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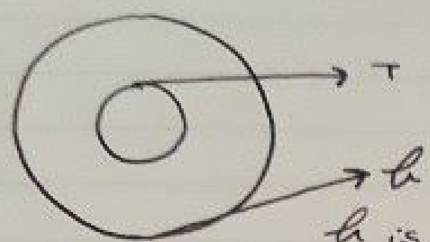
Dynamics

1) **For velocity along the plane to be a constant, net force along the place should be zero. Also the net torque acting on the cylinder (wheelchair) must be zdro.So that there is no angular acceleration that changes the velocity.**



f is friction
net torque can't be 0 i.e. the direction of the friction is the opposite.

$\Rightarrow$ $T \times r \times \cos\phi = fR$

Along the plane,

$F_{net} = T\cos\phi + f - mg\sin\phi = 0$

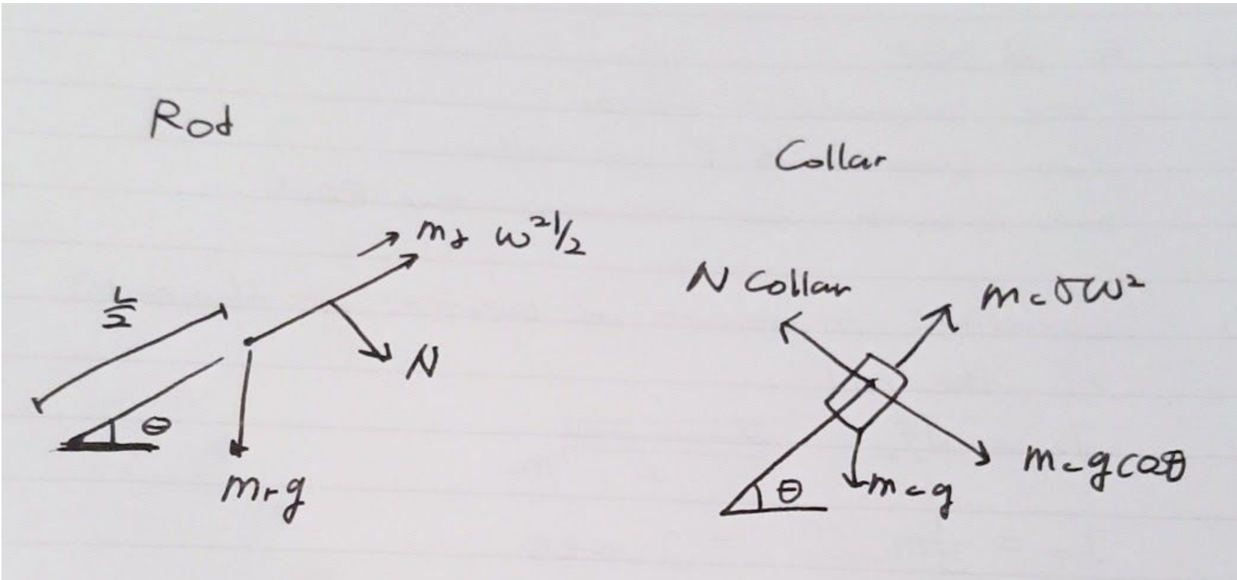
$$T\cos\phi + \frac{Tr\cos\phi}{R} = \frac{mgR}{R+r}(\tan\phi)$$

