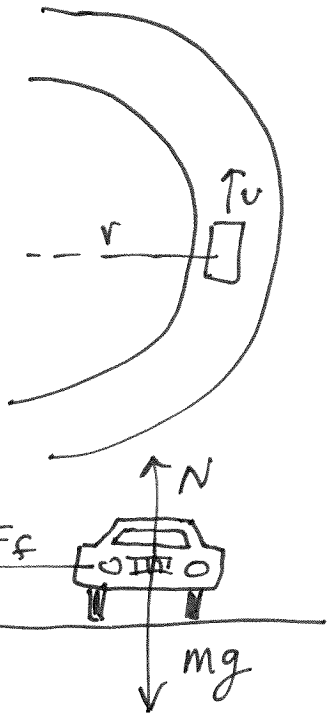
Chapter 6 Problem 77

$r = 65\,m$

$\mu = 0.70$



What is the maximum speed at which the car can traverse the curve without slipping?

From the free-body diagram the frictional force is providing the centripetal acceleration.

From Newton's 2nd Law

$$\sum \vec{F} = m\vec{a}$$

$$\vec{F}_f + \vec{N} + \vec{W} = m\vec{a}$$

$$-F_f\hat{i} + N\hat{j} - mg\hat{j} = -ma\hat{i}$$

x-dir: $-F_f = -ma$

y-dir: $N - mg = 0$

$F_f = \mu N$

The maximum centripetal acceleration provided is,

$$ma = F_f = \mu N = \mu mg$$

$$a = \frac{\mu mg}{m} = \mu g = (0.70)(9.80\,m/s^2)$$

$$a = 6.86\,m/s^2$$

From the centripetal acceleration formula

$$a = \frac{v^2}{r} \longrightarrow v = \sqrt{a \cdot r}$$

$$v = \sqrt{(6.86\,m/s^2)(65\,m)}$$

$$= 21\,m/s$$

[This is equal to $21\,m/s\left(\frac{2.24\,mph}{1\,m/s}\right) = 47\,mph$]