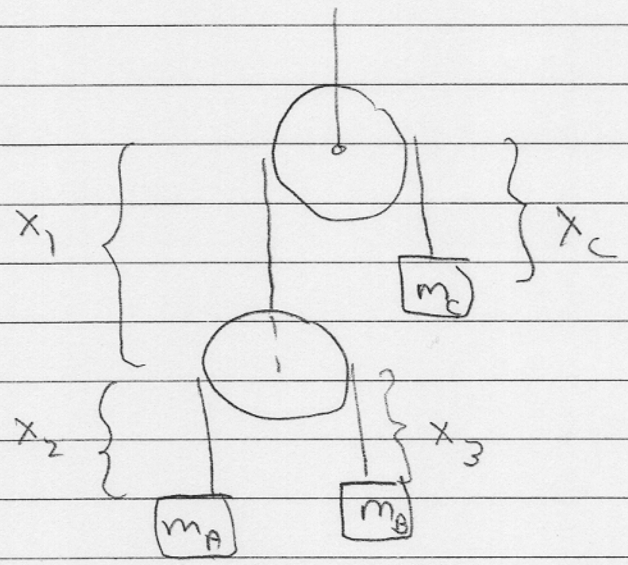
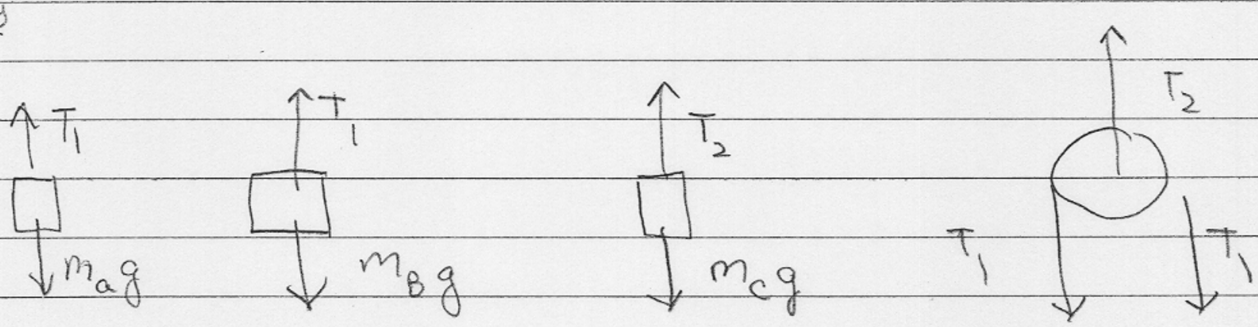
Solution



F_{Bdy}



$$T_1 - m_a g = m_a a_a \qquad (\#1)$$

$$T_1 - m_B g = m_b a_b \qquad (\#2)$$

$$T_2 - m_c g = m_c a_c \qquad (\#3)$$

$$T_2 - 2T_1 = \cancel{m}^{0} a \Rightarrow T_2 = 2T_1 \qquad (\#4)$$

Then

$X_A = x_1 + x_2$ $\qquad x_1 + x_c = L$ $\qquad a_1 = -a_c$

$X_B = x_1 + x_3$ $\qquad x_2 + x_3 = L$ $\qquad a_2 = -a_3$

$$a_a = \ddot{X}_A = \ddot{x}_1 + \ddot{x}_2 = -a_c + a_2 \qquad (Eq \#5)$$

$$a_B = \ddot{X}_B = \ddot{x}_1 + \ddot{x}_3 = -a_c - a_2 \qquad (Eq \#6)$$

Equations: 6

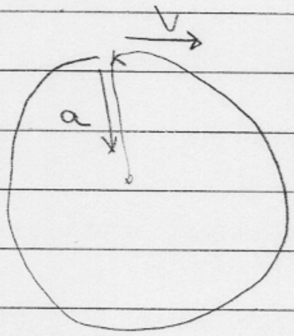
Unknowns: $T_1, T_2, a_a, a_b, a_c, a_2$

