* **58.** (I) Neptune is an average distance of 4.5×10^9 km from the Sun. Estimate the length of the Neptunian year given that the Earth is 1.50×10^8 km from the Sun on the average.

* **59.** (II) Halley's comet orbits the Sun roughly once every 76 years. It comes very close to the surface of the Sun on its closest approach (Fig. 5–39). Estimate the greatest distance of the comet from the Sun. Is it still "in" the Solar System? What planet's orbit is nearest when it is out there? [*Hint*: The mean distance *s* in Kepler's third law is half the sum of the nearest and farthest distance from the Sun.]

FIGURE 5–39 Problem 59.

* **60.** (II) Our Sun rotates about the center of the Galaxy $(M_G \approx 4 \times 10^{41}\,\text{kg})$ at a distance of about 3×10^4 light-years $(1\,\text{ly} = 3 \times 10^8\,\text{m/s} \times 3.16 \times 10^7\,\text{s/y} \times 1\,\text{y})$. What is the period of our orbital motion about the center of the Galaxy?

* **61.** (II) Table 5–3 gives the mass, period, and mean distance for the four largest moons of Jupiter (those discovered by Galileo in 1609). (*a*) Determine the mass of Jupiter using the data for Io. (*b*) Determine the mass of Jupiter using data for each of the other three moons. Are the results consistent?

TABLE 5–3 Principal Moons of Jupiter

Moon	Mass (kg)	Period (Earth days)	Mean distance from Jupiter (km)
Io	8.9×10^{22}	1.77	422×10^3
Europa	4.9×10^{22}	3.55	671×10^3
Ganymede	15×10^{22}	7.16	1070×10^3
Callisto	11×10^{22}	16.7	1883×10^3

* **62.** (II) Determine the mass of the Earth from the known period and distance of the Moon.

* **63.** (II) Determine the mean distance from Jupiter for each of Jupiter's moons, using Kepler's third law. Use the distance of Io and the periods given in Table 5–3. Compare to the values in the Table.

* **64.** (II) The asteroid belt between Mars and Jupiter consists of many fragments (which some space scientists think came from a planet that once orbited the Sun but was destroyed). (*a*) If the center of mass of the asteroid belt (where the planet would have been) is about three times farther from the Sun than the Earth is, how long would it have taken this hypothetical planet to orbit the Sun? (*b*) Can we use these data to deduce the mass of this planet?

* **65.** (III) A science-fiction tale describes an artificial "planet" in the form of a band completely encircling a sun (Fig. 5–40). The inhabitants live on the inside surface (where it is always noon). Imagine that this sun is exactly like our own, that the distance to the band is the same as the Earth–Sun distance (to make the climate temperate), and that the ring rotates quickly enough to produce an apparent gravity of *g* as on Earth. What will be the period of revolution, this planet's year, in Earth days?

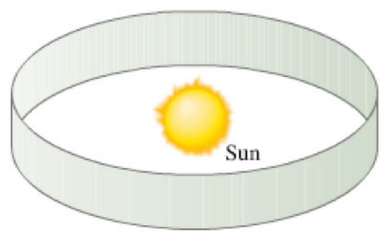

FIGURE 5–40 Problem 65.

General Problems

66. Tarzan plans to cross a gorge by swinging in an arc from a hanging vine (Fig. 5–41). If his arms are capable of exerting a force of 1400 N on the vine, what is the maximum speed he can tolerate at the lowest point of his swing? His mass is 80 kg, and the vine is 5.5 m long.

FIGURE 5–41 Problem 66.

67. How far above the Earth's surface will the acceleration of gravity be half what it is on the surface?

68. On an ice rink, two skaters of equal mass grab hands and spin in a mutual circle once every 2.5 s. If we assume their arms are each 0.80 m long and their individual masses are 60.0 kg, how hard are they pulling on one another?

69. Because the Earth rotates once per day, the apparent acceleration of gravity at the equator is slightly less than it would be if the Earth didn't rotate. Estimate the magnitude of this effect. What fraction of *g* is this?

70. At what distance from the Earth will a spacecraft traveling directly from the Earth to the Moon experience zero net force because the Earth and Moon pull with equal and opposite forces?

71. You know your mass is 65 kg, but when you stand on a bathroom scale in an elevator, it says your mass is 82 kg. What is the acceleration of the elevator, and in which direction?