32. (II) A 28-g rifle bullet traveling 230 m/s buries itself in a 3.6-kg pendulum hanging on a 2.8-m-long string, which makes the pendulum swing upward in an arc. Determine the vertical and horizontal components of the pendulum's displacement.

33. (II) (*a*) Derive a formula for the fraction of kinetic energy lost, $\Delta\text{KE}/\text{KE}$, for the ballistic pendulum collision of Example 7–10. (*b*) Evaluate for $m = 14.0\text{ g}$ and $M = 380\text{ g}$.

34. (II) An internal explosion breaks an object, initially at rest, into two pieces, one of which has 1.5 times the mass of the other. If 7500 J were released in the explosion, how much kinetic energy did each piece acquire?

35. (II) A 920-kg sports car collides into the rear end of a 2300-kg SUV stopped at a red light. The bumpers lock, the brakes are locked, and the two cars skid forward 2.8 m before stopping. The police officer, knowing that the coefficient of kinetic friction between tires and road is 0.80, calculates the speed of the sports car at impact. What was that speed?

36. (II) A ball is dropped from a height of 1.50 m and rebounds to a height of 1.20 m. Approximately how many rebounds will the ball make before losing 90% of its energy?

37. (II) A measure of inelasticity in a head-on collision of two objects is the *coefficient of restitution*, *e*, defined as

$$e = \frac{v'_A - v'_B}{v_B - v_A},$$

where $v'_A - v'_B$ is the relative velocity of the two objects after the collision and $v_B - v_A$ is their relative velocity before it. (*a*) Show that $e = 1$ for a perfectly elastic collision, and $e = 0$ for a completely inelastic collision. (*b*) A simple method for measuring the coefficient of restitution for an object colliding with a very hard surface like steel is to drop the object onto a heavy steel plate, as shown in Fig. 7–36. Determine a formula for *e* in terms of the original height *h* and the maximum height h' reached after one collision.

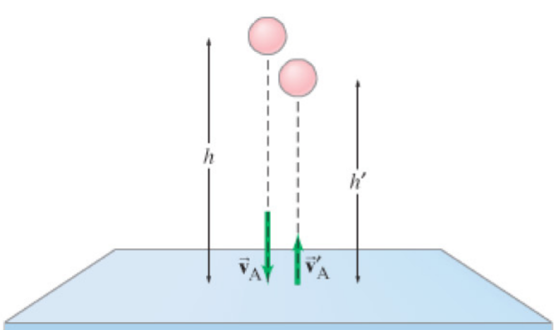

FIGURE 7–36 Problem 37. Measurement of the coefficient of restitution.

38. (II) A wooden block is cut into two pieces, one with three times the mass of the other. A depression is made in both faces of the cut, so that a firecracker can be placed in it with the block reassembled. The reassembled block is set on a rough-surfaced table, and the fuse is lit. When the firecracker explodes, the two blocks separate and slide apart. What is the ratio of distances each block travels?

39. (III) A 15.0-kg object moving in the $+x$ direction at 5.5 m/s collides head-on with a 10.0-kg object moving in the $-x$ direction at 4.0 m/s. Find the final velocity of each mass if: (*a*) the objects stick together; (*b*) the collision is elastic; (*c*) the 15.0-kg object is at rest after the collision; (*d*) the 10.0-kg object is at rest after the collision; (*e*) the 15.0-kg object has a velocity of 4.0 m/s in the $-x$ direction after the collision. Are the results in (*c*), (*d*), and (*e*) "reasonable"? Explain.

* 7–7 Collisions in Two Dimensions

*** 40.** (II) A radioactive nucleus at rest decays into a second nucleus, an electron, and a neutrino. The electron and neutrino are emitted at right angles and have momenta of $9.30 \times 10^{-23}\text{ kg}\cdot\text{m/s}$ and $5.40 \times 10^{-23}\text{ kg}\cdot\text{m/s}$, respectively. What are the magnitude and direction of the momentum of the second (recoiling) nucleus?

*** 41.** (II) An eagle $(m_A = 4.3\text{ kg})$ moving with speed $v_A = 7.8\text{ m/s}$ is on a collision course with a second eagle $(m_B = 5.6\text{ kg})$ moving at $v_B = 10.2\text{ m/s}$ in a direction perpendicular to the first. After they collide, they hold onto one another. In what direction, and with what speed, are they moving after the collision?

*** 42.** (II) Billiard ball A of mass $m_A = 0.400\text{ kg}$ moving with speed $v_A = 1.80\text{ m/s}$ strikes ball B, initially at rest, of mass $m_B = 0.500\text{ kg}$. As a result of the collision, ball A is deflected off at an angle of 30.0° with a speed $v'_A = 1.10\text{ m/s}$. (*a*) Taking the *x* axis to be the original direction of motion of ball A, write down the equations expressing the conservation of momentum for the components in the *x* and *y* directions separately. (*b*) Solve these equations for the speed v'_B and angle θ'_B of ball B. Do not assume the collision is elastic.

*** 43.** (III) After a completely inelastic collision between two objects of equal mass, each having initial speed *v*, the two move off together with speed $v/3$. What was the angle between their initial directions?

*** 44.** (III) Two billiard balls of equal mass move at right angles and meet at the origin of an *xy* coordinate system. Ball A is moving upward along the *y* axis at 2.0 m/s, and ball B is moving to the right along the *x* axis with speed 3.7 m/s. After the collision, assumed elastic, ball B is moving along the positive *y* axis (Fig. 7–37). What is the final direction of ball A and what are their two speeds?

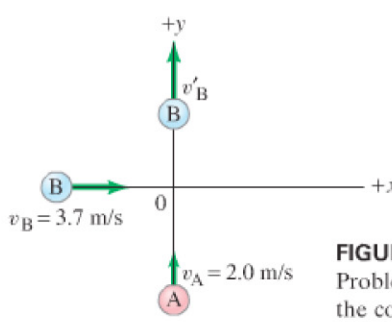

FIGURE 7–37 Problem 44. (Ball A after the collision is not shown.)

*** 45.** (III) A neon atom ($m = 20.0\text{ u}$) makes a perfectly elastic collision with another atom at rest. After the impact, the neon atom travels away at a 55.6° angle from its original direction and the unknown atom travels away at a −50.0° angle. What is the mass (in u) of the unknown atom? [*Hint*: You can use the law of sines.]