FORMULÁRIO: P1

$$\frac{dy}{dx}+p(x)\,y(x)=q(x) \qquad y(x)=e^{-\int^{x} p(u)du}\left[\int^{x} e^{\int^{s} p(u)du}\, q(s)\,ds + C\right]$$

$$e^{i\theta}=\cos\theta + i\,\mathrm{sen}\,\theta$$

$$\vec r = r\hat r,\quad \vec v = \dot r\hat r + r\dot\theta\hat\theta,\quad \vec a = (\ddot r - r\dot\theta^2)\hat r + (r\ddot\theta + 2\dot r\dot\theta)\hat\theta$$

$$\vec r = \rho\hat\rho + z\hat k,\quad \vec v = \dot\rho\hat\rho + \rho\dot\varphi\hat\varphi + \dot z\hat k,\quad \vec a = (\ddot\rho - \rho\dot\varphi^2)\hat\rho + (\rho\ddot\varphi + 2\dot\rho\dot\varphi)\hat\varphi + \ddot z\hat k$$

$$\vec r = r\hat r,\quad \vec v = \dot r\hat r + r\dot\theta\hat\theta + r\dot\varphi\,\mathrm{sen}\,\theta\hat\varphi,\quad \vec a = (\ddot r - r\dot\theta - r\dot\varphi^2\,\mathrm{sen}^2\theta)\hat r + (r\ddot\theta + 2\dot r\dot\theta - r\dot\varphi^2\,\mathrm{sen}\,\theta\cos\theta)\hat\theta +$$
$$+ (r\ddot\varphi\,\mathrm{sen}\,\theta + 2\dot r\dot\varphi\,\mathrm{sen}\,\theta + 2r\dot\theta\dot\varphi\cos\theta)\hat\varphi$$

$$\vec\nabla = \frac{\partial}{\partial r}\hat r + \frac{1}{r}\frac{\partial}{\partial\theta}\hat\theta + \frac{1}{r\,\mathrm{sen}\,\theta}\frac{\partial}{\partial\varphi}\hat\varphi \qquad \vec\nabla = \frac{\partial}{\partial\rho}\hat\rho + \frac{1}{\rho}\frac{\partial}{\partial\varphi}\hat\varphi + \frac{\partial}{\partial z}\hat k$$

$$\vec\nabla\wedge\vec B = \frac{1}{r\,\mathrm{sen}\,\theta}\left[\frac{\partial}{\partial\theta}\left(\mathrm{sen}\,\theta\, B_\varphi\right) - \frac{\partial B_\theta}{\partial\varphi}\right]\hat r + \frac{1}{r}\left[\frac{1}{\mathrm{sen}\,\theta}\frac{\partial B_r}{\partial\varphi} - \frac{\partial\left(r B_\varphi\right)}{\partial r}\right]\hat\theta + \frac{1}{r}\left[\frac{\partial\left(r B_\theta\right)}{\partial r} - \frac{\partial B_r}{\partial\theta}\right]\hat\varphi$$

$$\vec\nabla\wedge\vec A = \left(\frac{1}{\rho}\frac{\partial A_z}{\partial\varphi} - \frac{\partial A_\varphi}{\partial z}\right)\hat\rho + \left(\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial\rho}\right)\hat\varphi + \left(\frac{\partial\left(\rho A_\varphi\right)}{\partial\rho} - \frac{\partial A_\rho}{\partial\varphi}\right)\hat k$$

$$\vec F(\vec r) = -\frac{G M_T m}{r^2}\hat r \qquad V(r) = -\int_{r_0}^{r} F(r')\,dr' \qquad V_{efetivo} = \frac{L^2}{2mr^2} + V(r)$$

$$\vec F = -\vec\nabla V$$

$$\int_{r_0}^{r}\frac{dr}{(E - V(r) - \frac{L^2}{2mr^2})^{1/2}} = \sqrt{\frac{2}{m}}\,t \qquad mr^2\dot\theta = L \qquad \vec L = \vec r\wedge\vec p$$

$$\int_{r_0}^{r}\frac{L}{mr^2}\frac{dr}{\left(E - V(r) - \frac{L^2}{2mr^2}\right)^{1/2}} = \sqrt{\frac{2}{m}}(\theta - \theta_0)$$

