

Formulário MSF20022:

$$v_x(t) = \frac{dx}{dt}$$

$$a_x(t) = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$$

$$v_x(t + \delta t) = v_x(t) + \left. \frac{dv_x}{dt} \right|_t \delta t + \frac{1}{2} \left. \frac{d^2v_x}{dt^2} \right|_t \delta t^2 + \frac{1}{3!} \left. \frac{d^3v_x}{dt^3} \right|_t \delta t^3 + \mathcal{O}(\delta t^4)$$

$$\vec{F} = m \vec{a}$$

$$W = \int_C \vec{F} \cdot d\vec{r} = \int_{t_0}^{t_1} \vec{F} \cdot \vec{v} dt = \frac{1}{2} m |\vec{v}_1|^2 - \frac{1}{2} m |\vec{v}_0|^2 \quad \int_C \vec{F}^{(conservativa)} \cdot d\vec{r} = E_{p0} - E_{p1}$$

$$\vec{F}_{res} = -m D |\vec{v}| \vec{v} \quad \vec{F}_{res} = -\frac{C_{res}}{2} A \rho_{ar} |\vec{v}| \vec{v} \quad |\vec{F}_{rol}| = \mu |\vec{N}|$$

$$\vec{F}_{Magnus} = \frac{1}{2} A \rho_{ar} r \vec{\omega} \times \vec{v} \quad \vec{F}_{grav} = -G \frac{m M}{|\vec{r}|^2} \frac{\vec{r}}{|\vec{r}|} \quad \vec{F}_{elástica} = -k \vec{r}$$

$$\vec{F}_{elet} = -k_e \frac{q Q}{|\vec{r}|^2} \frac{\vec{r}}{|\vec{r}|} \quad \vec{F}_{elet} = q \vec{E}_{elet}$$

$$F_x = -\frac{dE_p}{dx} \quad E_p = m g y \quad E_p = \frac{1}{2} k x^2 \quad E_p = -G \frac{m M}{|\vec{r}|}$$

$$P_o = \vec{F} \cdot \vec{v}$$

$$\int_{t_0}^{t_1} \vec{F}(t) dt = \vec{p}_1 - \vec{p}_0$$

$$\sum \vec{F}^{ext} = \frac{d\vec{P}}{dt}$$

$$x(t) = A \cos(\omega t + \phi) \quad \omega = \sqrt{\frac{K}{M}} \quad E = \frac{1}{2} k A^2$$

$$E_p(x) = E_p(x_{min}) + \left. \frac{dE_p}{dx} \right|_{x_{min}} \delta x + \frac{1}{2} \left. \frac{d^2E_p}{dx^2} \right|_{x_{min}} \delta x^2 + \frac{1}{3!} \left. \frac{d^3E_p}{dx^3} \right|_{x_{min}} \delta x^3 + \mathcal{O}(\delta x^4)$$

$$x(t) = \frac{a_0}{2} + a_1 \cos(\omega t) + b_1 \sin(\omega t) + a_2 \cos(2\omega t) + b_2 \sin(2\omega t) + \dots$$

$$a_n = \frac{2}{T} \int_t^{t+T} f(t) \cos(n\omega t) dt, \quad n = 0, 1, 2, \dots \quad b_n = \frac{2}{T} \int_t^{t+T} f(t) \sin(n\omega t) dt, \quad n = 1, 2, \dots$$

$$x(t) = A e^{-\frac{b}{2m}t} \cos(\omega t + \phi) \quad \omega = \sqrt{\omega_0^2 - \left(\frac{b}{2m}\right)^2}$$

$$A(\omega_f) = \frac{F_0/m}{\sqrt{(\omega_f^2 - \omega_0^2)^2 + \left(\frac{b \omega_f}{m}\right)^2}}$$

$$y(x, t) = A \sin(kx - \omega t + \phi)$$

Grandezas físicas e conversões:

$$1 \text{ polegada} = 1 \text{ in} = 0,39370 \text{ m}$$

$$1 \text{ pé} = 1 \text{ ft} = 2,54 \text{ cm}$$

$$1 \text{ milha} = 1,609344 \text{ km}$$

$$1 \text{ rad} = 57.29578 \text{ graus}$$

$$1 \text{ cv (cavalo – vapor métrico)} = 735,4975 \text{ W}$$

$$1 \text{ hp (cavalo – vapor inglês)} = 745,715 \text{ W}$$

$$M_{Sol} = M = 1.989 \times 10^{30} \text{ kg}$$

$$1 \text{ AU} = 1.489 \times 10^{11} \text{ m}$$

$$1 \text{ ano} = 365,24 \text{ dias}$$

$$G = 6,67 \times 10^{11} \text{ m}^3 / (\text{kg} \cdot \text{s}^2) = 4\pi^2 \text{ AU}^3 / (\text{M} \cdot \text{ano}^2)$$