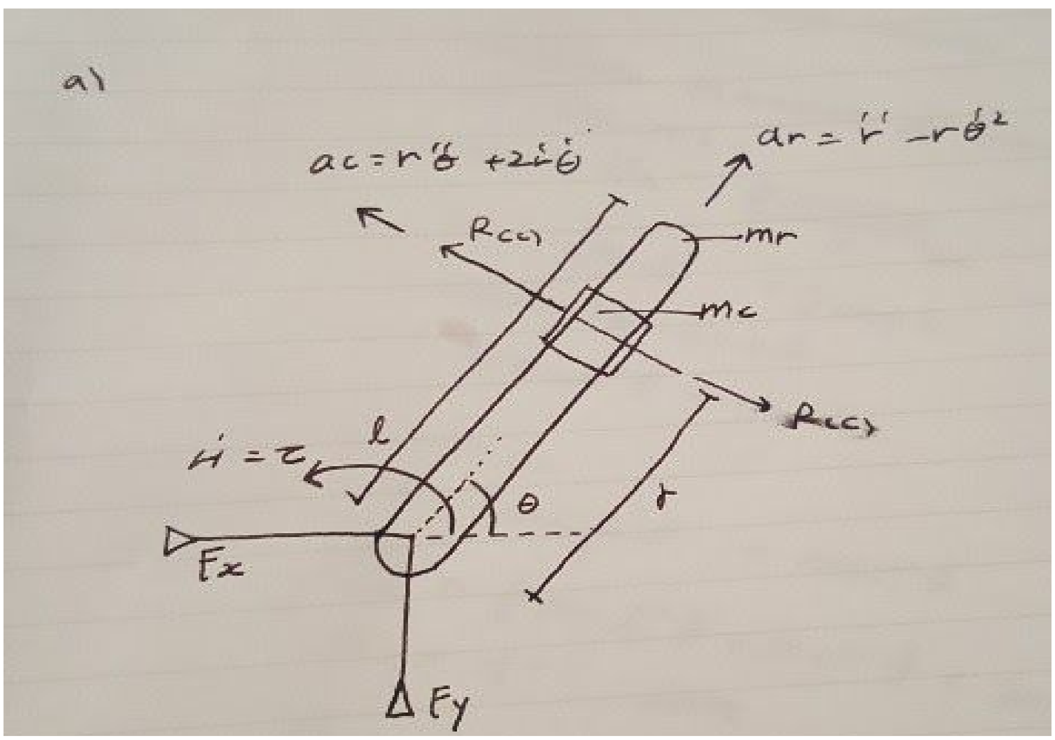
$\therefore$ T necessary to roll w.c up on constant speel

$$T = \frac{mgR}{R+r}(\tan\phi)$$

2) Rod and Collar

a)





b) # of DOF

One Degree of F of rod

Two Degree of F of collar

but in both cases we need two EOM

c) Consider moment of Inertia at the end of the rod

$J_o = J_{G/2}$

$J_o = \frac{1}{3} m_c l^2 = J$ wrt O.

angular mom. wrt O

$= \frac{1}{3} m_c l^2 \dot\theta + m_c r^2 \dot\theta$

d) $= \dot H$ col

$H = \frac{m_c l^2 \dot\theta}{3} + m_c r^2 \dot\theta$

$\frac{dH}{dt} = \frac{1}{3} m_r l^2 \ddot\theta + m_c r^2 \ddot\theta + 2 m_c r \dot r \dot\theta$

$\dot H = \frac{1}{3}$ " " same

$\dot H = \frac{1}{3} m_r l^2 \ddot\theta + m_c r^2 \ddot\theta + 2 m_c r \dot r \dot\theta$

E) EOM

$\dot H = \tau$ (torque)

EOM for θ $= \frac{1}{3} m_r l^2 \ddot\theta + m_c r^2 \ddot\theta + 2 m_c r \dot r \dot\theta$

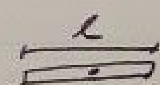
F) EOM for collar

EOM $= m_c(\ddot r - r \dot\theta^2)$

$\ddot r = r \dot\theta^2$

$\frac{d^2 r}{dt^2} = r \dot\theta^2$

* mass moment of Inertia wrt O.



to find mm I wrt O, consider length of rod to be 2l. with 2mc.

$J = \frac{1}{12}(2m_c) \times (2l^2) = \frac{2 m_c l^2}{3}$ J wrt O, collar

h) python code copy/ pasted from spyder

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This is the solution for number 2#

```
"""
import numpy as np
import matplotlib.pyplot as plt
from scipy.integrate import odeint

# Define system constants
1 = 1
mcollar = 1
mrod = 1
tau = 1
X0 = 0
V0 = 0
Q0 = 0
Z0 = 0


# Define Equation of Motion
def function(y, t, constants):

    X, V, Z, Q = Y
    mc, mr, tau, 1 = constants
    denom = (1/3)*(mr)*(1**2) + (mc * X**2)
    dydt = [V, X*(Z**2), Z, ((Z*(-2)*(mc)*X*V))/(denom + tau/denom)]
    return dydt

# initial set up
y0 = [X0, V0, Z0, Q0]
# Create the samples for the output of the ODE solver
t = np.linspace(0, 1, 10001)
sol = odeint (function, y0, t, args=(parameters))


# Plot1 results
plt.title( 'collar displavement in sec')
plt.plot(t, sol[:, 0], 'g', label = 'x(t)')
plt.legend (loc='best')
plt.xlable('time (s)')
plt.ylable('displacement (m)')
```

```
plt.grid ()
plt.show()

#Plot2 results
plt.title( 'Theta')
plt.plot(t, sol[:, 2], 'b', label = 'Theta(t)')
plt.legend (loc='best')
plt.xlable('time (s)')
plt.ylable('Theta(rad)')
plt.grid ()
plt.show()
```