Macchina in frenata

partendo da $v_1 = 80\ Km/h$
frenata in $d = 57\ m$
partendo da $v_2 = 52\ Km/h$
frenata in $d = 25\ m$

1) $a = ?$ 2) $t_{reazione} = ?$

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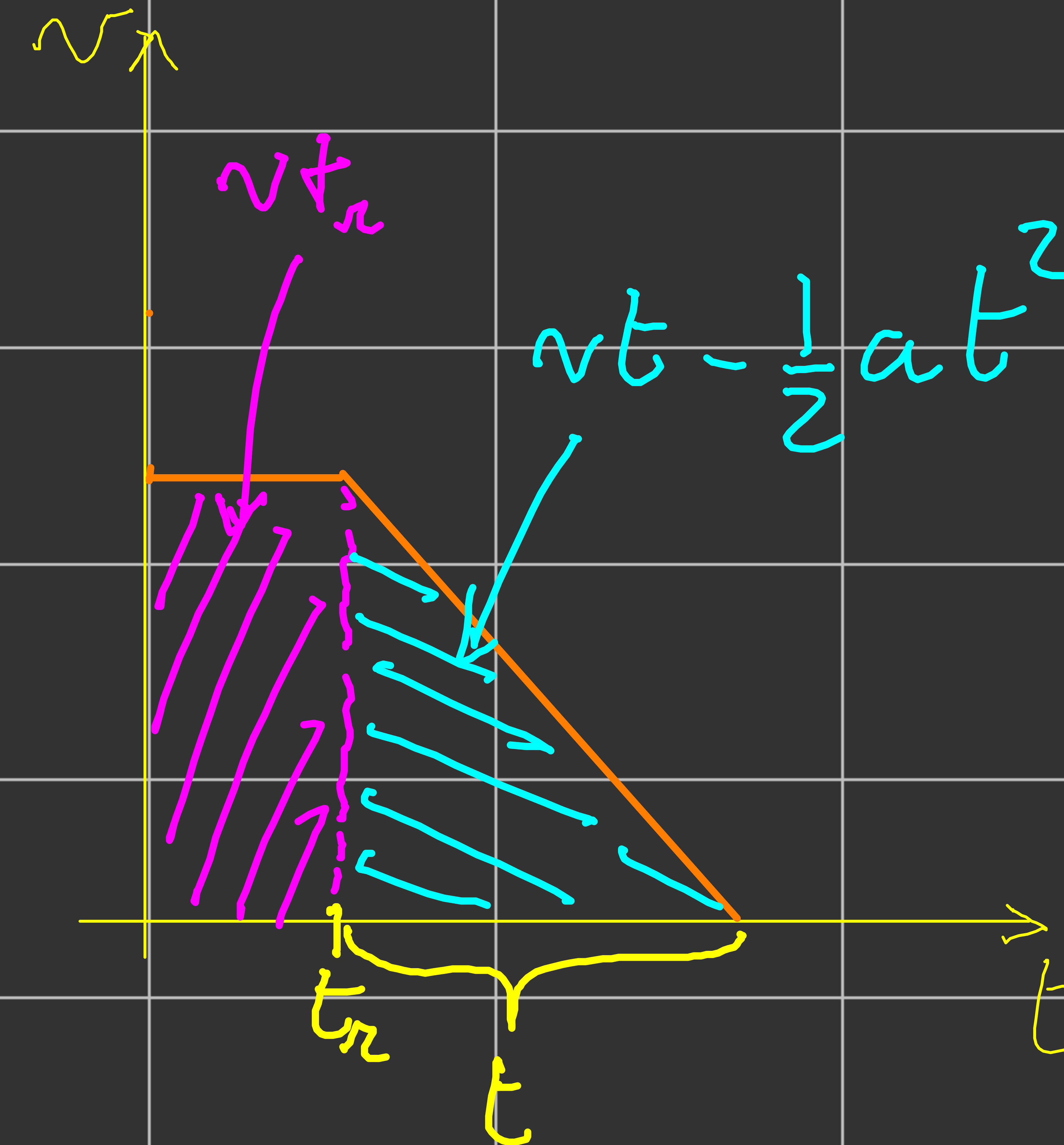

$$\begin{cases} d_1 = v_1 t_r + v_1 t_1 - \frac{1}{2} a t_1^2 \\ d_2 = v_2 t_r + v_2 t_2 - \frac{1}{2} a t_2^2 \end{cases}$$

