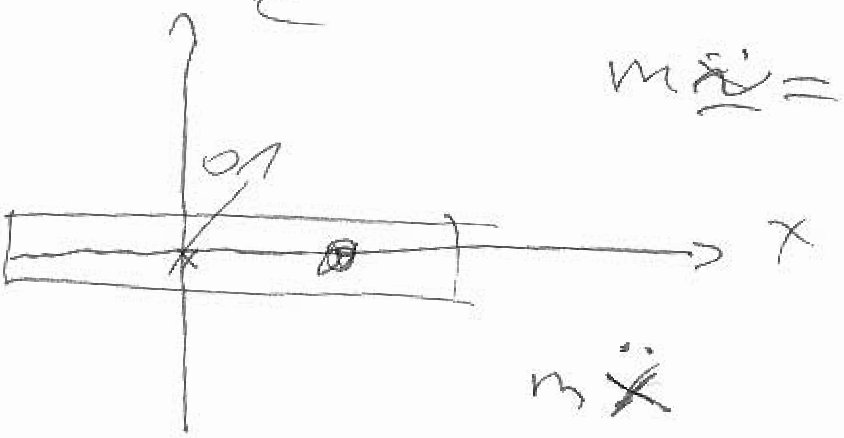


$$m\ddot{\underline{r}} = \underline{F} - 2m\underline{\omega}\times\underline{v}$$
$$-m\underline{\omega}\times(\underline{\omega}\times\underline{r})$$
$$\underbrace{\cancel{-m\dot{\underline{\omega}}\times\underline{r}}}_{0}$$

$m\cancel{\ddot{x}}$

$$\underline{r}' = \underline{r}'(\underline{r}(t), t)$$

$\boxed{\underline{\omega}=(0,0,\omega)}$ $\quad \underline{F} = \underline{N}$

$$\ddot{\underline{r}} = (\ddot{x}, \ddot{y}, \ddot{z}) =$$

$\hat{e}_z \times \hat{e}_y$

$-\hat{e}_y \times \hat{e}_z$

$$\left\{\begin{aligned} \ddot{\underline{r}} &= (\ddot{x}, 0, 0) \\ \dot{\underline{r}} &= (\dot{x}, 0, 0) \\ \underline{r} &= (x(t), 0, 0) \end{aligned}\right.$$

$$m\ddot{x} = 0 + m\omega^2 x$$
$$0 = m\ddot{y} = N_y - 2m\omega v$$
$$0 = m\ddot{z} = N_z \quad \cancel{\omega^2 x}$$

$$\ddot{x} = \underbrace{\cancel{m}\omega^2}_{>0} x \quad / \; e^{\lambda t}$$

$\cancel{x(t)}$ $\quad x(t)$ $\qquad \lambda^2 = \cancel{m}\omega^2$

$\lambda = \pm\sqrt{\cancel{m}\omega^2} = \omega$

$e^{\omega t} \quad e^{-\omega t}$

$x(0) := 0 \qquad \dot{x}(0) = v$

$$x(t) = c_1 e^{\omega t} + c_2 e^{-\omega t}$$

$$0 = x(0) = c_1 + c_2 \quad \frac{A}{2} := c_1 = -c_2$$

$$-\dot{x}(t) = c_1 \omega e^{\omega t} \cancel{+} \omega c_2 e^{-\omega t} =$$

$$v = \dot{x}(0) = c_1 \omega - c_2 \omega = \frac{A}{2}(\omega - (-1)\omega) =$$

$$v = A\omega$$

$$A = \frac{v}{\omega}$$

$$x(t) = A \underbrace{\frac{1}{2}\left(e^{\omega t} - e^{-\omega t}\right)}_{sh(\omega t)}$$

$$\ddot{x}(t) = -\frac{D}{m}x + \omega^2 x$$

$$\ddot{x}(t) = -\underbrace{\left(\frac{D}{m} - \omega^2\right)}\, x$$

$$\frac{D}{m} - \omega^2 < 0 \Rightarrow \quad 1.$$

$$\frac{D}{m} - \underbrace{\omega^2}_{\omega_0^2} = 0$$

ω_0

$$\frac{D}{m} - \omega^2 > 0$$

$x(t) = A\cos(\omega_0 t + \varphi_0)$

$\dot{x}(t) = -A\omega \sin(\omega_0 t + \varphi_0)$

$$\begin{cases} x(0) = A\cos(\varphi_0) \\ \dot{x}(0) = -A\omega \sin(\varphi_0) \end{cases}$$

