1. An 1100-kg car is backing out of a parking space at 5.5 m/s. The unobservant driver of a 1900-kg pickup truck is coasting through the parking lot at a speed of 3.2 m/s and runs straight into the rear bumper of the car.

   a) What is the change in internal energy of the two-vehicle system if the velocity of the pickup is 1.5 m/s backward after they collide?

   b) What is the coefficient of restitution for this collision?

2. Ball 1 is moving toward you at 7.00 m/s, and you decide to throw ball 2 at it to make it reverse its velocity. (ie. head back in the opposite direction, with the same speed it had before the collision). The balls collide head-on, and the coefficient of restitution for the collision is 0.900. Ball 1 has an inertia of 0.500 kg and ball 2 has an inertia of 0.550 kg. Call the direction of motion in which we throw ball 2 the $+x$ direction.

   a) How fast must ball 2 be traveling in order to reverse the velocity of ball 1?

   b) What is the initial relative velocity of the two balls?

   c) What is their reduced mass (μ)?

   d) What percentage of the original kinetic energy is convertible? Express your answer as a percentage with 3 significant digits.

   e) What is the x-component of the final velocity of ball 1 immediately after the collision?

   f) What is the x-component of the final velocity of ball 2 immediately after the collision?

3. You lean out of your dorm window, which is 15 m above the ground, and toss a 0.17-kg ball up to a friend at a window 15 m above you.

   a) What is the slowest initial speed at which you can throw the ball so that they just catch it?

   b) If you throw the ball at this speed and your friend misses it, what is its kinetic energy the instant before it hits the ground?

   c) Suppose you throw the ball directly downward at the speed calculated in part a) . What is its kinetic energy just before it hits the ground?

4. A 20.0-kg cart is connected to a 35.0-kg cart by a relaxed spring of spring constant 1000 N/m, and both carts are placed on a low-friction track. You can ignore friction between the carts and the track in solving this problem. You push the 20.0-kg cart in the direction of the 35.0-kg cart with a constant force of 10.0 N.

   a) What is the acceleration of the center of mass of the two-cart system at any instant? Assume that the direction of push is the positive direction.

   b) What is the acceleration of 20-kg cart at the instant you begin to push? Assume that the direction of push is the positive direction.

   c) What is the acceleration of 35-kg cart at the instant you begin to push? Assume that the direction of push is the positive direction.

   d) What is the acceleration of each cart when the spring has reached it's maximum compression?

5. A 53.0-kg acrobat must jump high and land on their brother's shoulders. To accomplish this, they leap from a crouched position to a height where their center of mass is 1.60 m above the ground. Their center of mass is 40.0 cm above the ground in the crouch and 90.0 cm above the ground when their feet leave the ground.

   a) What is the average force exerted on them by the ground during the jump?

   b) What is their maximum speed?