Phys101 Assignment Cover Sheet

First Name:_____ Last Name:_____ Mark: _____

Student ID:_____ Date: _____

Phys101 Written Assignment #4

Due Wed/Thur. Feb 2/3, 2011, at the end of tutorial

Textbook (Giancoli, 6th edition) page 134 problem #76.

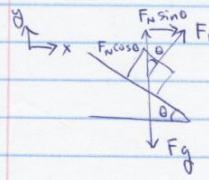
76. A curve of radius 67 m is banked for a design speed of $95\,\text{km/h}$. If the coefficient of static friction is 0.30 (wet pavement), at what range of speeds can a car safely handle the curve?

P101 WRITTEN ASSIGNMENT #4

76) A curve of radius 67m is banked for a design speed of 95 km/hr. If the coefficient of static friction is 0.30 (wet pavement), at what range of speeds can a car safely handle the curve?

$$95\frac{km}{hr} \times \frac{1000\,m}{1\,km} \times \frac{1\,hr}{60\,min} \times \frac{1\,min}{60\,s} = 26.4\,m/s$$

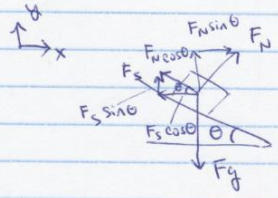
NO FRICTION:



$$\Sigma F_y = ma_y = 0$$
$$F_N \cos\theta - F_g = 0$$
$$F_N = \frac{mg}{\cos\theta}$$

$$\Sigma F_x = ma_x = \frac{mv^2}{r}$$
$$F_N \sin\theta = \frac{mv^2}{r}$$
$$\frac{mg\sin\theta}{\cos\theta} = \frac{mv^2}{r}$$
$$g\tan\theta = \frac{v^2}{r}$$
$$\theta = \tan^{-1}\left(\frac{v^2}{gr}\right)$$
$$\theta = \tan^{-1}\left(\frac{26.4^2}{9.8(67)}\right)$$
$$\theta = 46.7^\circ$$

FRICTION CASE 1:



$$\Sigma F_y = ma_y = 0$$
$$F_N \cos\theta + F_s \sin\theta - F_g = 0$$
$$F_N \cos\theta + \mu_s F_N \sin\theta = F_g$$
$$F_N(\cos\theta + \mu_s \sin\theta) = F_g$$
$$F_N = \frac{F_g}{(\cos\theta + \mu_s \sin\theta)}$$

$$\Sigma F_x = ma_x = \frac{mv^2}{r}$$
$$-F_s \cos\theta + F_N \sin\theta = \frac{mv^2}{r}$$
$$-\mu_s F_N \cos\theta + F_N \sin\theta = \frac{mv^2}{r}$$
$$F_N(-\mu_s \cos\theta + \sin\theta) = \frac{mv^2}{r}$$
$$\frac{mg(-\mu_s \cos\theta + \sin\theta)}{(\cos\theta + \mu_s \sin\theta)} = \frac{mv^2}{r}$$

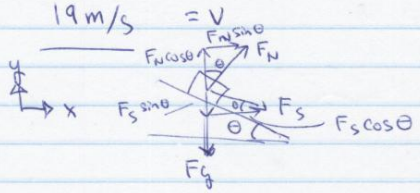
$$\therefore \quad 9.8\left(\frac{-.3\cos 46.7 + \sin 46.7}{\cos 46.7 + 0.3\sin 46.7}\right) = \frac{v^2}{67}$$

$$9.8\left(\frac{-0.21 + 0.728}{0.69 + 0.22}\right)(67) = v^2$$

$$9.8\left(\frac{0.518}{0.91}\right)(67) = v^2$$

$$19\ m/s = v$$

FRICTION CASE 2:



$$\Sigma F_y = ma_y = 0$$
$$F_N\cos\theta - F_S\sin\theta - F_g = 0$$
$$F_N(\cos\theta - \mu_s\sin\theta) = F_g$$
$$F_N = \frac{F_g}{(\cos\theta - \mu_s\sin\theta)}$$

$$\Sigma F_x = ma_x = \frac{mv^2}{r}$$

$$F_N\sin\theta + F_S\cos\theta = \frac{mv^2}{r}$$
$$F_N(\sin\theta + \mu_s\cos\theta) = \frac{mv^2}{r}$$

$$\frac{mg}{\cos\theta - \mu_s\sin\theta}(\sin\theta + \mu_s\cos\theta) = \frac{mv^2}{r}$$

$$(67)(9.8)\left(\frac{\sin 46.7 + 0.30\cos 46.7}{\cos 46.7 - 0.3\sin 46.7}\right) = v^2$$

$$(67)(9.8)\left(\frac{0.73 + 0.21}{0.69 - 0.22}\right) = v^2$$

$$(67)(9.8)\left(\frac{.94}{.47}\right) = v^2 \quad \Rightarrow \quad v = 36\ m/s$$

$\therefore 19\ m/s \leq v \leq 36\ m/$

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