$$\frac{\dot{x}(0)}{x(0)} = -\omega \, tg(\varphi_0)$$

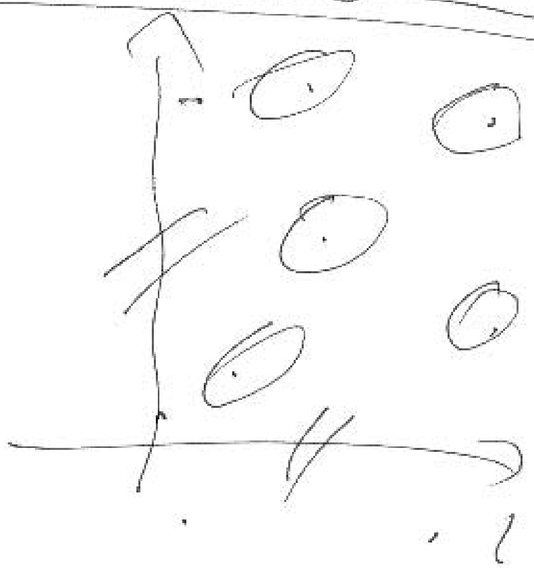
$\dot{x}(0) \rightsquigarrow$

---

② $x(t) = R\cos(\alpha t^2 + \delta)$

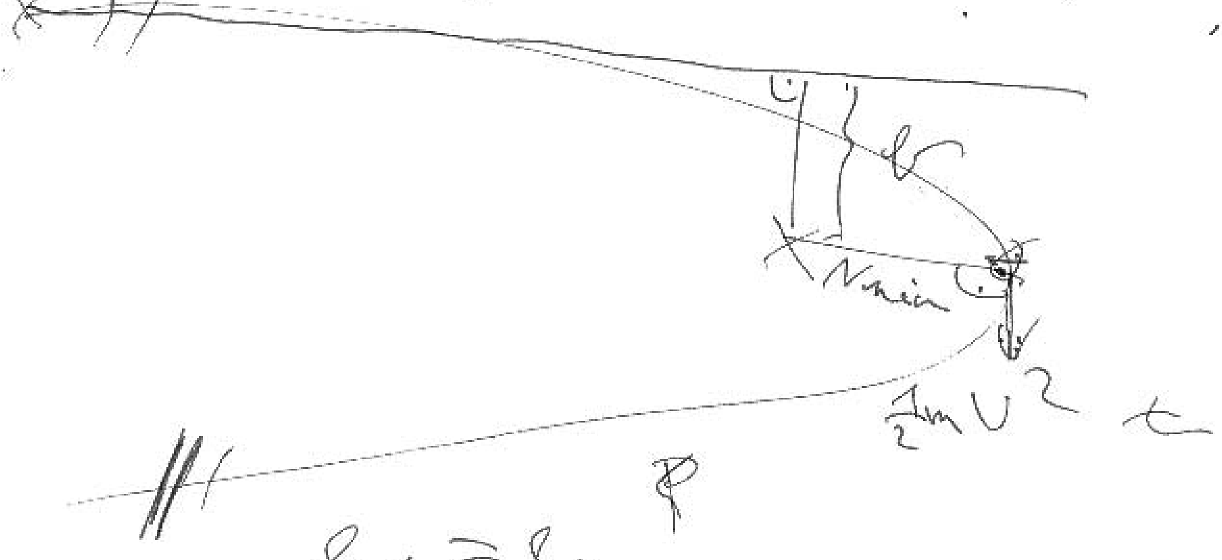
$y(t) = R\sin(\alpha t^2 + \delta)$

$$\begin{cases} \dot{x}(t) \\ \dot{y}(t) \end{cases}$$



③

flip



$\ell_1 = \ell_2$

$\boxed{E, \; \ell} \rightsquigarrow$

$$r(\varphi) = \frac{p}{1 + \varepsilon \cos(\varphi - \varphi_0)}$$

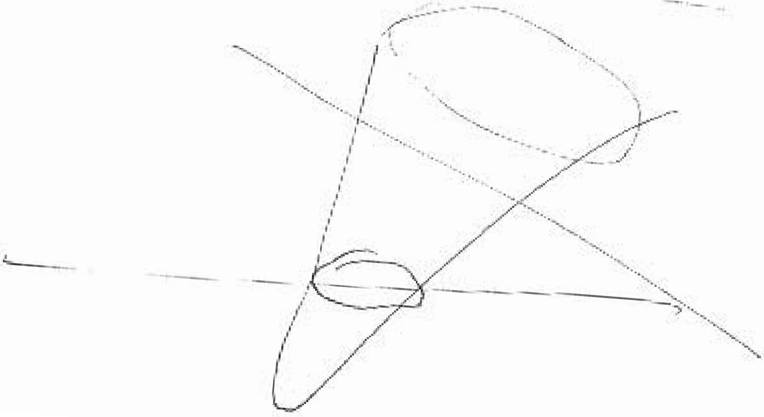
$\varphi_0 := 0$

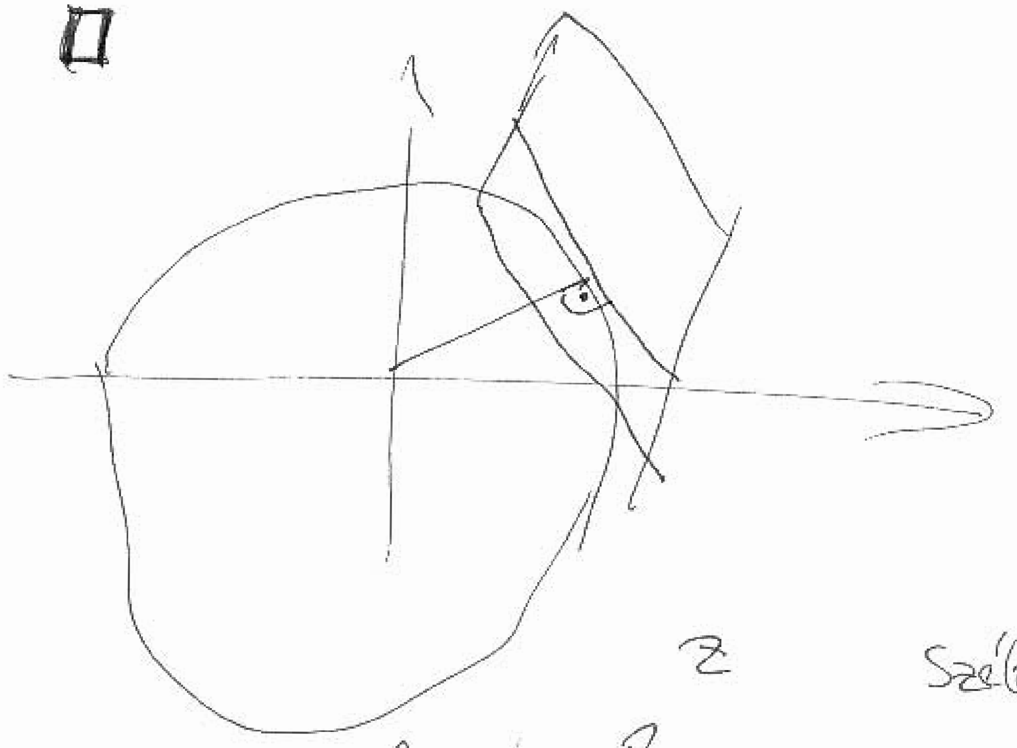
