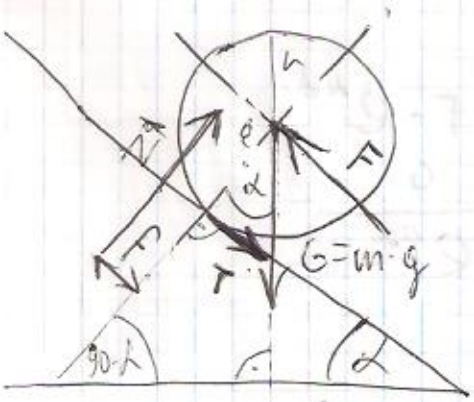
Rolling friction



Known:
m - mass [kg]
r - radius [m]
α - angle [rad]
f - rolling friction factor [m]
g - gravity acceleration [m/s^2]
T - sliding friction force [N]

Find:
F=F_{max} in equilibrium position [N]

Solution:

$$\sum F_{ix} = 0$$

$$-F + G \cdot \sin\alpha + T = 0 \rightarrow F = G \cdot \sin\alpha + T$$

$$\sum F_{iy} = 0$$

$$N - G \cdot \cos\alpha = 0 \rightarrow N = G \cdot \cos\alpha$$

$$M_{ic} = 0$$

$$-N \cdot f + T \cdot r = 0 \rightarrow T = \frac{N \cdot f}{r}$$

$$F = G \cdot \sin\alpha + T$$

$$F = G \cdot \sin\alpha + \frac{N \cdot f}{r}$$

$$F = G \cdot \sin\alpha + \frac{G \cdot \cos\alpha \cdot f}{r}$$

$$F = m \cdot g \left(\sin\alpha + \frac{\cos\alpha \cdot f}{r} \right)$$