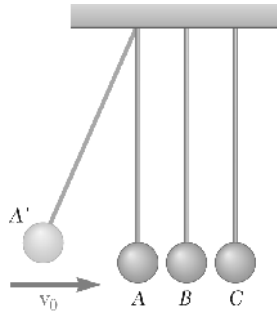


ME 104: Homework 4

Prof. Karl J. Hedrick: University of California, Berkeley

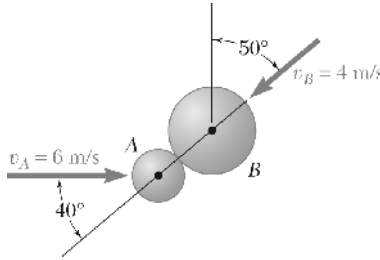
Due Monday, October 5th

Chapter 13, Problem 160



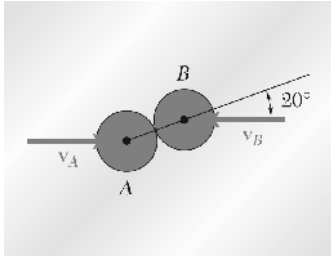
Three steel spheres of equal weight are suspended from the ceiling by cords of equal length which are spaced at a distance slightly greater than the diameter of the spheres. After being pulled back and released, sphere A hits sphere B , which then hits sphere C . Denoting by e the coefficient of restitution between the spheres and by v_0 the velocity of A just before it hits B , determine (a) the velocities of A and B immediately after the first collision, (b) the velocities of B and C immediately after the second collision. (c) Assuming now that n spheres are suspended from the ceiling and that the first sphere is pulled back and released as described above, determine the velocity of the last sphere after it is hit for the first time. (d) Use the result of Part c to obtain the velocity of the last sphere when $n = 6$ and $e = 0.95$.

Chapter 13, Problem 165



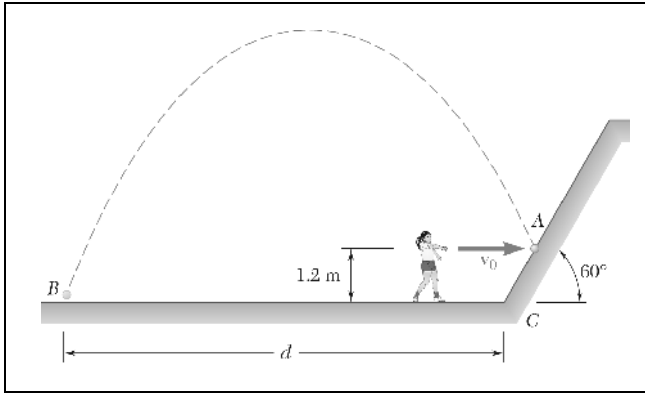
A 600-g ball A is moving with a velocity of magnitude 6 m/s when it is hit as shown by a 1-kg ball B , which has a velocity of magnitude 4 m/s. Knowing that the coefficient of restitution is 0.8 and assuming no friction, determine the velocity of each ball after impact.

Chapter 13, Problem 166



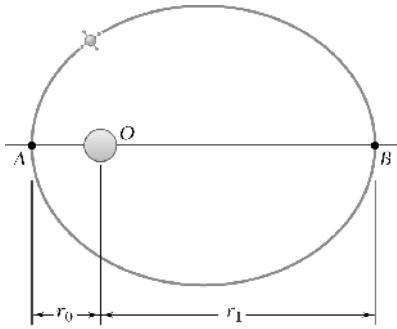
Two identical hockey pucks are moving on a hockey rink at the same speed of 3 m/s and in parallel and opposite directions when they strike each other as shown. Assuming a coefficient of restitution $e = 1$, determine the magnitude and direction of the velocity of each puck after impact.

Chapter 13, Problem 170



A girl throws a ball at an inclined wall from a height of 1.2 m, hitting the wall at A with a horizontal velocity v_0 of magnitude 15 m/s. Knowing that the coefficient of restitution between the ball and the wall is 0.9 and neglecting friction, determine the distance d from the foot of the wall to the Point B where the ball will hit the ground after bouncing off the wall.