$$\frac{1}{r} = B + A\cos\theta \text{ onde } \quad B > A \text{ elípse com } B = \frac{1}{a(1-\varepsilon^2)} \text{ e } A = \varepsilon B$$

$$B = A \text{ parábola com } B = A = \frac{1}{a}$$

$$B < A \text{ hipérbole com } \begin{cases} 0 < B < A \text{ (ramo+)} \\ -A < B < 0 \text{ (ramo−)} \end{cases} \quad B = \frac{\pm 1(\text{ramo}\pm)}{a(\varepsilon^2 - 1)} \text{ e } A = \pm\varepsilon B(\text{ramo}\pm)$$

$$\frac{d^2u}{d\theta^2} + u = -\frac{m}{L^2u^2}F\left(\frac{1}{u}\right),\ u=1/r \qquad \left(\frac{du}{d\theta}\right)^2 + u^2 = \frac{2m}{L^2}\left[E - V\left(\frac{1}{u}\right)\right]$$

$$E = \frac{1}{2}m\dot r^2 + \frac{L^2}{2mr^2} + V(r)$$

FORMULÁRIO: P2

$e^{i\theta} = \cos\theta + i\,\mathrm{sen}\,\theta$

$\vec{r} = r\hat{r}, \quad \vec{v} = \dot{r}\hat{r} + r\dot{\theta}\theta, \quad \vec{a} = (\ddot{r} - r\dot{\theta}^2)\hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\hat{\theta}$

$\vec{r} = \rho\hat{\rho} + z\hat{k}, \quad \vec{v} = \dot{\rho}\hat{\rho} + \rho\dot{\varphi}\hat{\varphi} + \dot{z}\hat{k}, \quad \vec{a} = (\ddot{\rho} - \rho\dot{\varphi}^2)\hat{\rho} + (\rho\ddot{\varphi} + 2\dot{\rho}\dot{\varphi})\hat{\varphi} + \ddot{z}\hat{k}$

$\vec{r} = r\hat{r}, \quad \vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta} + r\dot{\varphi}\,\mathrm{sen}\,\theta\hat{\varphi}, \quad \vec{a} = (\ddot{r} - r\dot{\theta} - r\dot{\varphi}^2\,\mathrm{sen}^2\,\theta)\hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta} - r\dot{\varphi}^2\,\mathrm{sen}\,\theta\cos\theta)\hat{\theta} +$

$+ (r\ddot{\varphi}\,\mathrm{sen}\,\theta + 2\dot{r}\dot{\varphi}\,\mathrm{sen}\,\theta + 2r\dot{\theta}\dot{\varphi}\cos\theta)\hat{\varphi}$

$$\vec{\nabla} = \frac{\partial}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial}{\partial\theta}\hat{\theta} + \frac{1}{r\,\mathrm{sen}\,\theta}\frac{\partial}{\partial\varphi}\hat{\varphi} \qquad \vec{\nabla} = \frac{\partial}{\partial\rho}\hat{\rho} + \frac{1}{\rho}\frac{\partial}{\partial\varphi}\hat{\varphi} + \frac{\partial}{\partial z}\hat{k}$$

$$\vec{\nabla}\wedge\vec{B} = \frac{1}{r\,\mathrm{sen}\,\theta}\left[\frac{\partial}{\partial\theta}\left(\mathrm{sen}\,\theta\,B_\varphi\right) - \frac{\partial B_\theta}{\partial\varphi}\right]\hat{r} + \frac{1}{r}\left[\frac{1}{\mathrm{sen}\,\theta}\frac{\partial B_r}{\partial\varphi} - \frac{\partial\left(r\,B_\varphi\right)}{\partial r}\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial(r\,B_\theta)}{\partial r} - \frac{\partial B_r}{\partial\theta}\right]\hat{\varphi}$$

$$\vec{\nabla}\wedge\vec{A} = \left(\frac{1}{\rho}\frac{\partial A_z}{\partial\varphi} - \frac{\partial A_\varphi}{\partial z}\right)\hat{\rho} + \left(\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial\rho}\right)\hat{\varphi} + \left(\frac{\partial\left(\rho A_\varphi\right)}{\partial\rho} - \frac{\partial A_\rho}{\partial\varphi}\right)\hat{k}$$

