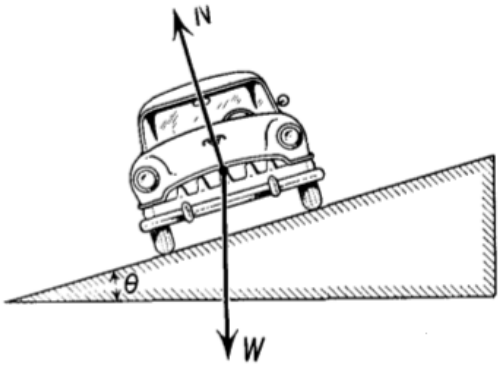
Answer on Question 68956, Physics, Other

Question:

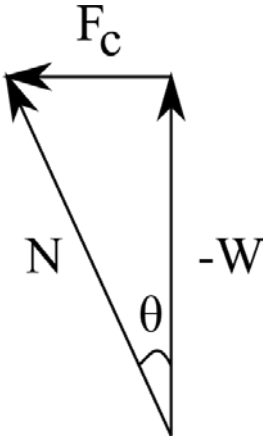
Show that the angle of banking is independent of mass of the vehicle.

Answer:

Let's consider the motion of the vehicle on the curved banked road:



There are two forces acting on the vehicle: the weight, W (or mg), and the normal force, N. The y-component of the normal force neutralize the weight, and its x-component provides the necessary centripetal force for the curved motion of the vehicle, as shown in the force diagram below:



Then, applying the Newton's Second Law of Motion on x- and y-axis we get:

$$\sum F_x = ma_x,$$

$$F_c = N sin\theta = ma_c = \frac{mv^2}{R} \ (1),$$

$$\sum F_y = ma_y = 0,$$

$$Ncos\theta - W = 0,$$

$$Ncos\theta = W = mg, (2).$$

Dividing the equation (1) by equation (2) we get:

$$\frac{sin\theta}{cos\theta} = \frac{v^2}{gR},$$

$$tan\theta = \frac{v^2}{gR},$$

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

So, as we can see, the angle of banking is independent of mass m of the vehicle.