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$$\begin{cases} d_1 = v_1 t_r + v_1 t_1 - \frac{1}{2} a t_1^2 \\ d_2 = v_2 t_r + v_2 t_2 - \frac{1}{2} a t_2^2 \end{cases}$$

$$v_1 = a t_1 \rightarrow t_1 = \frac{v_1}{a}$$

$$v_2 = a t_2 \rightarrow t_2 = \frac{v_2}{a}$$

$$\begin{cases} d_1 = v_1 t_r + \frac{v_1^2}{a} - \frac{1}{2} a \frac{v_1^2}{a^2} \\ d_2 = v_2 t_r + \frac{v_2^2}{a} - \frac{1}{2} a \frac{v_2^2}{a^2} \end{cases}$$

$$\begin{cases} d_1 = \underline{v_1 t_r} + \underline{\frac{1}{2} \frac{v_1^2}{a}} \\ d_2 = \underbrace{v_2 t_r}_{\text{rettangolo}} + \underbrace{\frac{1}{2} \frac{v_2^2}{a}}_{\text{triangolo}} \end{cases}$$

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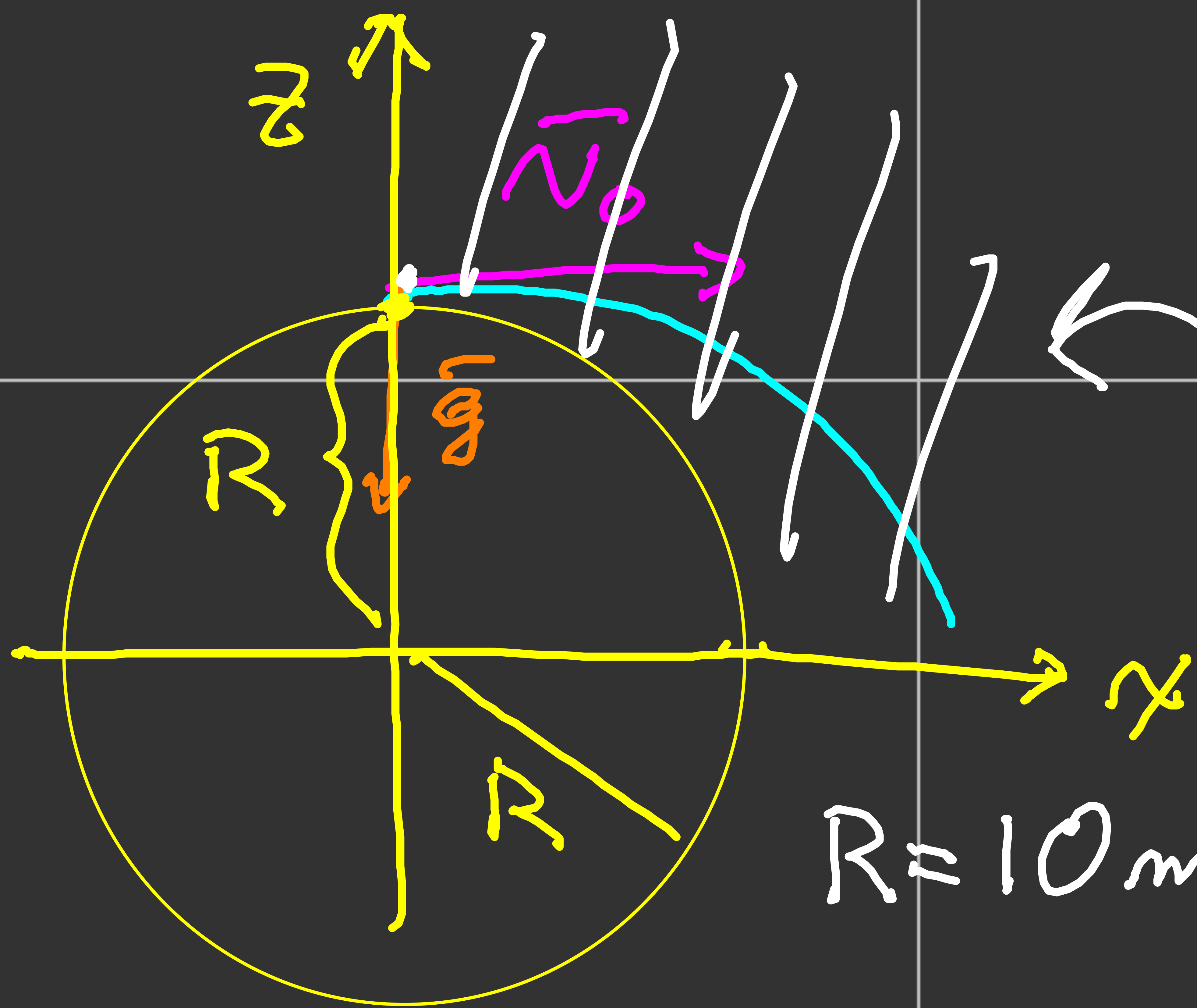
$$\begin{cases} t_r = \frac{d_1}{v_1} - \frac{v_1}{2a} \\ d_2 = \frac{v_2 d_1}{v_1} - \frac{v_1 v_2}{2a} + \frac{v_2^2}{2a} \end{cases}$$