Now show enthusiasm! and solve

you should find

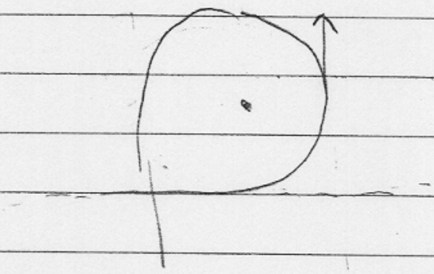
$$\boxed{a_c = \frac{4 m_a m_b - m_c (m_a + m_b)}{4 m_a m_b + m_c (m_a + m_b)}\, g}$$

Last Time



$$a_R = \frac{v^2}{R}$$

Started to discuss highway exit ramps

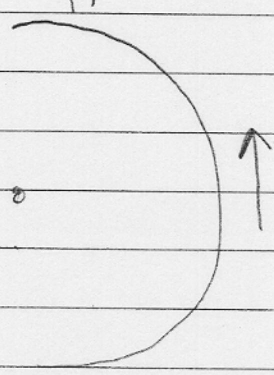


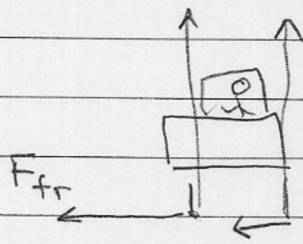
- Estimated Speed ≈ 30 mph ~ 13 m/s
- Estimated Turning circle