$$r_{min} = \frac{p}{1 + \varepsilon}$$

E, ℓ

$\varepsilon \; , \; p$

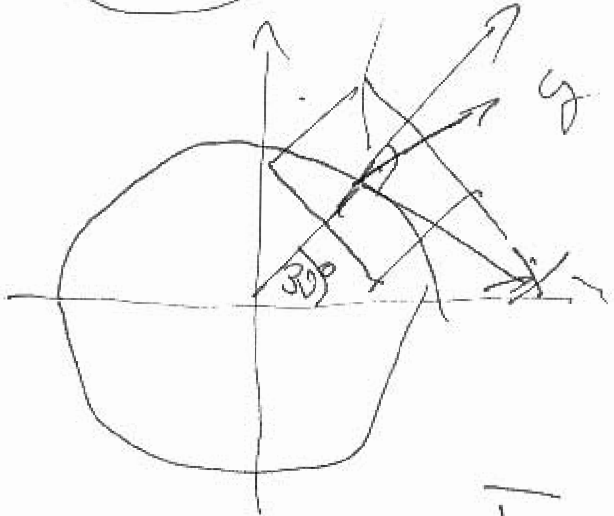
$\hookrightarrow p = \dfrac{\ell^2}{m A}$ $\qquad \varepsilon = \sqrt{1 + \dfrac{2E}{m} \dfrac{\ell^2}{A^2}}$





$T = 24h$

$\omega =$



Szélesség

mg

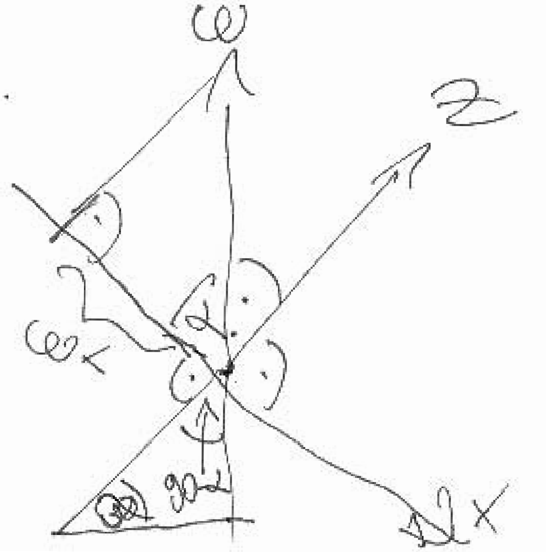
mg

$\underline{g} = (0, 0, -g)$

$$m\ddot{\underline{r}} = \underline{F} - 2m(\underline{\omega} \times \underline{v}) + 0$$

$$\underline{F} = \underline{N} + m\underline{g}$$

$\underline{\omega} \times \underline{v}$



$\underline{v} = (0, v, 0)$

$\underline{r} = (0, y, 0)$

$\underline{a} = (0, 0, 0)$

$\alpha = 30$

$\underline{\omega} = \omega(-\cos\alpha, \sin\alpha, 0)$

$\underline{\omega} = \omega\left(-\frac{\sqrt{3}}{2}, \frac{1}{2}, 0\right)$

$$\underline{\omega} \times \underline{V} = \omega \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} & 0 \\ 0 & V & 0 \end{vmatrix} =$$

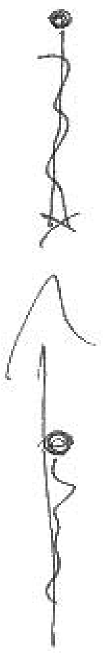
$$= 0\hat{i} + \cancel{\frac{\sqrt{3}}{2}}\, 0\hat{j} \boxed{\cancel{+}\, \frac{\sqrt{3}}{2}\omega V \hat{k}}$$

