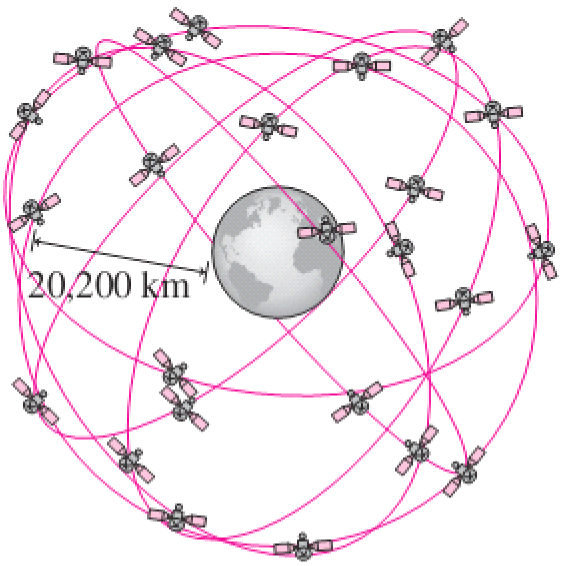
Section Three Linear momentum Gravity

Part One

The Global Positioning System (GPS) uses a "constellation" of some 30 satellites to provide accurate positioning for any point on Earth (Fig. 3.1). GPS receivers time radio signals traveling at the speed of light from three of the satellites to find the receiver's position. Signals from one or more additional satellites provide corrections, eliminating the need for high-accuracy clocks in individual GPS receivers. GPS satellites are in circular orbits at 20,200 km altitude.



1. What's the approximate orbital period of GPS satellites?

a. 90 min

b. 8 h

c. 12 h

d. 24 h

e. 1 week

2. What's the approximate speed of GPS satellites?

a. 9.8 m/s

b. 500 m/s

c. 1.7 km/s

d. 4 km/s

e. 12 km/s

3. What's the approximate escape speed at GPS orbital distance?

a. 4 km/s

b. 5.5 km/s

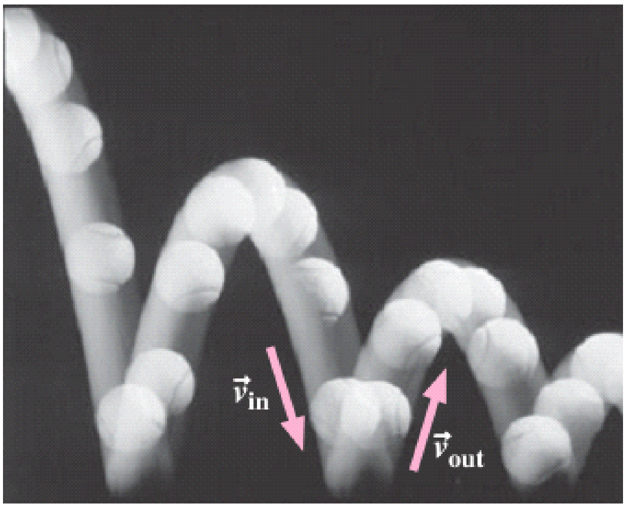
c. 6.3 km/s

d. 9.8 km/s

e. 11 km/s

4. The current generation of GPS satellites has masses of 844 kg. What's the approximate total

energy of such a satellite?
a. 6 GJ
b. 3 GJ
c. -3 GJ
d. -6 GJ
e. -8GJ
You're interested in the intersection of physics and sports, and you recognize that many sporting events involve collisions—bat and base-ball, foot and football, hockey stick and puck, basketball and floor. Using strobe photography, you embark on a study of such collisions .Figure 3.2 is your strobe photo of a ball bouncing off the floor. The ball is launched from a point near the top left of the photo and your camera then captures it undergoing three subsequent collisions with the floor.

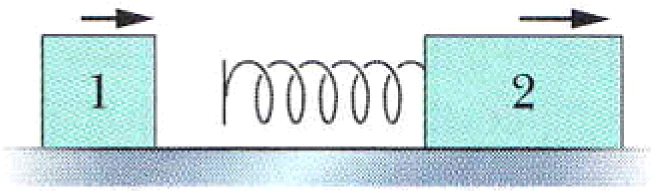


5. The collisions between ball and floor are
a. totally elastic.
b. totally inelastic.
c. neither totally elastic nor totally inelastic.
6. The fraction of the ball's mechanical energy that's lost in the second collision is
a. about 10%.
b. a little less than half.
c. a little more than half.
d. about 90%.
7. The component of the ball's velocity whose magnitude is most affected by the collisions is
a. horizontal.
b. vertical.
c. Both are affected equally.
8. Compared with the time between bounces, the duration of each collision is
a. a tiny fraction of the time between bounces.
b. a significant fraction of the time between bounces.
c. much longer than the time between bounces.

Part two

1 A uniform soda can of mass 0.140 kg is 12.0 cm tall and filled with I.3l kg of soda. Then small holes are drilled in the top and bottom (with negligible loss of metal) to drain the soda. What is the height h of the COM of the can and contents (a) initially and (b) after the can loses all the soda? (c) What happens to h as the soda drains out? (d) If x is the height of the remaining soda at any given instant, find x when the com reaches its lowest point.

2 In Fig. 3.3, block 1, (mass 2.0 kg) is moving right-ward at 10 m/s and block 2 (mass 5.0 kg) is moving right-ward at 3.0 m/s. The surface is frictionless, and a spring with a spring constant of II20 N/m is fixed to block 2. Find the maximum compression?



3 A particle of mass 0.67 kg is a distance d= 23 cm from one end of a uniform rod with length L =3.0 m and mass M =5.0 kg. What is the magnitude of the gravitational force F on the particle from the rod?

4 The presence of an unseen planet orbiting a distant star can sometimes be inferred from the motion of the star as we see it. As the star and planet orbit the center of mass of the star-planet system, the star moves toward and away from us with what is called the line of sight velocity, a motion that can be detected. Figure 3.4 shows a graph of the line of sight velocity versus time for the star 14 Herculis. The star's mass is believed to be 0.90 of the mass of our Sun. Assume that only one planet orbits the star and that our view is along the plane of the orbit. Then approximate (a) the planet's mass in terms of Jupiter's mass m_J and (b) the planet's orbital radius in terms of Earth's orbital radius r_E.