$$\begin{cases} t_r = \boxed{0.18\ s} \\ a = \frac{1}{2} \frac{v_2^2 v_1 - v_1^2 v_2}{v_1 d_2 - v_2 d_1} = \boxed{1.7\ m/s^2} \end{cases}$$

$$\begin{cases} d_1 = v_1 t_r + \frac{1}{2} \frac{v_1^2}{a} \\ d_2 = v_2 t_r + \frac{1}{2} \frac{v_2^2}{a} \end{cases}$$

Collina semisferica

1



$R = 10\,m$

v_0 minima affinché il pallone non atterri sulla collina

LEGGI ORARIE

$$\begin{cases} x(t) = v_0 t \rightarrow t = \dfrac{x}{v_0} \\ z(t) = z(0) - \dfrac{1}{2} g t^2 = z(0) - \dfrac{1}{2} g \dfrac{v_0^2}{x^2} \end{cases}$$

superficie sfera

$$x_s^2 + z_s^2 = R^2$$

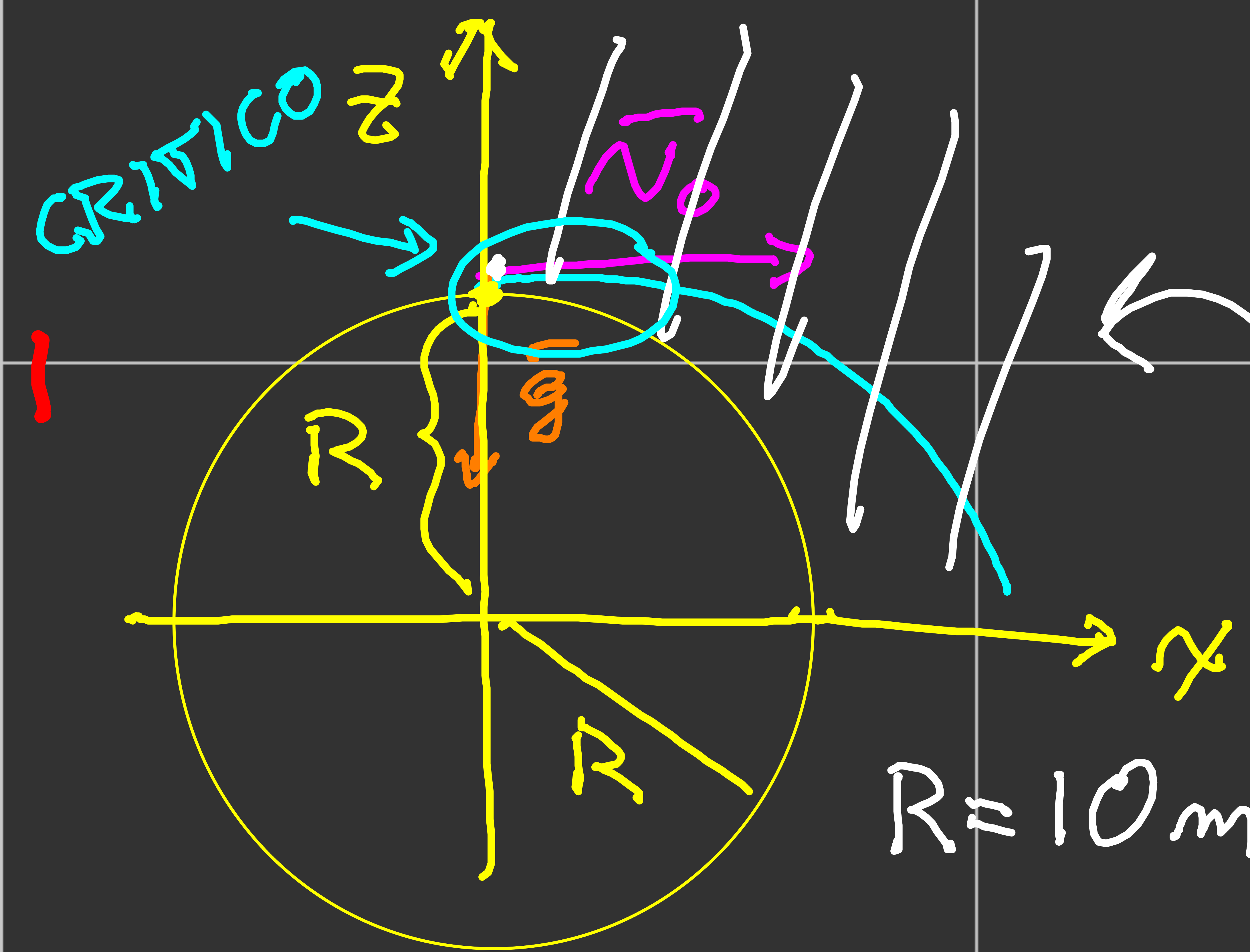
affinché il pallone non tocchi la sfera

$$x^2(t) + z^2(t) > R^2$$

$$x^2 + \left(\overset{=R}{z_0} - \frac{1}{2} g \frac{x^2}{v_0^2}\right)^2 > R^2$$

Traiettorie

Collina semisferica



$R = 10\,m$

v_0 minima affinché il pallone non atterri sulla collina

$$x^2(t) + z^2(t) > R^2$$

$$x^2 + \left(\underbrace{z_0}_{=R} - \frac{1}{2} g \frac{x^2}{v_0^2}\right)^2 > R^2$$