Chapter 12, Problem 102

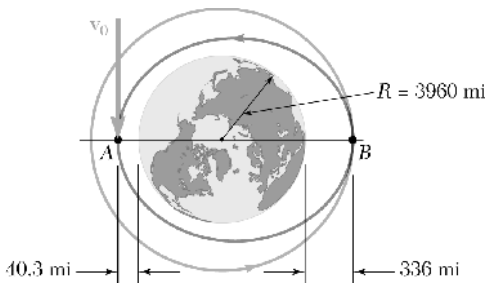


A satellite describes an elliptic orbit about a planet of mass M . Denoting by r_0 and r_1 , respectively, the minimum and maximum values of the distance r from the satellite to the center of the planet, derive the relation

$$\frac{1}{r_0} + \frac{1}{r_1} = \frac{2GM}{h^2}$$

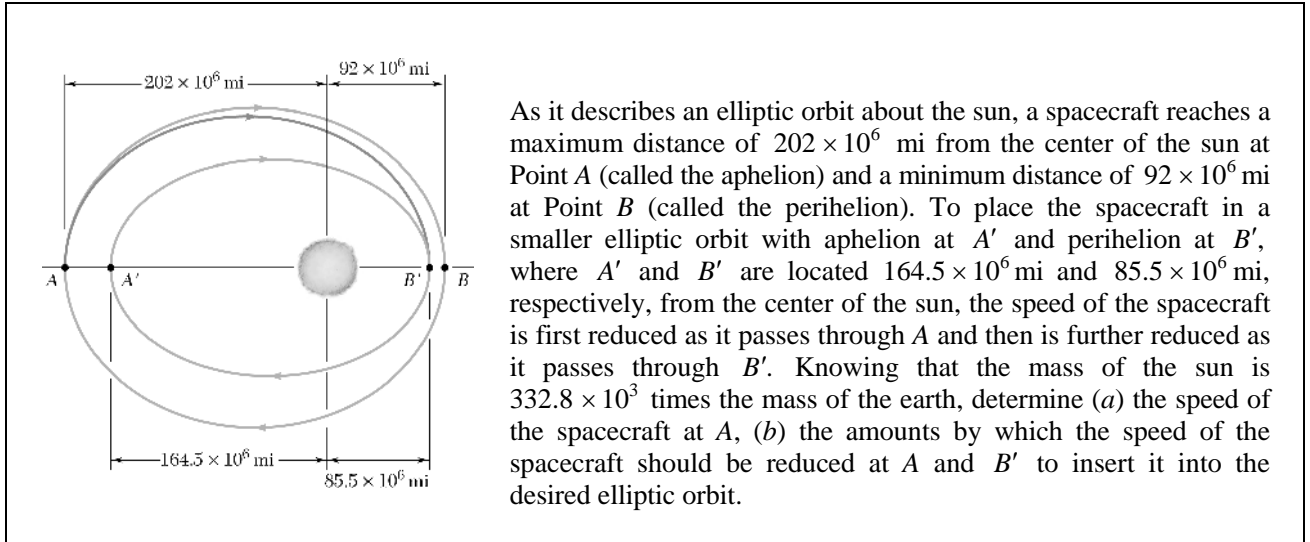
where h is the angular momentum per unit mass of the satellite.

