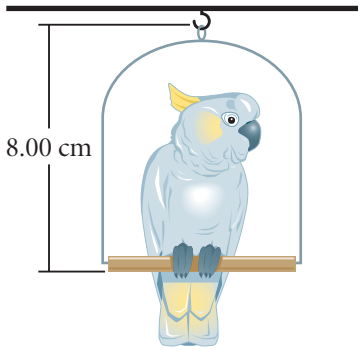
43. The bird perched on the swing shown in the diagram has a mass of 52.0 g, and the base of the swing has a mass of 153 g. The swing and bird are originally at rest, and then the bird takes off horizontally at 2.00 m/s. How high will the base of the swing rise above its original level? Disregard friction.



44. An 85.0 kg astronaut is working on the engines of a spaceship that is drifting through space with a constant velocity. The astronaut turns away to look at Earth and several seconds later is 30.0 m behind the ship, at rest relative to the spaceship. The only way to return to the ship without a thruster is to throw a wrench directly away from the ship. If the wrench has a mass of 0.500 kg, and the astronaut throws the wrench with a speed of 20.0 m/s, how long does it take the astronaut to reach the ship?

45. A 2250 kg car traveling at 10.0 m/s collides with a 2750 kg car that is initially at rest at a stoplight. The cars stick together and move 2.50 m before friction causes them to stop. Determine the coefficient of kinetic friction between the cars and the road, assuming that the negative acceleration is constant and that all wheels on both cars lock at the time of impact.

46. A constant force of 2.5 N to the right acts on a 1.5 kg mass for 0.50 s.

a. Find the final velocity of the mass if it is initially at rest.

b. Find the final velocity of the mass if it is initially moving along the *x*-axis with a velocity of 2.0 m/s to the left.

47. Two billiard balls with identical masses and sliding in opposite directions have an elastic head-on collision. Before the collision, each ball has a speed of 22 cm/s. Find the speed of each billiard ball immediately after the collision. (See Appendix A for hints on solving simultaneous equations.)

Graphing Calculator Practice

Momentum

As you learned earlier in this chapter, the linear momentum, **p**, of an object of mass *m* moving with a velocity **v** is defined as the product of the mass and the velocity. A change in momentum requires force and time. This fundamental relationship between force, momentum, and time is shown in Newton's second law of motion.

$$\mathbf{F} = \frac{\Delta \mathbf{p}}{\Delta t}, \text{ where } \Delta \mathbf{p} = m\mathbf{v_f} - m\mathbf{v_i}$$

In this graphing calculator activity, you will determine the force that must be exerted to change the momentum of an object in various time intervals. This activity will help you better understand

- the relationship between time and force
- the consequences of the signs of the force and the velocity

Visit go.hrw.com and enter the keyword **HF6MOMX** to find this graphing calculator activity. Refer to **Appendix B** for instructions on downloading the program for this activity.