$$x^2 + R^2 - Rg\frac{x^2}{v_0^2} + \frac{g^2 x^4}{4 v_0^4} > R^2$$

ZONA CRITICA: x piccola

$$x^4 \ll x^2$$

trascuro x^4

$$x^2\left(1 - \frac{Rg}{v_0^2}\right) > R^2 - R^2$$
$$> 0$$

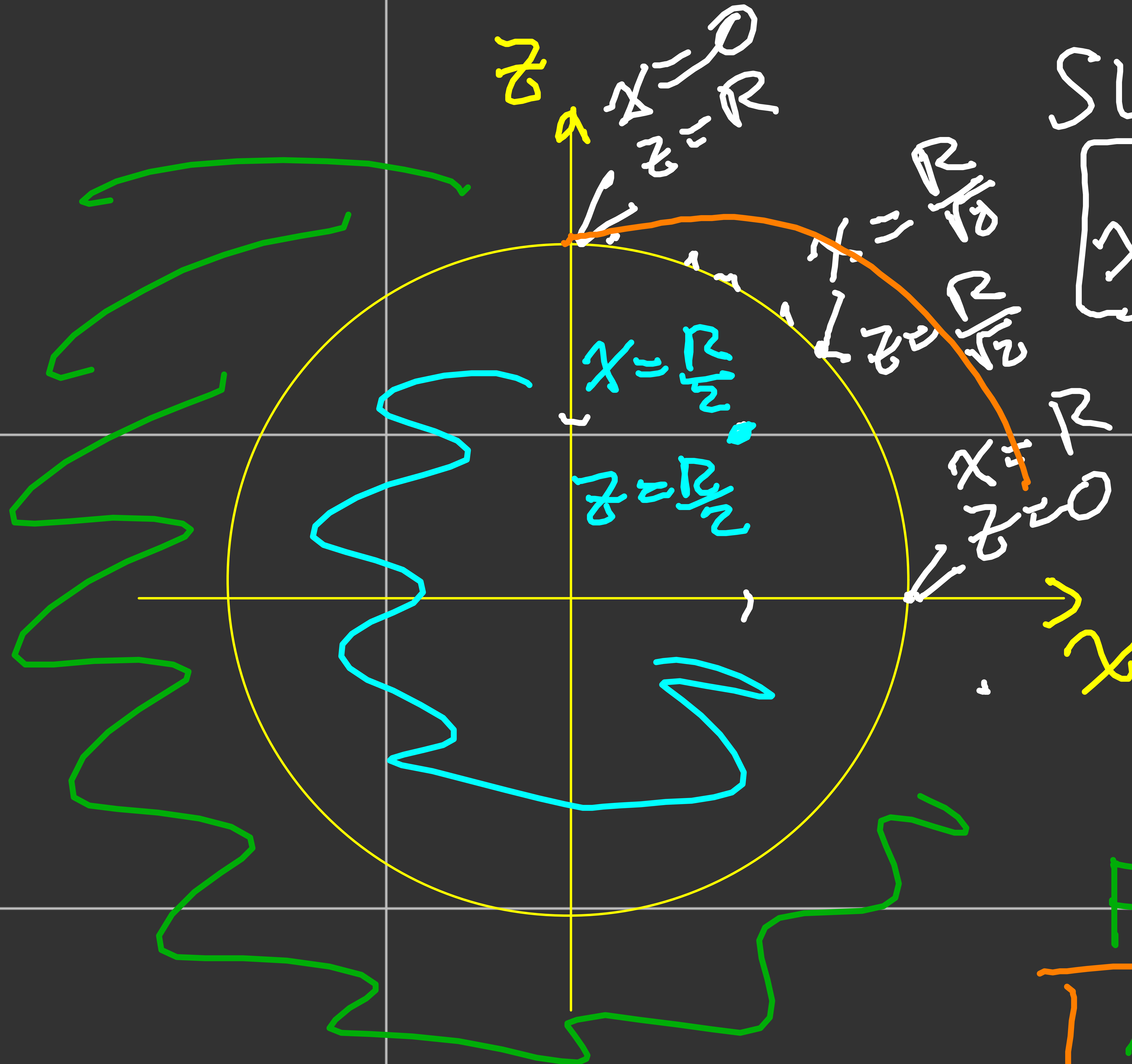
$$1 - \frac{Rg}{v_0^2} > 0$$

$$\frac{Rg}{v_0^2} < 1$$

$$Rg < v_0^2$$

$$v_0 > \sqrt{Rg}$$

$$\boxed{v_0 > 9.9\ m/s}$$



SULLA CRF

$$\boxed{x^2+z^2=R^2}$$

DENTRO CRF

