Aufgabe 1) 3/3

$$-F_g \stackrel{!}{=} F_z = \frac{m v_L^2}{r} \Leftrightarrow v_L^2 = -\frac{F_g \cdot r}{m} = g \cdot r \Rightarrow E_{kin} = \frac{1}{2} m v_L^2 = \frac{1}{2} m g r$$

Die kinetische Energie am höchsten Punkt des Loopings ist

$$E_{kin} = \cancel{m} \cdot \cancel{g} \cdot (h - 2r) \stackrel{!}{=} \frac{1}{2} \cancel{m} \cancel{g}\, r$$

$$\Leftrightarrow h - 2r = \frac{1}{2} r$$

$$\Leftrightarrow h = \frac{5}{2} r$$

Aufgabe 2) 5,5/6

a) $$\frac{(-a m_1 + (L+b) m_2)}{m_1 + m_2} = s$$

b) $0 \leq s \leq L$

c) $F_a = \left(1 - \frac{s}{L}\right) \cdot (m_1 + m_2) g \quad F_b = \frac{s}{L} \cdot (m_1 + m_2) g$

Rechnung dazuschreiben!

$s = 0{,}7$ m

$F_a = 8{,}829$ N

$F_b = 20{,}601$ N

Aufgabe 3 7/7

a) $\vec{V}_0 = \hat{e}_z \omega \times \vec{r}_0 = \begin{bmatrix} \omega R \\ 0 \\ 0 \end{bmatrix}$

$\Delta t = \frac{\pi}{\omega}$

b) $V_{ball} = \frac{-2\vec{r}_0}{\Delta t} = \begin{bmatrix} 0 \\ \frac{2}{\pi} R \omega \\ 0 \end{bmatrix}$

$r(t) = V_{ball} \cdot t + \vec{r}_0 \quad$ mit $t \in [0, \Delta t]$

c) $\vec{v}\,' = \vec{V}_{ball} - \vec{V}_0 = \begin{bmatrix} -\omega R \\ \frac{2}{\pi} R \omega \\ 0 \end{bmatrix}$

$$\alpha = \arccos \frac{\vec{v}\,' \cdot \hat{e}_y}{|\vec{v}\,'|} = \arccos \left[\frac{\frac{2}{\pi} R \omega}{\sqrt{(\omega R)^2 + (\frac{2}{\pi} R \omega)^2}} \right]$$

$$= \arccos \frac{2}{\pi \sqrt{1 + \frac{4}{\pi^2}}} \approx 57{,}518°$$

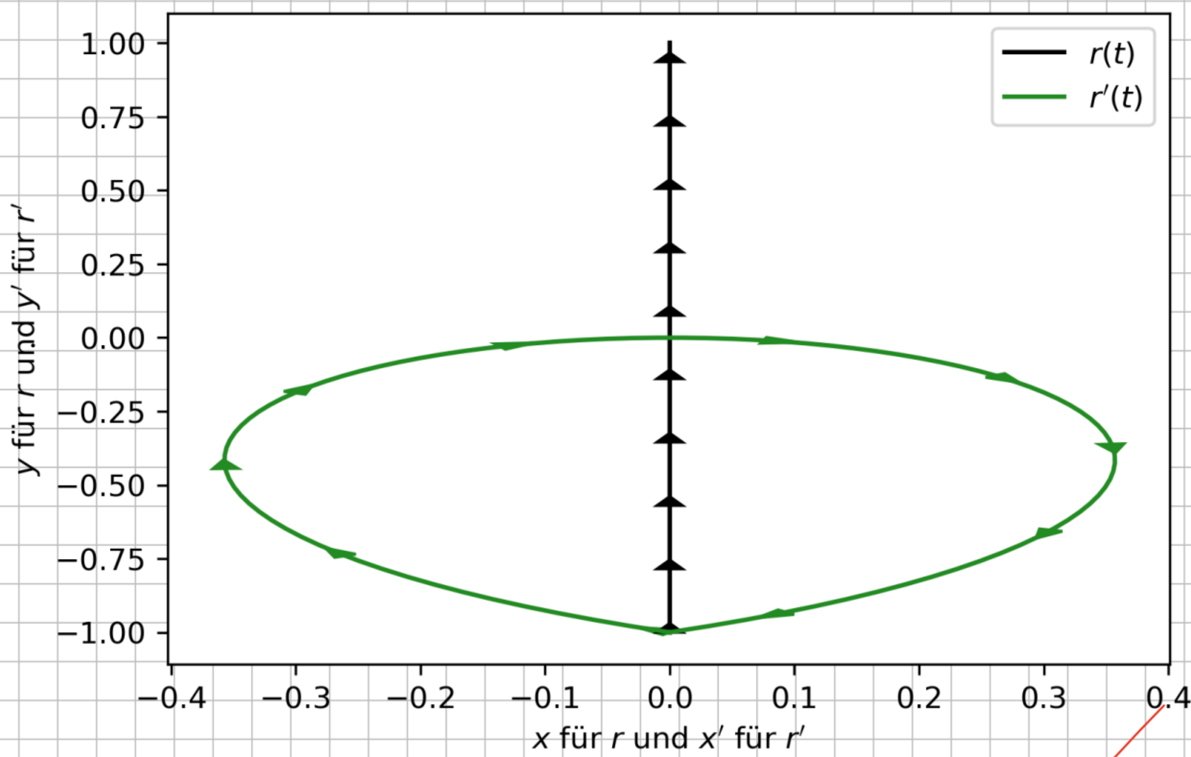
d) Mit $\vec{r}(t) = [0 \quad \frac{2}{\pi} R\omega t]^T$