$$\left(\frac{d\vec{A}}{dt}\right)_S = \left(\frac{d\vec{A}}{dt}\right)_{S'} + \vec{\omega}\wedge\vec{A}$$

$$m\left(\frac{d^2\vec{r}}{dt^2}\right)_{S'} = m\left(\frac{d^2\vec{r}}{dt^2}\right)_S - 2m\vec{\omega}\wedge\vec{v}_{S'} - m\,\vec{\omega}\wedge\left(\vec{\omega}\wedge\vec{r}\right) - m\dot{\vec{\omega}}\wedge\vec{r}$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial\dot{q}_k}\right) - \frac{\partial L}{\partial q_k} \quad , \qquad L = T - V\,, \qquad H = \sum_{k=1}^{f} p_k\dot{q}_k - L$$

$$\dot{q}_k = \frac{\partial H}{\partial p_k} \qquad \dot{p}_k = -\frac{\partial H}{\partial q_k} \qquad \frac{\partial H}{\partial t} = -\frac{\partial L}{\partial t} \text{ onde, } k = 1, 2, \text{........}, f$$

FORMULÁRIO

$e^{i\theta} = \cos\theta + i\,\mathrm{sen}\,\theta$

$\vec{r} = r\hat{r},\quad \vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta},\quad \vec{a} = (\ddot{r} - r\dot{\theta}^2)\hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\hat{\theta}$ (polares)

$\vec{r} = \rho\hat{\rho} + z\hat{k},\quad \vec{v} = \dot{\rho}\hat{\rho} + \rho\dot{\varphi}\hat{\varphi} + \dot{z}\hat{k},\quad \vec{a} = (\ddot{\rho} - \rho\dot{\varphi}^2)\hat{\rho} + (\rho\ddot{\varphi} + 2\dot{\rho}\dot{\varphi})\hat{\varphi} + \ddot{z}\hat{k}$ (cilíndricas)

$\vec{r} = r\hat{r},\quad \vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta} + r\dot{\varphi}\,\mathrm{sen}\theta\,\hat{\varphi},\quad \vec{a} = (\ddot{r} - r\dot{\theta} - r\dot{\varphi}^2\mathrm{sen}^2\theta)\,\hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta} - r\dot{\varphi}^2\mathrm{sen}\theta\,\cos\theta)\hat{\theta} +$
$+ (r\ddot{\varphi}\mathrm{sen}\theta + 2\dot{r}\dot{\varphi}\mathrm{sen}\theta + 2r\dot{\theta}\dot{\varphi}\cos\theta)\,\hat{\varphi}$ (esféricas)

$$\vec{\nabla} = \frac{\partial}{\partial\rho}\hat{\rho} + \frac{1}{\rho}\frac{\partial}{\partial\varphi}\hat{\varphi} + \frac{\partial}{\partial z}\hat{k} \qquad \vec{\nabla} = \frac{\partial}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial}{\partial\theta}\hat{\theta} + \frac{1}{r\,\mathrm{sen}\theta}\frac{\partial}{\partial\varphi}\hat{\varphi}$$

$$\vec{\nabla}\wedge\vec{A} = \left(\frac{1}{\rho}\frac{\partial A_z}{\partial\varphi} - \frac{\partial A_\varphi}{\partial z}\right)\hat{\rho} + \left(\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial\rho}\right)\hat{\varphi} + \left(\frac{\partial(\rho A_\varphi)}{\partial\rho} - \frac{\partial A_\rho}{\partial\varphi}\right)\hat{k}$$

$$\vec{\nabla}\wedge\vec{B} = \frac{1}{r\,\mathrm{sen}\theta}\left[\frac{\partial}{\partial\theta}(\mathrm{sen}\theta\;B_\varphi) - \frac{\partial B_\theta}{\partial\varphi}\right]\hat{r} + \frac{1}{r}\left[\frac{1}{\mathrm{sen}\theta}\frac{\partial B_r}{\partial\varphi} - \frac{\partial(r B_\varphi)}{\partial r}\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial(r B_\theta)}{\partial r} - \frac{\partial B_r}{\partial\theta}\right]\hat{\varphi}$$