$$x^2+z^2=\frac{R^2}{4}+\frac{R^2}{4}=\frac{R^2}{2}<R$$

$$x^2+z^2<R$$

FUORI CRF

$$\boxed{x^2+z^2>R}$$

Moto circolare NON uniforme

punto materiale

traiettoria circolare

$R = 10\,m$

$\omega(t) = A\sqrt{t}$

$A = 2.0\ rad/s^{3/2}$

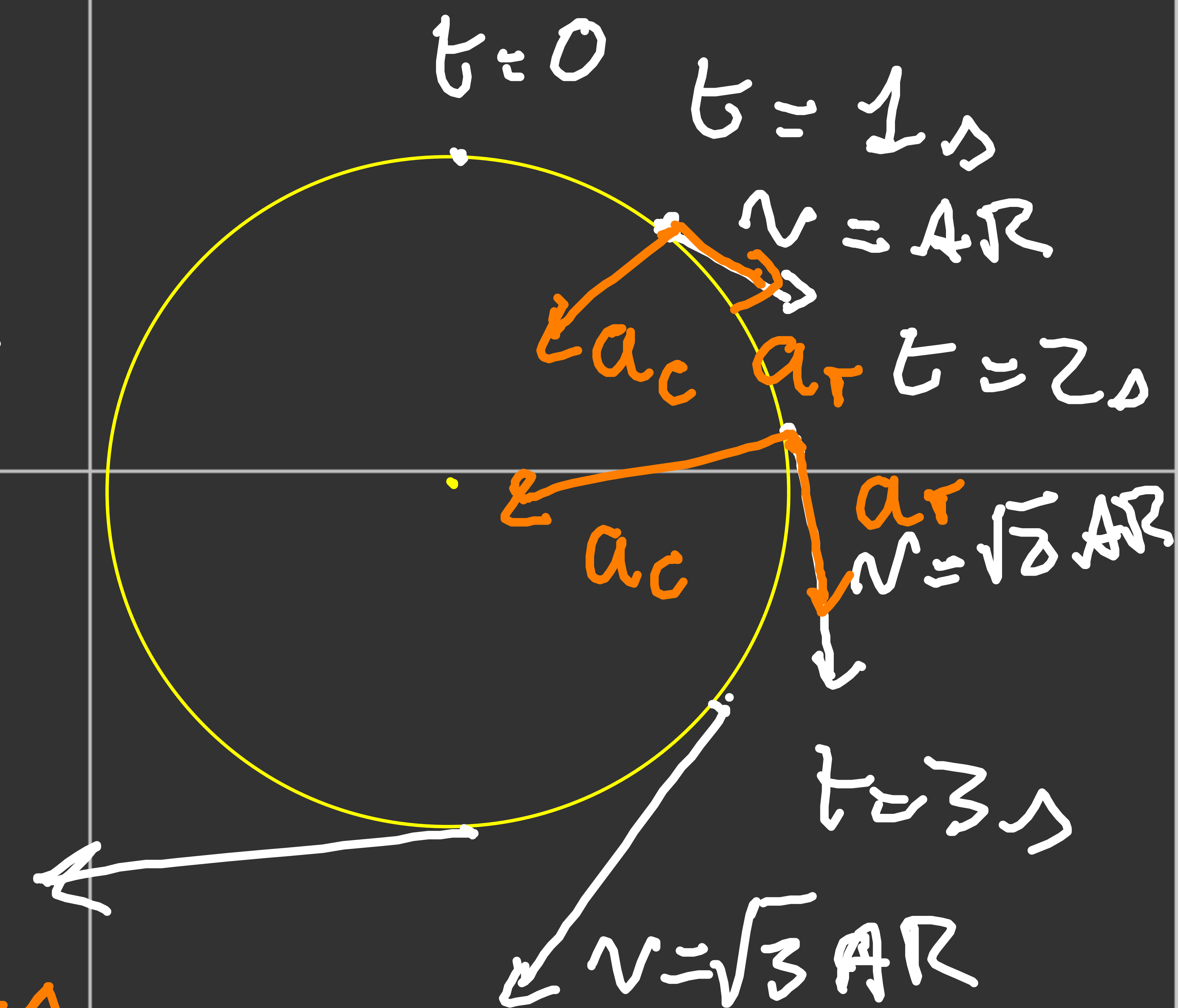
a) con $t_1 = 0.4\,s$

$a(t_1) = ?$

$v = \omega R$

$= AR\sqrt{t}$

$$\bar{a} = \frac{d\bar{v}}{dt} = \underbrace{\frac{dv}{dt}\hat{t}}_{a_T} + \underbrace{\frac{v^2}{R}\hat{n}}_{a_c}$$



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punto materiale
traiettoria circolare

$R = 10\,m$

$\omega(t) = A\sqrt{t}$

$A = 2.0\ rad/s^{3/2}$

a) con $t_1 = 0.4\,s$

$a(t_1) = ?$

$a(t_1) = 22\,m/s^2$

$v = \omega R$
$= AR\sqrt{t}$

$$\bar{a} = \frac{d\bar{v}}{dt} = \underbrace{\frac{dv}{dt}}_{a_T}\hat{t} + \underbrace{\frac{v^2}{R}}_{a_C}\hat{n}$$

