A}{B} + \left(\frac{A}{B} + C\right)e^{Bx}$
$\frac{d^2f}{dx^2} = A \overset{f(0)=C, f'(0)=B}{\longrightarrow} f(x) = C + Bx + \frac{1}{2}Ax^2$
$\frac{d^2f}{dx^2} = -\omega^2 x \overset{f(0)=A, f'(0)=B}{\longrightarrow} f(x) = A\cos\omega t + \frac{B}{\omega}\sin\omega t$

Cinematica

$v_x = \frac{dx}{dt}$; $a_x = \frac{dv_x}{dt}$
$\Delta x = v_{ix}\Delta t + \frac{1}{2}a_x(\Delta t)^2$
$v_{fx}^2 - v_{ix}^2 = 2a_x\Delta x$
moto oscillatorio
$x(t) = A\sin(\omega + \varphi), \quad \omega = \frac{2\pi}{T}$
$v^2(x) = \omega^2\left(A^2 - x^2\right)$
moto rotatorio
$\omega = \frac{d\theta}{dt}$; $v = \omega R$;
radial acceleration $a_r = v\omega = \frac{v^2}{R} = \omega^2 R$
accelerazione angolare $\alpha = \frac{d\omega}{dt} = \frac{a_T}{R}$
$\vec{v} = \vec{\omega} \times \vec{r}$
$\theta(t) = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$\omega_{fx}^2 - \omega_{ix}^2 = 2\alpha\Delta\theta$
in generale ...
$\vec{v} = \frac{dr}{dt}\ \hat{u}_r + r\frac{d\ \hat{u}_r}{dt} = \frac{dr}{dt}\ \hat{u}_r + r\frac{d\theta}{dt}\ \hat{u}_\theta = \vec{v}_r + \vec{v}_\theta$
$\vec{a} = \vec{a}_T + \vec{a}_N = \vec{\alpha} \times \vec{r} + \vec{\omega} \times \vec{v} = \vec{\alpha} \times \vec{r} + \vec{\omega} \times \vec{\omega} \times \vec{r}$
moti relativi inerziali
$\vec{v}_{WT} = \vec{v}_{WG} - \vec{v}_{TG}$
moti relativi non inerziali
$\vec{a} = \vec{a}' + \vec{a}_{O'} + \vec{\omega} \times \vec{\omega} \times \vec{r}' + \frac{d\vec{\omega}}{dt} \times \vec{r}' + 2\vec{\omega} \times \vec{v}'$
$\vec{F}_{centr} = -m\vec{\omega} \times \vec{\omega} \times \vec{r}'$
$\vec{F}_{coriolis} = -2m\vec{\omega} \times \vec{v}'$

Dinamica del punto

quantiá di moto $\vec{p} = m\vec{v}$
$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$
Forza gravitazionale $\vec{F} = -G\frac{m_1 m_2}{r^2}\hat{r}$
Forza d'attrito $\vec{F} = \mu\vec{N}$
Forza elastica $\vec{F} = -kx$ where k elastic constant
Periodo del pendolo $T = 2\pi\sqrt{\frac{L}{g}}$
Momento angolare $\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times m\vec{v}$
Momento di una forza $\vec{\tau} = \vec{r} \times \vec{F}$
$\frac{d\vec{L}}{dt} = \vec{r} \times \sum \vec{F} = \vec{\tau}$
Impulso $\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$

Energia

Lavoro $W = \vec{F} \cdot d\vec{s}$
Potenza $\mathcal{P} = \frac{dW}{dt} = \vec{F} \cdot \vec{v}$
Energia cinetica $E_k = \frac{1}{2}mv^2 = \frac{p^2}{2m} = \Delta W$
Energia potenziale $U_{pot} = -W$
Conservazione dell'energia $\Delta K + \Delta U = \Delta E_{mech} = W_{nc}$,
dove nc sta per non conservative
Energia potentiale gravitazionale (campo $\|$*)* $U = mgh$
Energia potentiale gravitazionale $U = -G\frac{mM}{r}$
Energia potentiale elastica $U = \frac{1}{2}kx^2$

Sistemi di punti

centro di massa $\vec{r}_{CM} = \frac{\sum m_i \vec{r}_i}{M}$
$\vec{v}_{CM} = \frac{\vec{p}_{tot}}{M_{tot}}$
$\vec{a}_{CM} = \frac{1}{M_{tot}} \sum \vec{F}^{(E)} = \frac{1}{M_{tot}} \vec{F}^{(E)}_{net}$

conservazione quantitá di moto
$\Delta \vec{p}_{tot} = 0$
conservazione dell'energia
$\Delta E_{tot} = 0$
1a eq. cardinale
$\vec{F}^{(E)}_{net} = \frac{d\vec{p}_{tot}}{dt}$
2a eq. cardinale
$\frac{d\vec{L}}{dt} = -\vec{v}_O \times m\vec{v}_{CM} + \vec{\tau}^{(E)}$

1 Koenig
$\vec{L} = \vec{L}' + \vec{L}_{CM}$
2 Koenig
$E_k = E'_k + E_{k,CM}$

$W^{(E)} + W^{(I)} = \Delta E_k$

campo G $\parallel$
$\vec{\tau} = \vec{r}_{CM} \times M_{tot}\vec{g}$
$U_G = M_{tot} g h_{CM}$

Corpo rigido

Densità $\rho = \frac{dm}{dV}$
Centro di massa $\vec{r}_{CM} = \frac{1}{V} \int_V \rho \vec{r} dV$

campo G $\parallel$
in generale $\vec{F}_\parallel = \left|\vec{F}\right| \hat{u}_\parallel$
Forze peso $\vec{W} = mg\hat{z}$
Momento forza peso $\vec{\tau} = \vec{r}_{CM} \times mg\hat{z}$
Energia potenziale gravitazionale $E_p = mgz_{CM}$

Quantità di moto
$\vec{p}_{tot} = \vec{P} = m\vec{v}_{CM}$
Momento angolare
$\vec{L}_{CM} = \vec{r}_{CM} \times \vec{P}$
$\vec{L}_z = I_z \vec{\omega}$

$\frac{d\vec{L_z}}{dt} = I_z \frac{d\vec{\omega}}{dt} = I_z \vec{\alpha} = \vec{\tau_z}$
$\frac{d\vec{L_\perp}}{dt} = \vec{\tau_\perp}$
$E_k = \frac{L_z^2}{2I_z}$

Momenti di inerzia
$I = \sum_{i=1}^{N} m_i r_i^2 = Md^2 + I_{CM}$

- Anello $I = mR^2$
- Disco/cilindro $I = \frac{1}{2}mR^2$
- Sfera $I = \frac{2}{5}mR^2$
- Sfera cava $I = \frac{2}{3}mR^2$
- Asta $I = \frac{1}{12}mL^2$

Puro rotalamento
$\vec{v}_{CM} = -\vec{\omega} \times \vec{r}$
$v_{CM} = \omega r$
$a_{CM} = \alpha r$
attrito volvente $\tau_v = hN$