Chapter 12, Problem 103



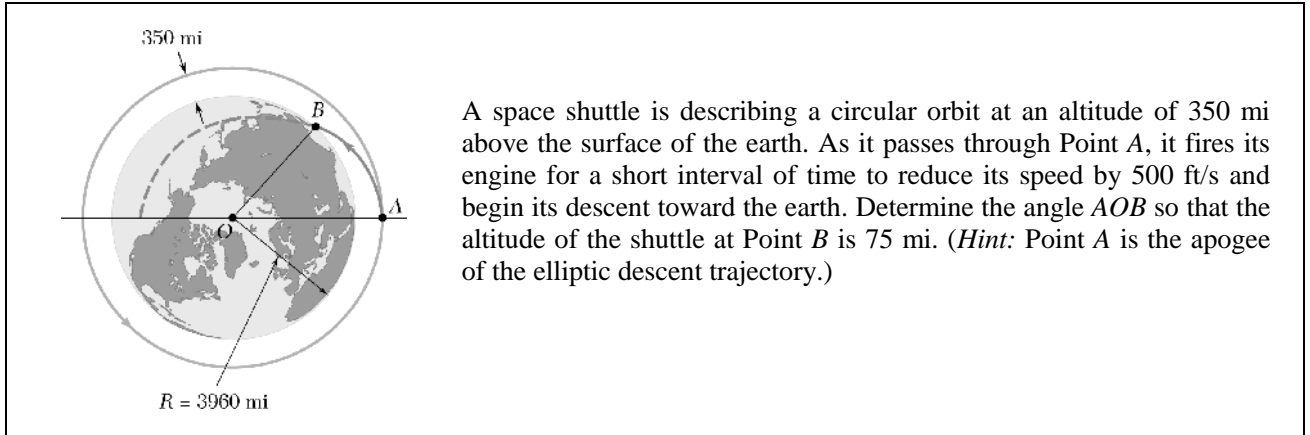
At main engine cutoff of its thirteenth flight, the space shuttle Discovery was in an elliptic orbit of minimum altitude 40.3 mi and maximum altitude 336 mi above the surface of the earth. Knowing that at Point *A* the shuttle had a velocity v_0 parallel to the surface of the earth and that the shuttle was transferred to a circular orbit as it passed through Point *B*, determine (a) the speed v_0 of the shuttle at *A*, (b) the increase in speed required at *B* to insert the shuttle into the circular orbit.

Chapter 12, Problem 105



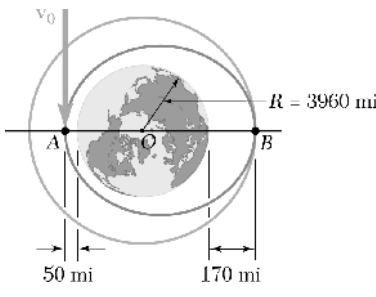
As it describes an elliptic orbit about the sun, a spacecraft reaches a maximum distance of 202×10^6 mi from the center of the sun at Point A (called the aphelion) and a minimum distance of 92×10^6 mi at Point B (called the perihelion). To place the spacecraft in a smaller elliptic orbit with aphelion at A' and perihelion at B' , where A' and B' are located 164.5×10^6 mi and 85.5×10^6 mi, respectively, from the center of the sun, the speed of the spacecraft is first reduced as it passes through A and then is further reduced as it passes through B' . Knowing that the mass of the sun is 332.8×10^3 times the mass of the earth, determine (a) the speed of the spacecraft at A, (b) the amounts by which the speed of the spacecraft should be reduced at A and B' to insert it into the desired elliptic orbit.

Chapter 12, Problem 117



A space shuttle is describing a circular orbit at an altitude of 350 mi above the surface of the earth. As it passes through Point A , it fires its engine for a short interval of time to reduce its speed by 500 ft/s and begin its descent toward the earth. Determine the angle AOB so that the altitude of the shuttle at Point B is 75 mi. (*Hint:* Point A is the apogee of the elliptic descent trajectory.)

Chapter 12, Problem 133



The diagram shows a cross-section of Earth with center O and radius $R = 3960$ mi. Two orbits are shown: an inner circular orbit and an outer elliptic orbit. The elliptic orbit has its perigee at Point A , which is 50 mi above the Earth's surface. The circular orbit has its radius equal to the distance from the center O to Point B , which is 170 mi above the Earth's surface. A velocity vector v_0 is shown at Point A , tangent to the elliptic orbit. The Earth's surface is represented by a circle with center O .

At engine burnout on a mission, a shuttle had reached Point A at an altitude of 40 mi above the surface of the earth and had a horizontal velocity v_0 . Knowing that its first orbit was elliptic and that the shuttle was transferred to a circular orbit as it passed through Point B at an altitude of 170 mi, determine (a) the time needed for the shuttle to travel from A to B on its original elliptic orbit, (b) the periodic time of the shuttle on its final circular orbit.