$$R \sim 30\,m$$

- $m_{car} \simeq 2000\,kg$

Then if



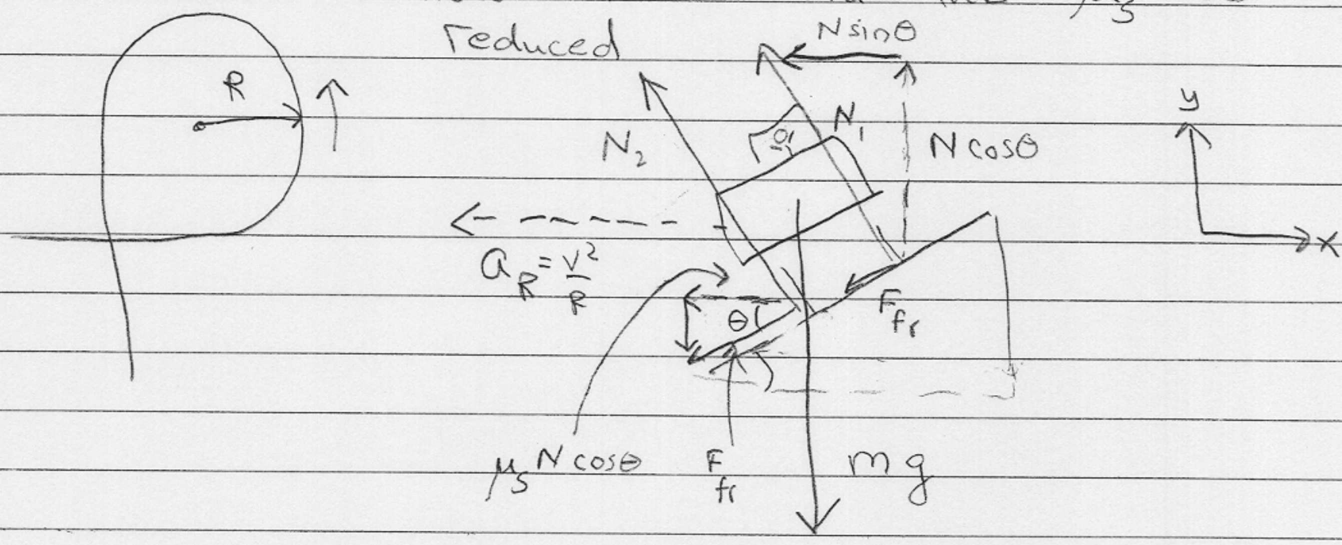


$$4F_{fr} = \frac{mv^2}{R}$$

$$4\mu_s \frac{\overbrace{mg}^{N}}{4} = \frac{mv^2}{R}$$

$$\mu_s = \frac{v^2}{Rg} = \frac{(13\,m/s)^2}{(30\,m)(9.8\,m/s^2)} \simeq 0.58$$

Now Suppose the road is banked by 15° how much could the μ_s be reduced



x|

$$-\mu_s N\cos\theta - N\sin\theta = ma_x$$

y|

$$-mg - \mu_s N\sin\theta + N\cos\theta = m\cancel{a_y}^{0}$$

Analyze constraints

$$a_x = -\frac{v^2}{R} \qquad a_y = 0$$

Now

$$-\mu_s N\cos\theta - N\sin\theta = -m\frac{v^2}{R} \qquad -mg - \mu_s N\sin\theta + N\cos\theta = 0$$

unknowns: μ_s, N knowns: mg, θ, v, R

equations: 2

Now

$$N(\cos\theta - \mu_s \sin\theta) = mg \Rightarrow N = \frac{mg}{\cos\theta - \mu_s \sin\theta}$$

So

$$N(\mu_s \cos\theta + \sin\theta) = \frac{mv^2}{R}$$

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

$$\frac{\mu_s c + s}{c - \mu_s s} = \frac{v^2}{Rg} \qquad c \equiv \cos\theta \quad s \equiv \sin\theta$$

$$\mu_s c + s = (v^2/Rg)(c - \mu_s s)$$

$$\mu_s c + \mu_s s\, v^2/Rg = (v^2/Rg)c - s$$

$$\mu_s = \frac{(v^2/Rg)c - s}{(c + s\, v^2/Rg)}$$

$$\mu_s = \frac{(v^2/Rg)\cos\theta - \sin\theta}{\cos\theta + \sin\theta(v^2/Rg)}$$

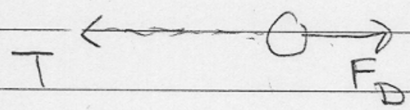
$$\mu_s \simeq 0.27$$

wet pavement

Loose Item In Chp 4

Drag Forc

Liquid or gas



Force resisting the motion

$F_D \propto v$

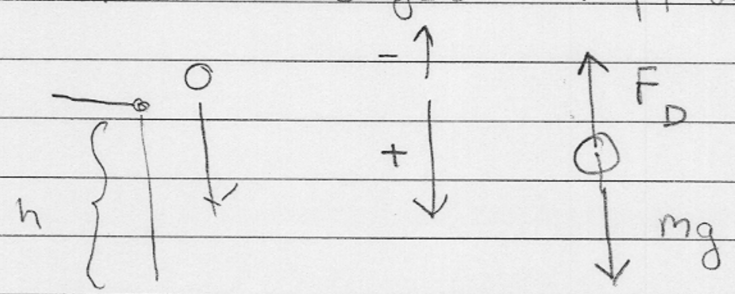
for small velocities

So

$$F_D = -bv$$

const

Consider an object dropped from rest



$$F_D - mg = ma$$

$$(-bv) + mg = ma$$

points up v

Eventually the object reaches a constant "terminal" velocity where $a=0$

$$-bv_T + mg = 0 \quad \text{or} \quad v_T = +\frac{mg}{b}$$

Now lets find the velocity vs. time

$$-bv + mg = \overbrace{m\frac{dv}{dt}}^{a}$$

$$\int_{t_i}^{t_f} dt = \int_{v_i}^{v_f} \frac{m\,dv}{mg - bv}$$

$$t_f - t_i = -\frac{1}{b} m \log(mg - bv) \Big|_{v_i}^{v_f}$$

$v_i = 0$

$t_i = 0$

$t_f = t$

$$t = -\frac{1}{b} m \left[\log(mg - bv) - \log mg\right]$$

$$-\frac{bt}{m} = \log\left(1 - \frac{bv}{mg}\right)$$

$$e^{-bt} = 1 - \frac{bv}{mg} \implies V = \frac{mg}{b}(1 - e^{-bt})$$

Picture