$$\vec{F}(\vec{r}) = -\frac{G M_T\, m}{r^2}\hat{r} \qquad V(r) = -\int_{r_0}^{r} F(r')\,dr' \qquad V_{efetivo} = \frac{L^2}{2mr^2} + V(r)$$

$$\vec{F} = -\vec{\nabla}V$$

$$\int_{r_0}^{r}\frac{dr}{(E - V(r) - \frac{L^2}{2mr^2})^{1/2}} = \sqrt{\frac{2}{m}}\,t \qquad mr^2\dot{\theta} = L \qquad \vec{L} = \vec{r}\wedge\vec{p}$$

$$\int_{r_0}^{r}\frac{L}{mr^2}\frac{dr}{\left(E - V(r) - \frac{L^2}{2mr^2}\right)^{1/2}} = \sqrt{\frac{2}{m}}(\theta - \theta_0)$$

$\frac{1}{r} = B + A\cos\theta$ onde $B > A$ elípse com $B = \frac{1}{a(1-\varepsilon^2)}$ e $A = \varepsilon B$

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$$\frac{d^2u}{d\theta^2}+u=-\frac{m}{L^2u^2}F(\frac{1}{u}) \text{ , u=1/r} \qquad \left(\frac{du}{d\theta}\right)^2+u^2=\frac{2m}{L^2}\left[E-V\left(\frac{1}{u}\right)\right]$$

$$E=\frac{1}{2}m\dot{r}^2+\frac{L^2}{2mr^2}+V(r)$$

$$\left(\frac{d\vec{A}}{d\,t}\right)_S=\left(\frac{d\vec{A}}{d\,t}\right)_{S'}+\vec{\omega}\wedge\vec{A}$$

$$m\left(\frac{d^2\vec{r}}{d\,t^2}\right)_S=m\left(\frac{d^2r}{d\,t^2}\right)_{S'}+2m\vec{\omega}\wedge\vec{v}'+m\,\vec{\omega}\wedge(\vec{\omega}\wedge\vec{r})+m\dot{\vec{\omega}}\wedge\vec{r}$$

$$Q_k=\sum_{i=1}^{N}F_{ix}\frac{\partial x_i}{\partial q_k}+F_{iy}\frac{\partial y_i}{\partial q_k}+F_{iz}\frac{\partial z_i}{\partial q_k} \qquad Q_k=-\frac{\partial V}{\partial q_k} \qquad \frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_k}\right)-\frac{\partial T}{\partial q_k}=Q_k$$

$$\left(\frac{\partial T}{\partial \dot{q}_k}\right)=p_k$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_k}\right)-\frac{\partial L}{\partial q_k}=0 \quad \text{onde } L=T-V$$

$$T=\sum_{k=1}^{3N}\sum_{l=1}^{3N}\frac{1}{2}A_{kl}\dot{q}_k\dot{q}_l+\sum_{k=1}^{3N}B_k\dot{q}_k+T_0$$

$$A_{kl}=\sum_{i=1}^{N}m_i\left(\frac{\partial x_i}{\partial q_k}\frac{\partial x_i}{\partial q_l}+\frac{\partial y_i}{\partial q_k}\frac{\partial y_i}{\partial q_l}+\frac{\partial z_i}{\partial q_k}\frac{\partial z_i}{\partial q_l}\right)$$

$$B_k=\sum_{i=1}^{N}m_i\left(\frac{\partial x_i}{\partial q_k}\frac{\partial x_i}{\partial t}+\frac{\partial y_i}{\partial q_k}\frac{\partial y_i}{\partial t}+\frac{\partial z_i}{\partial q_k}\frac{\partial z_i}{\partial t}\right)$$

$$T_0=\sum_{i=1}^{N}\frac{1}{2}m_i\left[\left(\frac{\partial x_i}{\partial t}\right)^2+\left(\frac{\partial y_i}{\partial t}\right)^2+\left(\frac{\partial z_i}{\partial t}\right)^2\right]$$

$$H=\sum_{k=1}^{f}p_k\dot{q}_k-L$$

$$\dot{q}_k=\frac{\partial H}{\partial p_k}$$

$$\dot{p}_k=-\frac{\partial H}{\partial q_k}$$

$$\frac{\partial H}{\partial t}=-\frac{\partial L}{\partial t} \quad \text{com } k=1,2,\text{........}, f$$