

Chapter 6 Problems

1. A jet ($m = 2.00 \times 10^5$ kg), flying at 123 m/s, banks to make a horizontal circular turn. The radius of the turn is 3810 m. Calculate the necessary lifting force.

Answer: The horizontal component of the lift \mathbf{L} is the centripetal force that holds the plane in the circle. Thus

$$L \sin \theta = \frac{mv^2}{r}.$$

The vertical component of the lift supports the weight of the plane; therefore,

$$L \cos \theta = mg,$$

Dividing the first equation by the second gives

$$\tan \theta = \frac{v^2}{rg}.$$

This equation can be used to determine the banking angle, θ . Once θ is known, then the magnitude of \mathbf{L} can be found from either of the first two equations. One obtains $\theta = 22.1^\circ$ and $L = 2.12 \times 10^6$ N.

2. The weight of an object is the same on two different planets. The mass of planet A is only sixty percent that of planet B. Find r_A/r_B , the ratio of the radii of the planets.

Answer: Since the weights are the same, we have

$$\begin{aligned} g_A &= g_B \\ \frac{GM_A}{R_A^2} &= \frac{GM_B}{R_B^2} \\ \frac{M_A}{M_B} &= \frac{R_A^2}{R_B^2} \end{aligned}$$

where M and R denote the mass and radius of the particular planet, respectively. Since the mass of planet A is sixty percent that of planet B we have $M_A = 0.6M_B$. Then

$$\frac{R_A}{R_B} = \sqrt{0.6}.$$

3. A small mass M and small mass $3M$ are 1.00 m apart. Where should you put a third small mass so that the net gravitational force on it due to the other two masses is zero?

Answer: The point of interest must lie between the two masses, since gravity is always attractive. If we denote this point by r , then it lies $1.00m - r$ from one of the masses, say mass M , and r away from the second mass, $3M$. If we suppose that mass M lies to the left of our point of interest, the net force is then

$$\mathbf{F}_{net} = -\frac{GMm}{(1.00m - r)^2} + \frac{G3Mm}{r^2} = 0,$$

where m is the mass of our third small mass. The relative minus sign between these two terms arises from the fact that mass M pulls the third small mass to the left, whereas mass $3M$ pulls it to the right. Solving this expression for r yields $r = 0.75m$.