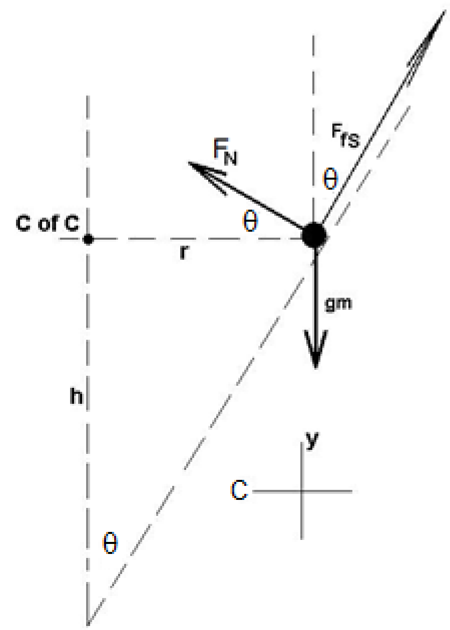
5-4)



Apply NII. Make one axis horizontal toward the central axis and the other (y) vertical.
The radius of the circle the block is moving in is $r = h \tan\theta$.
To start, let the frictional force be up the cone's surface, so we are finding the slowest case.

C: $+F_N \cos\theta - F_{fs} \sin\theta = ma_C = mr\omega^2$
y: $-gm + F_N \sin\theta + F_{fs} \cos\theta = ma_y = 0$
$F_{fs} = \mu_S F_N$ (critical point, just about to slide)

Substitute the 3rd eq into first two:
C: $+F_N \cos\theta - \mu_S F_N \sin\theta = mr\omega^2$
y: $-gm + F_N \sin\theta + \mu_S F_N \cos\theta = 0$

rearrange to divide out F_N:
C: $+F_N \cos\theta - \mu_S F_N \sin\theta = mr\omega^2$
y: $F_N \sin\theta + \mu_S F_N \cos\theta = gm$

$[\cos\theta - \mu_S \sin\theta]/[\sin\theta + \mu_S \cos\theta] = mr\omega^2/gm = (h \tan\theta)\omega^2/g$.

Solving:

$$\omega_{MIN} = \sqrt{\frac{g(\cos\theta - \mu_S \sin\theta)}{(h\ \tan\theta)(\sin\theta + \mu_S \cos\theta)}}\,.$$

To find ω_{MAX}, we only need to reverse the direction of the frictional force, and so we replace μ_S with $-\mu_S$ to obtain:

$$\omega_{MAX} = \sqrt{\frac{g(\cos\theta + \mu_S \sin\theta)}{(h\ \tan\theta)(\sin\theta - \mu_S \cos\theta)}}\,.$$