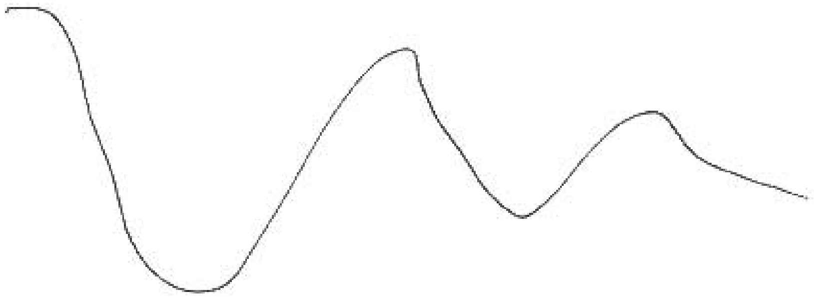
$$0 = m\ddot{x} = N_x$$

$$0 = m\ddot{y} = N_y$$

$$0 = m\ddot{z} = -mg + N_z + 2\cdot\frac{\sqrt{3}}{2}\omega V$$

$$N_z = mg + 2\frac{\sqrt{3}}{2}\omega V$$





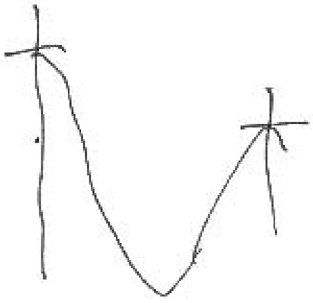
$$\beta = \frac{r}{2m}$$

$$m\ddot{x} = -\frac{r}{m}\dot{x} - Dx$$

$$\ddot{x} + 2\beta\dot{x} + \frac{D}{m}x = 0$$

$$x(t) = e^{-\beta t}\cos(\omega t + \varphi_0)$$

$$\omega = \sqrt{\omega_0^2 - \beta^2}$$



$$T = \frac{2\pi}{\omega} \qquad \boxed{\omega_0 = \sqrt{\frac{D}{m}}}$$

$$x(t+T) \neq x(t)$$

$$\frac{x(t+T)}{x(t)} = \frac{e^{-\beta(t+T)}}{e^{-\beta(t)}} =$$

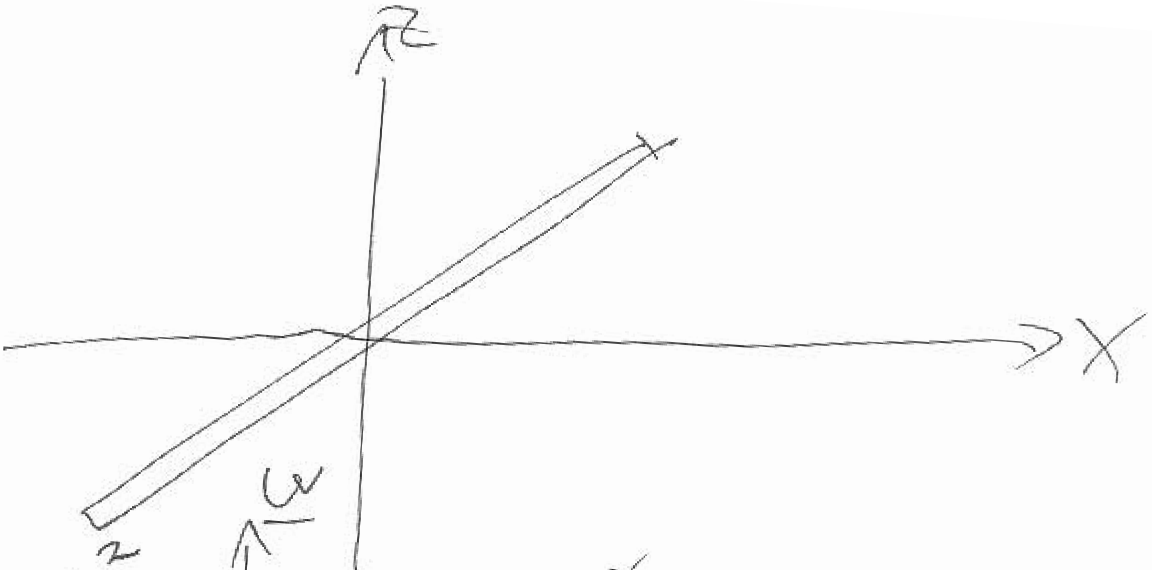
$$\frac{x(t)}{x(t+T)} = e^{\beta T}$$

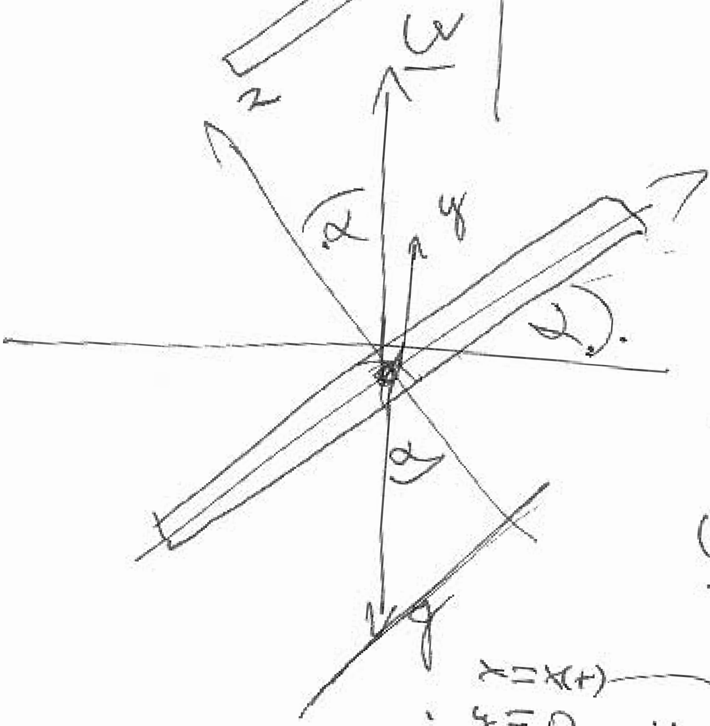
$$\frac{x(t+T)}{x(t)} = e^{-\beta T}$$

$$\Lambda = \ln\left(x(t)/x(t+T)\right) = \beta T$$

$$\frac{10}{1}$$

$$\omega = \sqrt{\omega_0^2 - \beta^2}$$





$\underline{g} = g(-\sin\alpha, 0, -\cos\alpha)$

$\underline{\omega} = \omega(\sin\alpha, 0, \cos\alpha)$

$x = x(t)$, $y = 0$, $z = 0$

$\dot{x} = \dot{x}(t)$, $\dot{y} = 0$, $\dot{z} = 0$

$\ddot{x} = \ddot{x}(t)$, $\ddot{y} = 0$, $\ddot{z} = 0$

$\underline{\omega} \times \underline{v}$

