Chapter 3 Problem 69 [†]

Given
$v = 1200\ km/h$
$a_{max} = 5\ g$

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

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

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

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

Therefore, the height at which the turn should begin is

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

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