$\vec{r}'(t) = A \cdot \vec{r}$ wobei A die Rotationsmatrix $A: \begin{bmatrix} \cos(\varphi) & -\sin(\varphi) \\ \sin(\varphi) & \cos(\varphi) \end{bmatrix}$

mit $\varphi = -\omega t$ da sich das Laborsystem relativ zum Karuselsystem mit $-\omega$ dreht.

$$\Rightarrow \vec{r}'(t) = \begin{bmatrix} \cos(\omega t) & \sin(\omega t) \\ -\sin(\omega t) & \cos(\omega t) \end{bmatrix} \cdot \vec{r}(t).$$

$$= \begin{bmatrix} \sin(\omega t)\left(\frac{2}{\pi} R\omega t - R\right) \\ \cos(\omega t)\left(\frac{2}{\pi} R\omega t - R\right) \end{bmatrix}$$

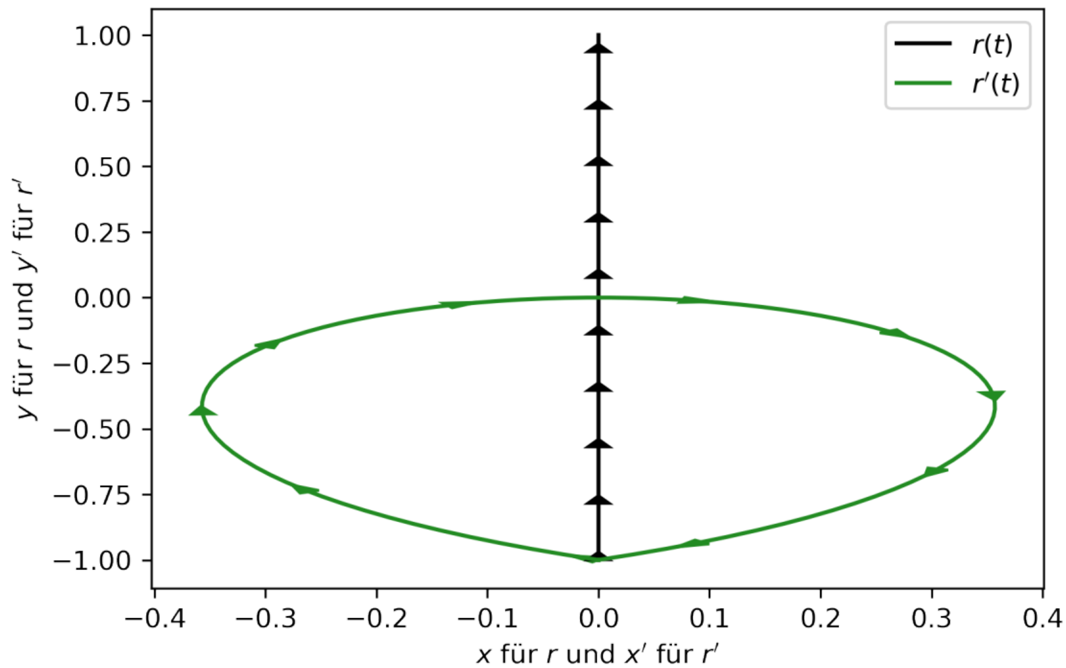


Ex_10

January 11, 2023

[48]:
```
import numpy as np
import matplotlib.pyplot as plt
from numpy import pi, sin, cos
import matplotlib as mpl
mpl.rcParams['figure.dpi'] = 300


omega = 1
R = 1
t_max = pi / omega
t = np.linspace(0, t_max, 100)

x_ = sin(omega*t)*(2/pi*R*omega*t - R )
y_ = cos(omega*t)*(2/pi*R*omega*t - R )

(omega*cos(omega*t)*(2/pi*R*omega*t - R ) + sin(omega*t)*2/pi*R*omega) * 0.0001
(-omega*sin(omega*t)*(2/pi*R*omega*t - R ) + cos(omega*t)*2/pi*R*omega) * 0.0001

y = 2/pi*R*omega*t - R
x = t*0

plt.plot(x,y, color="black", label="$r\\left(t\\right)$")
plt.plot(x_,y_, color="forestgreen", label="$r'\\left(t\\right)$")
plt.legend()
plt.xlabel("$x$ für $r$ und $x'$ für $r'$")
plt.ylabel("$y$ für $r$ und $y'$ für $r'$")

# Ab hier nur Code für Pfeile
numarrows = 10
[plt.arrow(
    sin(omega*i)*(2/pi*R*omega*i - R ),
    cos(omega*i)*(2/pi*R*omega*i - R ),
    (omega*cos(omega*i)*(2/pi*R*omega*i - R ) + sin(omega*i)*2/pi*R*omega) * 0.
↪0001,
    (-omega*sin(omega*i)*(2/pi*R*omega*i - R ) + cos(omega*i)*2/pi*R*omega) * 0.
↪0001,
    overhang=0, head_width=0.02, color="forestgreen")
```

```
for i in np.linspace(0, t_max-0.1, numarrows)]

[plt.arrow(0, 2/pi*R*omega*i - R, 0, 0.0001, overhang=0, head_width=0.02,␣
 ↪color="black") for i in np.linspace(0, t_max-0.1, numarrows)]
None
```




```
[ ]:
```