$$\omega \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \sin\alpha & 0 & \cos\alpha \\ \dot{x} & 0 & 0 \end{vmatrix} = 0 + \boxed{\omega \dot{x} \cos\alpha\, \hat{j}} + 0$$

$\underline{\omega} \times \underline{v} =$ $\boxed{\omega \dot{x} \cos\alpha\, \hat{j}}$

$$\underline{\omega} \times (\underline{\omega} \times \underline{r}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \sin\alpha & 0 & \cos\alpha \\ 0 & x\cos\alpha & 0 \end{vmatrix} \omega^2 =$$

$= \left(-\hat{i} \cos^2\alpha + \hat{k} \sin\cos\alpha \right) \omega^2 x =$

$m\ddot{\underline{r}} = \underline{F} - \cancel{mg}\, 2m\, \underline{\omega} \times \underline{v} - \cancel{m\omega \times (\omega \times r)}$ $m\underline{\omega} \times (\underline{\omega} \times \underline{r})$

$m\ddot{\underline{r}} = m\underline{g} - 2m(\underline{\omega} \times \underline{v}) - m\underline{\omega} \times (\underline{\omega} \times \underline{r})$

$m\ddot{x} = -mg\sin\alpha - 2 \; 0 \; + m\cos^2\alpha\, \omega^2 x$

$0 = m\ddot{y} = 0 + N_y - 2m\omega v\cos\alpha \quad 0$

$0 = m\ddot{z} = N_z - mg\cos\alpha + 0 \; \omega^2 x m \cos\alpha\sin\alpha$

$\ddot{x} = -g\sin\alpha + \cos^2\alpha\, \omega^2 x$

$\ddot{x} = -\lambda\dot{x} + mg$

$x \quad x_2 \quad 0 = -\lambda\dot{x} - mg$

$x(t) = \omega + \omega^2$