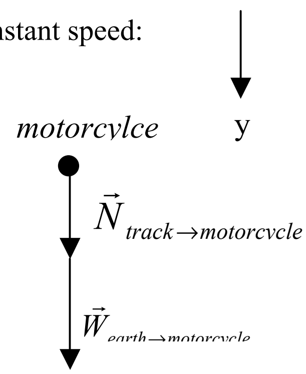
Spring 2001 Physics 2048 Test 3 solutions

Problem 5 (20 points)

Part A

Looking at the forces acting on the motorcycle moving through a circular loop at constant speed:



Circular motion at constant speed => $|\vec{F}^{net}| = \dfrac{mv^2}{R}$ everywhere on the loop.

At the top of the loop, $\vec{F}^{net} = \vec{N}_{tract \to motorcycly} + \vec{W}_{earth \to motorcycle}$, $\sum F_y^{net} = N + mg$

Note that both forces point downward.

$\dfrac{mv^2}{R} = N + mg$, Since m, R, and g are constant, v will be a minimum when $N = 0$.

$$v = \sqrt{Rg} = \sqrt{(5.0m)(9.8m/s^2} = 7.0m/s * \frac{3600s}{h} * \frac{1km}{1000m} = 25km/h$$

Note the bigger the radius R is, the higher the minimum speed v needed to go through the loop

Part B

Only gravity acts on the motorcycle + rider when they are in the air

$a_y = -9.8$ m/s^2 and $a_x = 0$ m/s^2 , since a = constant => use kinematics equations

$\Delta x = v_{0x}\, \Delta t$, $\Delta y = v_{0y}\, \Delta t - 1/2\, g\, \Delta t^2$

If we knew Δt, we could find Δx for the jump => let $\Delta y = 0$

$0 = v_{0y}\, \Delta t - 1/2\, g\, \Delta t^2$, $\Delta t = 0$ or $v_{0y} - 1/2\, g\, \Delta t = 0$

Since $\Delta t = 0$ is the start of the jump, $\Delta t = 2v_{0y}/g = 2\, v_0 \sin\theta / g$ is the time it take the motorcycle to make the jump.

$\Delta x = v_{0x}\, \Delta t = (v_0 \cos\theta)(2\, v_0 \sin\theta / g) = v_0^2 \sin 2\theta / g)$

$= (50$ km/h x 1000m/km x 1 h / 3600 s$)^2 \sin(2*30°) / 9.8$ m/s$^2 = 17$ m

The landing should be placed 17 m to the right of the jump ramp