Per $\hat{t}$ spazio 2D

$$a_T = \frac{dv}{dt} = \frac{d}{dt}\omega R \quad \text{(spazio angolare)}$$
$$= R\frac{d\omega}{dt} = R\frac{A}{2\sqrt{t}}$$

Per $\hat{n}$

$$a_C = \frac{v^2}{R} = \frac{\omega^2 R^2}{R} = A^2 R t$$

$$\bar{a} = \frac{AR}{2\sqrt{t}}\hat{t} + A^2 R t\,\hat{n}$$

$\hat{t} \perp \hat{n}$

$$|\bar{a}| = \sqrt{a_T^2 + a_C^2}$$
$$= \sqrt{\left(\frac{AR}{2\sqrt{t}}\right)^2 + \left(A^2 R t\right)^2}$$

Moto circolare NON uniforme

punto materiale

traiettoria circolare

$R = 10\,m$

$\omega(t) = A\sqrt{t}$

$A = 2.0\ rad/s^{3/2}$

a) con $t_1 = 0.4\,s$

$a(t_1) = ?$

b) t dopo un giro $= ?$ T

$$v = \omega R = AR\sqrt{t}$$

$$\bar{v} = \frac{d\bar{s}}{dt}$$

$$\bar{a} = \frac{d\bar{v}}{dt}$$

1 giro $\vartheta = 2\pi$

$$\omega(t) = \boxed{\frac{d\vartheta}{dt} = A\sqrt{t}}$$

EQ. DIFFERENZIALE

$$\int_0^T \frac{d\vartheta}{dt}\,dt = \int_0^T A\sqrt{t}\,dt$$

$$2\pi = [\vartheta]_0^{2\pi} = \int_0^{2\pi} d\vartheta = A\,\frac{2}{3}\left[t^{3/2}\right]_0^T = \frac{2}{3}AT^{3/2}$$

$$T = \left(\frac{3\pi}{A}\right)^{2/3} = \boxed{2.8\,s}$$

Lampadario in ascensore

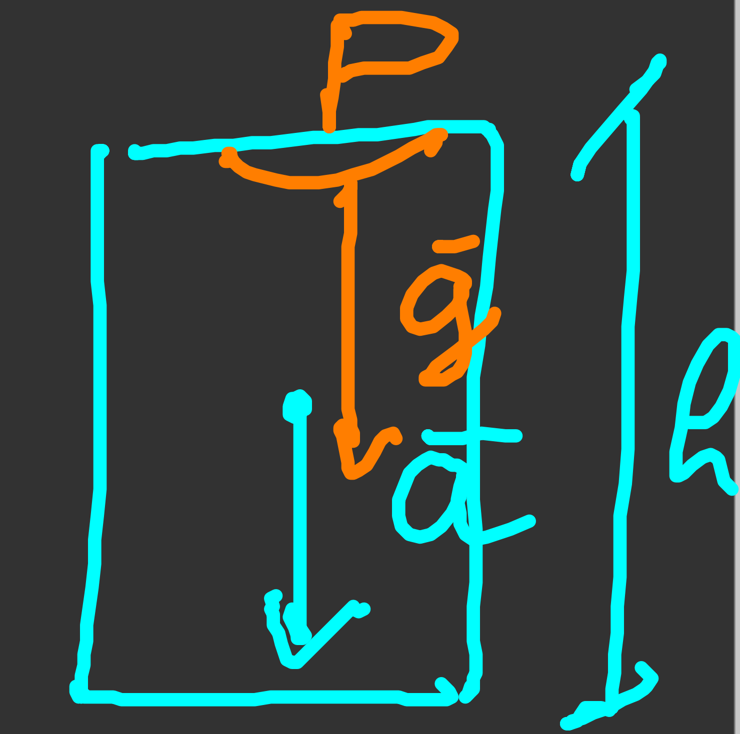
Ascensore discende con $|\bar{a}| = 1.51\, m/s^2$

