

Answer on Question #48381, Physics, Mechanics | Kinematics | Dynamics

You are on a circular racetrack that does not have banked turns. The radius of the tracks circle is $2.5 \times 10^2 \text{ m}$. Starting from rest you accelerate uniformly at a rate of 4 m/s^2 . The coefficient of friction is .8, how many seconds will it take to start sliding off of the track?

Solution:

Centripetal acceleration is part of moving in a circular path. Centripetal acceleration points toward the center of the circular path of the car, but is felt by passengers as a force pushing them to the outer edge of the circular path.

The equation for centripetal acceleration is:

$$a_r = \frac{v^2}{r}.$$

The dynamics equation is

$$ma_r = F_{fr}$$

The maximum amount of friction force that a surface can exert upon an object can be calculated using the formula below:

$$F_{frict} = \mu F_{norm} = \mu mg$$

Thus,

$$ma_r = \mu mg$$

$$a_r = \mu g$$

$$\frac{v^2}{r} = \mu g$$

The maximum velocity is

$$v = \sqrt{\mu gr} = \sqrt{0.8 * 9.8 * 2500} = 140 \text{ m/s}$$

The time we obtain from kinematics equation:

$$t = \frac{v - v_0}{a} = \frac{140 - 0}{4} = 35 \text{ s}$$

Answer: $t = 35 \text{ s}$