

Problem 2: Circular motion (15 pts)

A car of mass $m = 1000kg$ is traveling around a flat circular race track of radius $100m$. The static coefficient of friction between the tire and the road (against transverse motion) is $\mu = 0.5$. (Assume $g = 10m/s^2$)

- (a) How fast can the car travel before it starts to skid? Express the speed in the units of m/s .
- (b) What is the angular velocity ω of the car at the speed calculated in (a).
- (c) The driver of the car wants to drive faster. He loads $500kg$ of weight into the car to increase the friction force. Now how fast can the car travel without skidding?

Solution:

- (a) The max speed of the car should satisfy

$$m\frac{v^2}{r} = \mu mg$$

We find

$$v = \sqrt{\mu gr} = \sqrt{0.5 * 100 * 10} = 10\sqrt{5}m/s = 22m/s$$

- (b) The angular velocity is

$$\omega = v/r = 0.22/s$$

- (c) v does not depend on the mass. So the max speed is not changed.