il lampadario a $t=0$ si stacca

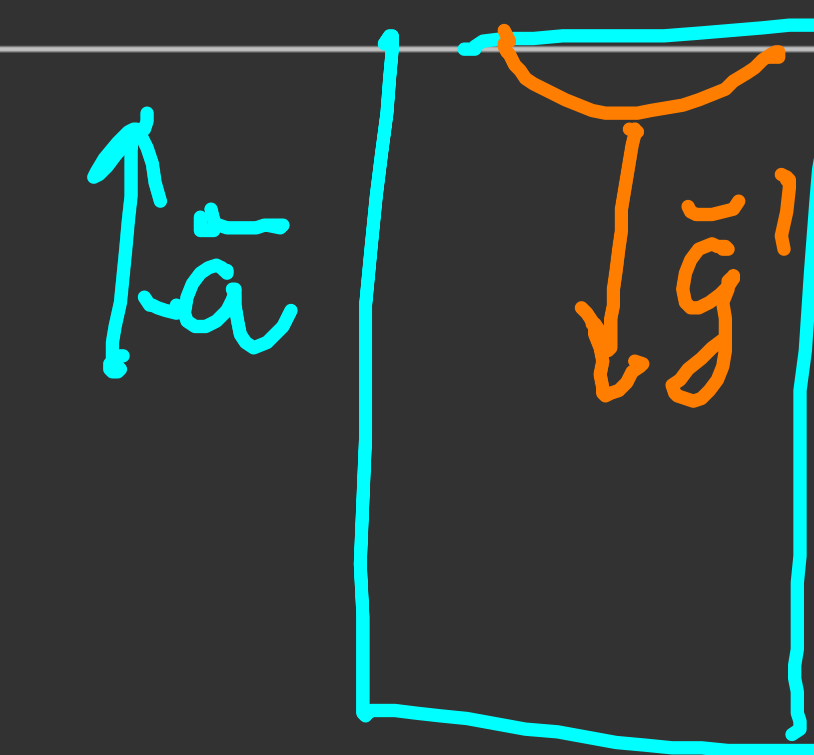
$h = 3m$

$t = ?$ lampadario sul pavimento

(A) esterno



(B) ascensore



$$\bar{a}_{PA} = \bar{a}_{PB} + \bar{a}_{BA}$$

$$\bar{g} = \bar{g}' + \bar{a}$$

1D

$$\bar{g}' = \bar{g} - \bar{a} \rightarrow g' = g - a = 9.81 - 1.51 = 8.30\, m/s^2$$

Lampadario in ascensore

Ascensore discendente con $|\bar{a}| = 1.51\,m/s^2$

Il lampadario a $t=0$ si stacca

$h = 3\,m$

$t = ?$ lampadario sul pavimento

$$\boxed{\bar{a}_{PA} = \bar{a}_{PB} + \bar{a}_{BA}} \quad \forall t$$

$$\bar{g} = \bar{g}' + \bar{a}$$

1D

$$\bar{g}' = \bar{g} - \bar{a} \rightarrow g' = g - a = 9.81 - 1.51 = 8.30\,m/s^2$$

13

$$l = \frac{1}{2} g' t^2$$

$$t = \sqrt{\frac{2l}{g'}} = 0.85\,s = \boxed{0.8\,s}$$

Ⓐ esterno

Ⓑ rotante

$$\bar{a}_{PA} = \frac{d\bar{v}_{PA}}{dt} = \frac{d}{dt}\left(\bar{v}_{PB} + \bar{\omega} \times \bar{r}_{PB}\right)$$

$$= \bar{a}_{PB} + \bar{\omega} \times \bar{v}_{PB} + \frac{d\bar{\omega}}{dt} \times \bar{r}_{PB} + \bar{\omega} \times \frac{d\bar{r}_{PB}}{dt}$$

$\bar{r}_{PA} = \bar{r}_{PB}$ stessa origine

$$\bar{v}_A = \bar{v}_{PB} + \bar{\omega} \times \bar{r}_{PB}$$

$$= \ldots \qquad + \bar{\omega} \times \left(\bar{v}_{PB} + \bar{\omega} \times \bar{r}\right)$$

$$= \bar{a}_{PB} + \frac{d\bar{\omega}}{dt} \times \bar{r} + \bar{\omega} \times (\bar{\omega} \times \bar{r}) + 2\bar{\omega} \times \bar{v}_{PB}$$

a_T $\qquad$ a_C $\qquad$ CORIOLIS

Ⓐ pianeta

Ⓑ esterno