

21. ● Three identical boxcars are coupled together and are moving at a constant speed of 20.0 m/s on a level track. They collide with another identical boxcar that is initially at rest and couple to it, so that the four cars roll on as a unit. Friction is small enough to be neglected. (a) What is the speed of the four cars? (b) What percentage of the kinetic energy of the boxcars is dissipated in the collision? What happened to this energy?
27. ●● A hungry 11.5 kg predator fish is coasting from west to east at 75.0 cm/s when it suddenly swallows a 1.25 kg fish swimming from north to south at 3.60 m/s . Find the magnitude and direction of the velocity of the large fish just after it snapped up this meal. Neglect any effects due to the drag of the water.
32. ● On a cold winter day, a penny (mass 2.50 g) and a nickel (mass 5.00 g) are lying on the smooth (frictionless) surface of a frozen lake. With your finger, you flick the penny toward the nickel with a speed of 2.20 m/s . The coins collide elastically; calculate both their final velocities (speed and direction).
33. ●● **Nuclear collisions.** Collisions between atomic and subatomic particles are often perfectly elastic. In one such collision, a proton traveling to the right at 258 km/s collides head-on and elastically with a stationary alpha particle (a helium nucleus, having mass $6.65 \times 10^{-27} \text{ kg}$). Consult Appendix E as needed. (a) Find the magnitude and direction of the velocity of each particle after the collision.