$$g = 9,80 \text{ m/s}^2$$

$$\rho_{ar} = 1.225 \text{ kg/m}^3$$

$$v_{som} = 340 \text{ m/s}$$

$$c = 299792,458 \text{ km/s} = 2,99792458 \times 10^8 \text{ m/s}$$

$$k_B = 1.380649 \times 10^{-23} \text{ J/K} = 8.61733 \times 10^{-5} \text{ eV/K}$$

$$\epsilon_0 = 8,854187817 \times 10^{-12} \text{ F/m}$$

$$k_e = 1/4\pi\epsilon_0 = 8,98755188 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$$

$$m_e = 9,10938356 \times 10^{-31} \text{ kg}$$

$$m_p = 1,67262 \times 10^{-27} \text{ kg} = 1836.151 m_e$$

$$m_n = 1,67493 \times 10^{-27} \text{ kg}$$

$$1 \text{ Å} = 10^{-10} \text{ m}$$

$$e = 1,602176208 \times 10^{-19} \text{ C}$$

$$e/c = 5,34428 \times 10^{-28} \text{ C} \cdot \text{m/s}$$

Grandezas matemáticas e Transformações Trigonométricas:

$$e = 2,71828183$$

$$\pi = 3,14159265$$

$$\sin(-x) = -\sin(x) \quad \sin(\pi - x) = \sin(x) \quad \sin\left(x \pm \frac{\pi}{2}\right) = \pm \cos(x)$$

$$\cos(-x) = +\cos(x) \quad \cos\left(x \pm \frac{\pi}{2}\right) = \mp \sin(x)$$

$$\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y \quad \cos(x \pm y) = \cos x \cos y \mp \sin x \sin y$$

$$\sin x \cos y = \frac{1}{2} [\sin(x + y) + \sin(x - y)]$$

$$\cos x \sin y = \frac{1}{2} [\sin(x + y) - \sin(x - y)]$$

$$\sin x \sin y = \frac{1}{2} [\cos(x - y) - \cos(x + y)]$$

$$\cos x \cos y = \frac{1}{2} [\cos(x - y) + \cos(x + y)]$$

$$\sin^2 x = \frac{1}{2} - \frac{1}{2} \cos 2x$$

$$\cos^2 x = \frac{1}{2} + \frac{1}{2} \cos 2x$$

$$\sin x \pm \sin y = 2 \cos\left(\frac{x \mp y}{2}\right) \sin\left(\frac{x \pm y}{2}\right)$$

$$\cos x + \cos y = 2 \cos\left(\frac{x+y}{2}\right) \cos\left(\frac{x-y}{2}\right) \quad \cos x - \cos y = 2 \sin\left(\frac{x+y}{2}\right) \sin\left(\frac{x-y}{2}\right)$$

Tabela 4A.1 Sistema Astronómico de unidades

Grandeza	Símbolo	Definição	Valor no SI	Conversão do SI
Massa	M	Massa do Sol	$1,989 \times 10^{30} \text{ kg}$	$1 \text{ kg} = 5,028 \times 10^{-31} M$
Distância	AU	Distância média da Terra ao Sol	$1,498 \times 10^{11} \text{ m}$	$1 \text{ m} = 6,676 \times 10^{-12} \text{ AU}$
Tempo	ano	Período da Terra em volta do Sol	$3,15 \times 10^7 \text{ s}$	$1 \text{ s} = 3,17 \times 10^{-8} \text{ ano}$

Neste sistema, a constante de gravitação é

$$G = 6,67 \times 10^{11} \frac{(6,676 \times 10^{-12} \text{ AU})^3}{(5,028 \times 10^{-31} M)(3,17 \times 10^{-8} \text{ ano})^2} = 4\pi^2 \text{ AU}^3/M \text{ ano}^2,$$

a unidade de energia é $5.50 \times 10^{38} \text{ J}$ e a unidade de velocidade é 4718.48 m/s

Tabela 4A.2. Dados experimentais do sistema solar.

	Massa (kg)	Período sideral (1 ano=365,24 dias)	Distância média ao Sol (semi-eixo maior)		Excentricidade	Inclinação eclíptica (grau)
			(10^{11} m)	(AU)		
Mercúrio	$3,301 \times 10^{23}$	0,2408	0,5791	0,3871	0,2056	7,004
Vénus	$4,669 \times 10^{24}$	0,6151	1,082	0,723	0,0068	3,394
Terra	$5,978 \times 10^{24}$	1	1,496	1	0,0167	0
Marte	$6,420 \times 10^{23}$	1,881	2,279	1,523	0,0934	1,850
Júpiter	$1,899 \times 10^{27}$	11,86	7,783	5,203	0,0481	1,306
Saturno	$5,685 \times 10^{26}$	29,46	14,27	9,54	0,0533	2,489
Urano	$8,686 \times 10^{25}$	84,02	28,69	19,18	0,0507	0,773
Neptuno	$1,025 \times 10^{26}$	164,8	44,98	30,07	0,0040	1,773
Sol	$1,989 \times 10^{30}$					
Lua	$7,353 \times 10^{22}$		384 400 km à Terra		0,055	5,144
Plutão	5×10^{23}	248	59,00	39,44	0,2533	17,142