Answer on Question 56689, Physics, Mechanics, Relativity

Question:

A flat (unbanked) curve on a highway has a radius of $215.0m$. A car rounds the curve at a speed of $25.0\,m/s$. What is the minimum coefficient of static friction that will prevent sliding? Suppose that the highway is icy and the coefficient of friction between the tires and pavement is only one-third what you found in the previous part. What should be the maximum speed of the car, so it can round the curve safely?

Solution:

a) When a car rounds the curve, the force of static friction provides the necessary centripetal force:

$$F_c = F_s,$$

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

$$\frac{v^2}{R} = \mu_s g.$$

From this formula we can find the minimum coefficient of static friction that will prevent sliding:

$$\mu_s = \frac{v^2}{Rg} = \frac{\left(25\frac{m}{s}\right)^2}{215m \cdot 9.8\frac{m}{s^2}} = 0.29$$

b) We can find the maximum speed of the car from the previous formula:

$$\frac{v_{max}^2}{R} = \mu_s g, \quad v_{max} = \sqrt{\mu_s R g}.$$

Substituting into the last formula $\frac{1}{3}\mu_s$ (from the condition of the question) we get:

$$v_{max} = \sqrt{\frac{1}{3}\mu_s R g} = \sqrt{\frac{1}{3} \cdot 0.29 \cdot 215m \cdot 9.8\frac{m}{s^2}} = 14.3\frac{m}{s}.$$

Answer:

a) $\mu_s = 0.29$, b) $v_{max} = 14.3\frac{m}{s}$.