

Chapter 3 Problem 72 †

Given

$$v = 1200 \text{ km/h}$$

$$a_{max} = 5 g$$

Solution

Find the height at which a jet must start a quarter turn.

Assume the jet is traveling in a circle in order to make its quarter turn. The acceleration experienced is then centripetal acceleration.

$$a = \frac{v^2}{r}$$

The height at which the turn starts will be the radius of the circle. Therefore, solving for the radius of the circle gives

$$r = \frac{v^2}{a}$$

Converting velocity into m/s gives

$$v = \frac{1200 \text{ km}}{h} \left(\frac{1 h}{3600 s} \right) \left(\frac{1000 m}{1 km} \right) = 333 \text{ m/s}$$

Max acceleration is $5 g$; however, $1 g$ is due to the force of gravity as the jet moves downward. The remaining $4 g$ is acceleration due to the jet traveling in the path of a circle. Therefore, the centripetal acceleration of the jet is

$$a = 4 g = 4(9.8 \text{ m/s}^2) = 39.2 \text{ m/s}^2$$

Therefore, the height at which the turn should begin is

$$r = \frac{(333 \text{ m/s})^2}{39.2 \text{ m/s}^2} = 2,830 \text{ m}$$

If you have been on a ride called the "Round-Up" you are familiar with the change in the g 's experienced depending on your location when spinning in a vertical circle. This ride spins you in a horizontal circle at constant speed. Once the speed is large enough, the whole ride tilts to the vertical. When you are at the lowest point, you experience more g 's than when you are at the top of the ride.

†Problem from Essential University Physics, Wolfson