

### Answer on Question #44915 – Physics - Mechanics | Kinematics | Dynamics

Sometimes a car overturns while turning at a curve. In such a case

- a) the inner wheels leave the ground first
- b) the outer wheels leave the ground first
- c) both the outer and inner wheels leave the ground simultaneously
- d) either of the wheels can leave the ground first

#### Solution

The centrifugal force acts on the center of mass of the car, which is at some elevation of  $h$  above ground. This will tend to lift the inner wheels off the ground, pivoting around the outer wheels. The torque exerted by the centrifugal force is  $F_c \cdot h$ . Gravity also acts on the center of mass, which is generally halfway between the inner and outer wheels. The torque applied by gravity is centered on the outer wheels and equals  $mg \frac{w}{2}$ , where  $w$  = the wheel separation. The car will overturn when

$$F_c \cdot h > mg \cdot \frac{w}{2}$$

$F_c = m \frac{v^2}{R}$ , where  $v$  is the velocity and  $R$  is the turn radius

$$h \cdot m \frac{v^2}{R} > mg \frac{w}{2}$$

$$h \cdot \frac{v^2}{R} > g \cdot \frac{w}{2}$$

The velocity needed to turn the car over is then

$$v > \sqrt{\frac{gRw}{2h}}$$

We can see that to tolerate high turn velocities,  $w$  must be large and  $h$  must be small.

Answer: a) the inner wheels leave the ground first