Velikost tečného a norm. zrychlení při vodorovném vrhu

$\vec{v}_0 = (v_0, 0, 0)$

$\vec{a} = (0, 0, -g)$

$\vec{r}_0 = (0, 0, h)$

$a_t = \frac{d\|\vec{v}\|}{dt}$

$a_n = \sqrt{a^2 - a_t^2}$

$\vec{v}(t) = (v_0, 0, -gt)$

$\|\vec{v}\| = \sqrt{v_0^2 + (gt)^2}$

$$a_t = \frac{2g^2 t}{2\sqrt{v_0^2 + g^2t^2}} = \frac{g^2 t}{\sqrt{v_0^2 + g^2 t^2}}$$

$$a_n = \sqrt{|\vec{a}|^2 - a_t^2} = \sqrt{g^2 - \frac{g^4 t^2}{v_0^2 + g^2 t^2}}$$

$$= g\sqrt{1 - \frac{g^2 t^2}{v_0^2 + g^2 t^2}} = g\sqrt{\frac{v_0^2}{v_0^2 + g^2 t^2}}$$

$$= \frac{g v_0}{\sqrt{v_0^2 + g^2 t^2}}$$

úkol:
2.23 – BOMBARDÉR (HOLUB)

kruhový pohyb:

$2\vec{r}\frac{d\vec{r}}{dt} = \vec{r}\cdot\vec{v}\cdot 2 = 0$

$\varphi(t) = \frac{s(t)}{r}$

$\omega(t) = \frac{d\varphi(t)}{dt}$

Obvodová rychlost:

$$\vec{v} = \vec{\omega} \times \vec{r}$$

$$\vec{a} = \frac{d(\vec{\omega} \times \vec{r})}{dt} = \underbrace{\frac{d\vec{\omega}}{dt}}_{\varepsilon} \times \vec{r} + \vec{\omega} \times \underbrace{\frac{d\vec{r}}{dt}}_{\vec{v}}$$

$$\vec{a} = \vec{\varepsilon} \times \vec{r} + \vec{\omega} \times \vec{v}$$

$$\vec{\omega} \times (\vec{\omega} \times \vec{r}) = bac - cab$$

$$= -\omega^2 r^2$$

2.28 Rumpál

$s(t) = \frac{1}{2} k t^2$

$k > 0$

$$v = \dot{s}(t) = kt$$

$$a_{posun} = \ddot{s} = k$$

$$a_t = k$$

$$v_{obvod} = kt$$

$$a_n = \frac{v^2}{R}$$

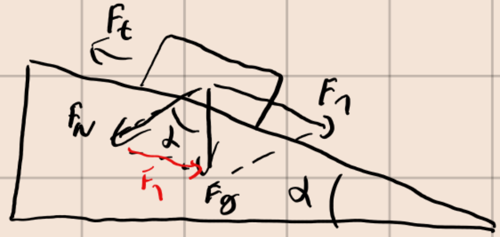
$$a_n = \frac{(kt)^2}{R}$$

$$a = \sqrt{a_t^2 + a_n^2} = \sqrt{k^2 + \frac{k^4 t^4}{R^2}}$$

$$\vec{a}(t) = \vec{a}_t(t) + \vec{a}_n(t)$$

3.6

$\boxed{x}$:



$F_t = \mu F_N$

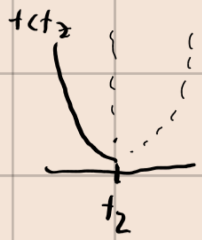
$\mu = ?$ abs $v = konst.$

$F_1 = F_t$

$\cancel{F_g} \cdot \sin\alpha = \mu \cdot \cancel{F_g} \cdot \cos\alpha$

$\operatorname{tg}\alpha = \mu$

3.9 Loď



$F_{brzdící}$ => rovnoměrně zpomalený pohyb

$v(t) = k^2 (t - t_z)^2$

čas zastavení

$a(t) = \frac{dv}{dt} = 2k^2 (t - t_z) = -2k^2 |t - t_z| = -2k\sqrt{v}$

$\sqrt{v(t)} = k|t - t_z|$

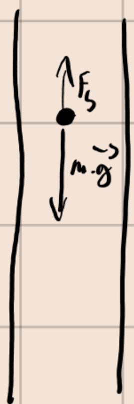
$F \sim -\sqrt{v}$

3.13 Kulička v oleji

malý průměr — vazká kapalina

Stokesova síla:

$\vec{F} = -k \cdot \vec{v} \quad | \; k > 0$



$F = \vec{F_g} + \vec{F_s}$

$F = m \cdot g - kv$

$m \frac{dv}{dt} = \underbrace{m \cdot g - kv}_{b(v)}$

dif. rovnice řešená separací

$$\int_0^{v(t)} \frac{m\,dv}{mg-kv} = \int_0^t dt$$

$$t = \int_0^{v} \frac{m\,dv}{mg-kv} \qquad \left| \begin{array}{l} s = mg - kv \\ ds = -k\,dv \\ dv = -\frac{ds}{k} \end{array} \right| \qquad \begin{array}{l} v=0 \rightarrow s = mg \\ v=v \rightarrow s = mg-kv \end{array}$$

$$t = \int_{mg}^{mg-kv} -\frac{m}{k}\,\frac{ds}{s} = -\frac{m}{k}\int_{mg}^{mg-kv} \frac{ds}{s} = -\frac{m}{k}\left[\ln|s|\right]_{mg}^{mg-kv} = -\frac{m}{k}\left|\frac{mg-kv}{mg}\right|$$

$$t = -\frac{m}{k}\left|\frac{mg-kv}{mg}\right|$$

$$e^{\left(-\frac{kt}{m}\right)} = \frac{mg-kv}{mg}$$

$$\frac{mg - mg\cdot e^{\left(-\frac{kt}{m}\right)}}{k} = v$$

$$v = \frac{mg}{k}\left(1 - e^{\left(-\frac{kt}{m}\right)}\right)$$