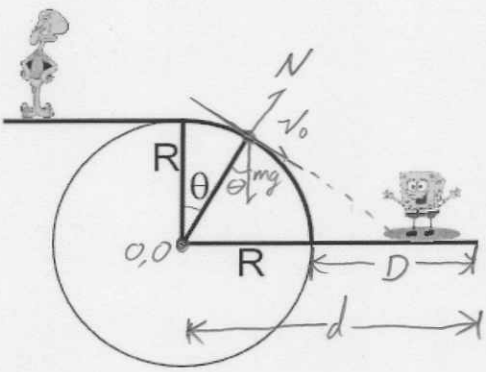
Force

Name: Key

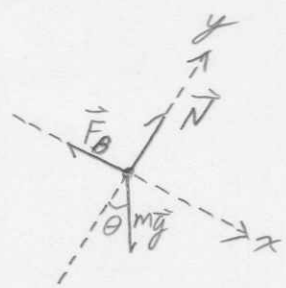
1. Squidward is driving 100 miles per hour on a road shaped like the one in the figure. The road has a hill whose radius of curvature, R, is ~~0.3~~ 0.14 miles.



a) At what angle θ will Squidward's car leave the road surface.

b) Spongebob is standing 530 ft from the base of the hill. Will Squidward's car land on him?

a)



In the x, $F_B - mg\,SIN\theta = 0$ to maintain $v = 100$ mi/h

In y: $N - mg\cos\theta = m\frac{v^2}{R}$ ← centripedal Force

The car loses contact when $N = 0$

then: $-mg\cos\theta = m\frac{v^2}{R}$

$$\theta = \cos^{-1}\left(\frac{v^2}{gR}\right)$$

$g = 9.8 \frac{m}{s} \cdot 3.28 \frac{Ft}{m} \cdot \frac{1}{5280} \frac{mi}{Ft} \cdot \left(3600 \frac{s}{h}\right)^2 = 7.9 \times 10^4 \, mi/hr^2$

$\theta = \cos^{-1}\left(\frac{100^2}{(7.9\times10^4)(0.14)}\right) = \underline{25^\circ}$

b) $V_0 = 100\ mi/h$, $\theta = 25°$; $D = 530\ Ft \cdot \frac{1}{5280}\frac{mi}{Ft} = 0.1$ miles

$d_B = R + D = 0.24$ miles

Kinematics

x: $r_x(t) = r_{ox} + v_{ox}t + \cancel{\frac{1}{2}a_x t^2}^{0}$ $\quad y$: $r_y(t) = r_{oy} + v_{oy}t + \frac{1}{2}a_y t^2$

$\boxed{d = R\,SIN\theta + V_0 COS\theta\, t}$ $\quad 0 = R COS\theta + V_0 SIN\theta\, t - \frac{1}{2}gt^2$

Pick plus or we get $-t$

$$t = \frac{+V_0 SIN\theta \oplus (V_0^2 SIN^2\theta + 2gR COS\theta)^{1/2}}{+g}$$

$$V_0 SIN\theta = 100\, SIN(25) = 42\ mi/h$$

$$t = \frac{1}{7.8\times10^{4}}\left(42 + \left(42 + 2(7.8\times10^{4})(0.14)COS(25)\right)^{1/2}\right)$$

$\boxed{t = 2.3\times10^{-3}\ hr \quad (8\ seconds)}$

So:

$$d = (0.14)(SIN(25)) + (100)COS(25)\cdot(2.3\times10^{-3})$$

$= 0.27$ miles

Spongebob is safe! (barely)