Name:_____ Class:_____ Date:_____

Circular Motion and Gravitation

Problem C

GRAVITATIONAL FORCE

PROBLEM

The sun has a mass of 2.0×10^{30} kg and a radius of 7.0×10^{5} km. What mass must be located at the sun's surface for a gravitational force of 470 N to exist between the mass and the sun?

SOLUTION

Given: $m_1 = 2.0 \times 10^{30}$ kg

$r = 7.0 \times 10^{5}$ km $= 7.0 \times 10^{8}$ m

$G = 6.673 \times 10^{-11}$ N•m^2/kg^2

$F_g = 470$ N

Unknown: $m_2 = ?$

Use Newton's universal law of gravitation, and rearrange it to solve for the second mass.

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$m_2 = \frac{F_g r^2}{G m_1} = \frac{(470\ \text{N})(7.0 \times 10^{8}\ \text{m})^2}{\left(6.673 \times 10^{-11}\ \frac{\text{N} \bullet \text{m}^2}{\text{kg}^2}\right)(2.0 \times 10^{30}\ \text{kg})}$$

$$m_2 = 1.7\ \text{kg}$$

ADDITIONAL PRACTICE

1. **Deimos, a satellite of Mars, has an average radius of 6.3 km. If the gravitational force between Deimos and a 3.0 kg rock at its surface is 2.5×10^{-2} N what is the mass of Deimos?**
2. **A 3.08×10^{4} kg meteorite is on exhibit in New York City. Suppose this meteorite and another meteorite are separated by 1.27×10^{7} m (a distance equal to Earth's average diameter). If the gravitational force between them is 2.88×10^{-16} N, what is the mass of the second meteorite?**
3. In 1989, a cake with a mass of 5.81×10^{4} kg was baked in Alabama. Suppose a cook stood 25.0 m from the cake. The gravitational force exerted between the cook and the cake was 5.0×10^{-7} N. What was the cook's mass?
4. **The largest diamond ever found has a mass of 621 g. If the force of gravitational attraction between this diamond and a person with a mass of 65.0 kg is 1.0×10^{-12} N, what is the distance between them?**

5. The passenger liners *Carnival Destiny* and *Grand Princess*, built recently, have a mass of about 1.0×10^8 kg each. How far apart must these two ships be to exert a gravitational attraction of 1.0×10^{-3} N on each other?

6. In 1874, a swarm of locusts descended on Nebraska. The swarm's mass was estimated to be 25×10^9 kg. If this swarm were split in half and the halves separated by 1.0×10^3 km, what would the magnitude of the gravitational force between the halves be?

7. Jupiter, the largest planet in the solar system, has a mass 318 times that of Earth and a volume that is 1323 times greater than Earth's. Calculate the magnitude of the gravitational force exerted on a 50.0 kg mass on Jupiter's surface.