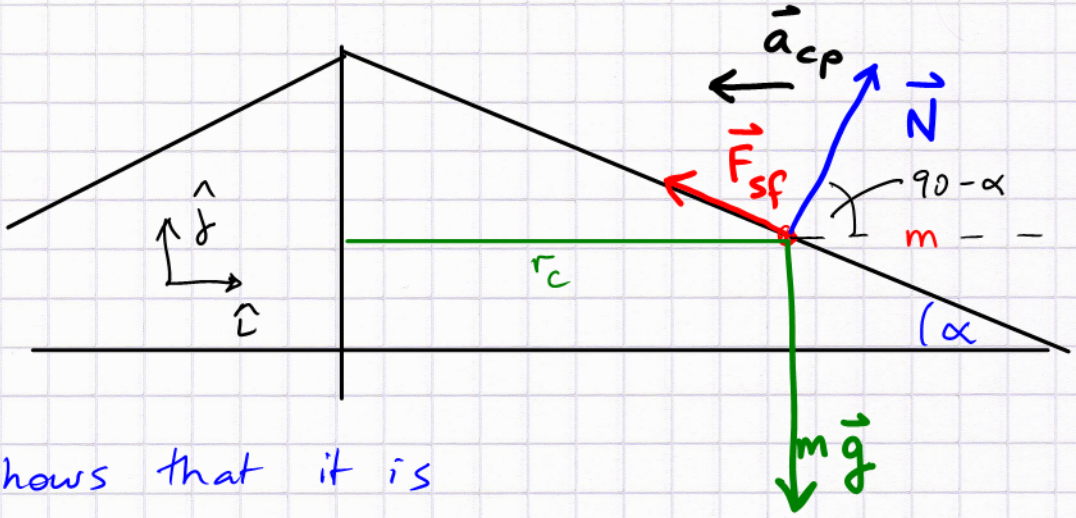
Problem 5.15 Reversed banked turn

$\mu_s = 0.50$

$\alpha = 10°$

$r_c = 15\ m$

$v_{max} = ?$



The drawing shows that it is difficult (α is too big!)

Max speed v_{max} implies: F_{sf} is at its limit: $\mu_s N$.

(1) $m\,a_{cp} = F_{sf}\cos\alpha - N_x$ horizontal motion

(2) $0 = mg - N_y - F_{sf}\sin\alpha$ vertical motion in equilibrium

Normal force components: $N_x = N\cos(90-\alpha) = N\sin\alpha$

$N_y = N\cos\alpha$

For max speed ($F_{sf} = \mu N$):

(1) $m\dfrac{v_{max}^2}{r_c} = N(\mu\cos\alpha - \sin\alpha)$

(2) $mg = N(\cos\alpha + \mu\sin\alpha)$

(2'): $N = \dfrac{mg}{\cos\alpha + \mu\sin\alpha}$

(1'): $\dfrac{m v_{max}^2}{r_c} = \dfrac{mg(\mu\cos\alpha - \sin\alpha)}{\cos\alpha + \mu\sin\alpha}$

$\Rightarrow v_{max} = \sqrt{\dfrac{g r_c(\mu\cos\alpha - \sin\alpha)}{\cos\alpha + \mu\sin\alpha}}$

with numbers:

$v_{max} = 6.61\ m/s$

$\rightarrow 6.6\ m/s$

only ~24 km/h!