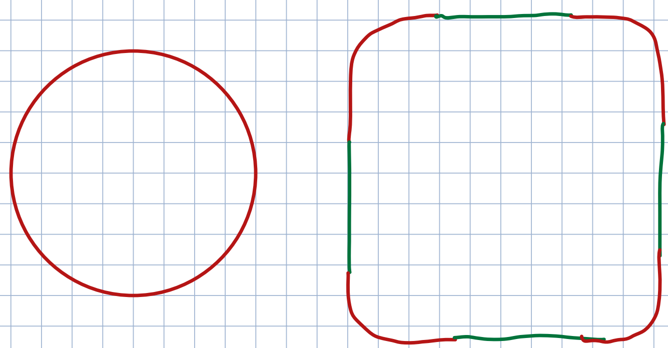
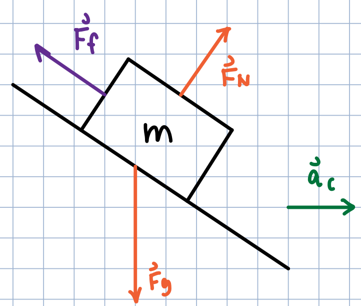
Veledromes and Circular Motion



When taking a turn at a velodrome, you are covering $\frac{1}{4}$ the circumference in a circle

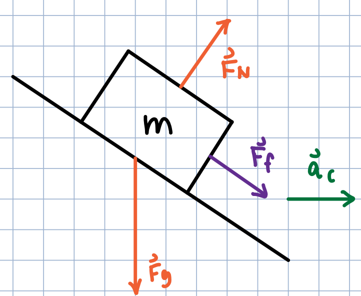
Velodromes and horizontal circles



As the velocity approaches 0, what happends?

Sliding down

c?



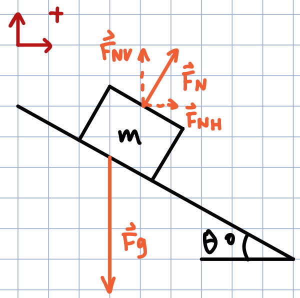
As the velocity approaches ∞, what happends?

Flying away

Angled Circular Ramp Example 1

2000 kg 20 m/s t?

A 2 tonne car is traveling 72 km/h while making a right turn. How long does it take to make this turn if the frictionless ramp is angled at 20 degrees?



V | $\vec{F}_{Net} = \vec{F}_{NV} + \vec{F}_g$

$m(0) = \vec{F}_N \cos\theta - \vec{F}_g$

$-\vec{F}_N \cos\theta = -mg$

$\vec{F}_N = \frac{mg}{\cos\theta}$

H | $\vec{F}_{Net} = \vec{F}_{NH}$

$m\vec{a}_c = \vec{F}_N \sin\theta$

$m\frac{2\pi v}{T} = \frac{mg}{\cos\theta}\sin\theta$

$\frac{2\pi v}{T} = g\tan\theta$

$T = \frac{2\pi v}{g\tan\theta}$

$T = \frac{2\pi(20)}{9.81\tan(20}$

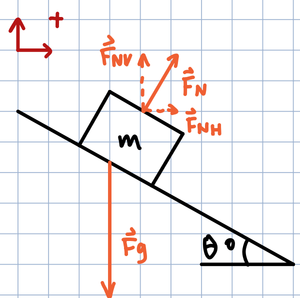
$T = 32.2s$

$t = \frac{1}{4}T$

$t = \frac{1}{4}(23.2)$

$t = 8.80s$

A car is on a frictionless ramp angled at 10 degrees. The radius of the turn is 25m, what velocity must you travel so that you don't climb or slide down the ramp?



V | $\vec{F}_{Net} = \vec{F}_{NV} + \vec{F}_g$

$m(0) = \vec{F}_N \cos\theta - \vec{F}_g$

$\vec{F}_N = \frac{mg}{\cos\theta}$

H | $\vec{F}_{Net} = \vec{F}_{NH}$

$m\vec{a}_c = \frac{mg}{\cos\theta}\sin\theta$

$m\left(\frac{v^2}{R}\right) = \frac{mg}{\cos\theta}\sin\theta$

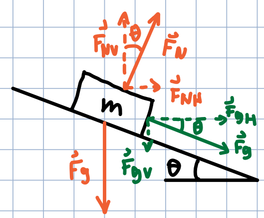
$\frac{v^2}{R} = g\tan\theta$

$v = \sqrt{Rg\tan\theta}$

$v = \sqrt{25(9.81)\tan(10}$

$v = 6.58\ m/s$

A car is on a ramp (u = 0.1) angled at 10 degrees. The radius of the turn is 25m, what. is the fastest it can go without changing vertical position?



V | $\vec{F}_{Net} = \vec{F}_{NV} + \vec{F}_g + \vec{F}_{fV}$

$m(0) = \vec{F}_N\cos\theta - mg - \vec{F}_f\sin\theta$

$0 = \vec{F}_N\cos\theta - mg - \mu\vec{F}_N\sin\theta$

$mg = \vec{F}_N(\cos\theta - \mu\sin\theta)$

$\vec{F}_N = \frac{mg}{\cos\theta - \mu\sin\theta}$

H | $\vec{F}_{Net} = \vec{F}_{NH} + \vec{F}_{fH}$

$m\vec{a}_c = \vec{F}_N\sin\theta + \vec{F}_f\cos\theta$

$m\left(\frac{v^2}{R}\right) = \vec{F}_N\sin\theta + \mu\vec{F}_N\cos\theta$

$m\left(\frac{v^2}{R}\right) = \vec{F}_N(\sin\theta + \mu\cos\theta)$

$m\left(\frac{v^2}{R}\right) = \frac{mg}{\cos\theta - \mu\sin\theta}(\sin\theta + \mu\cos\theta)$

$\frac{v^2}{R} = \frac{g(\sin\theta + \mu\cos\theta)}{\cos\theta - \mu\sin\theta}$

$v = \sqrt{\frac{25(9.81(\sin 10 + 0.1\cos 10))}{\cos(10) - 0.1\sin(10)}}$