1. In a railroad yard, a train is being assembled. An empty boxcar, coasting at 3 m/s, strikes a loaded car that is stationary, and the cars couple together. Each of the boxcars has a mass of 9000 kg when empty, and the loaded car contains 55,000 kg of lumber. Find the speed of the coupled boxcars.

2. An astronaut of mass 80 kg carries an empty oxygen tank of mass 10 kg. By pushing the tank away with a speed of 2.0 m/s, the astronaut recoils in the opposite direction. Find the speed with which the astronaut moves off into space.

3. A tennis player returns a 30 m/s serve straight back at 25 m/s, after making contact with the ball for 0.50 s. The ball has a mass of 0.20 kg. How much force did the racket exert on the ball?

4. A 50 kg cart is moving across a frictionless floor at 2.0 m/s. A 70 kg boy, riding in the cart, jumps off so that he hits the floor with zero velocity. How large an impulse did the boy give to the cart? What was the velocity of the cart after the boy jumped?

5. Two girls with masses of 50 kg and 70 kg are at rest on frictionless in-line skates. The larger girl pushes the smaller girl so that the smaller girl rolls away at a speed of 10 m/s. Calculate the impulse that each girl imparts to the other. What is the speed of the larger girl?

6. A 2 kg melon is balanced on a circus performer's head. An archer shoots a 50 g arrow at the melon with a speed of 30 m/s. The arrow passes through the melon and emerges with a speed of 18 m/s. Find the speed of the melon as it flies off the performer's head.

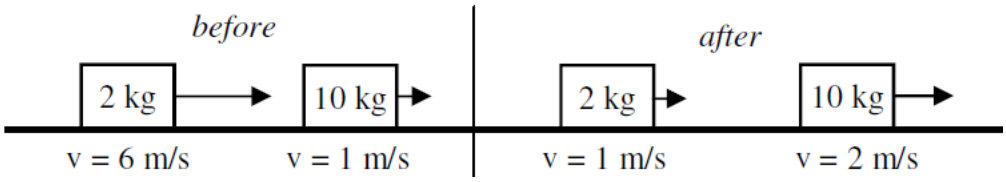
7. Old cannons were built on wheeled carts, both to facilitate moving the cannon and to allow the cannon to recoil when fired. When a 150 kg cannon and cart recoils at 1.5 m/s, at what velocity would a 10 kg cannonball leave the cannon?

8. On an icy road, a 5000 kg truck rear-ends a 1200 kg car that had been traveling at 13 m/s, causing the truck to slow from 14 m/s to 12 m/s and the car to speed up. Find the final velocity of the car.

9. During alpha decay, an atom ejects two protons and two neutrons (an alpha particle, which is also a helium nucleus). When radium-226 decays, it becomes radon-222 by ejecting an alpha particle. How many times larger will the final velocity of the alpha particle be compared to the final velocity of the radon-222?

10. Airplanes manoeuvre on the ground by using thrust from their jets or propellers. A fully loaded, 396,900 kg Boeing 747-400 gets a total of 1100 kiloNewtons of thrust from its jet engines. Take off speed depends on a number of factors like air temperature, airplane weight, and airport elevation, but let us say that lift off will occur at 272 km/h. Determine the time the plane takes to go from 0 to 272 km/h. Calculate the impulse the plane receives from the engines during take-off.

11.




Is this collision elastic or inelastic?

12. A delivery van of mass 1200 kg, travelling south at 20 m s–1, collides head-on with a power pole. The impact crushes the crumple zone of the van by 0.60 m bringing the van to rest against the pole. Calculate the average force that the pole exerts on the van, time for the impact, initial momentum and final momentum of the van and explain how momentum has been conserved in this collision.

13. A car of mass 1000 kg travelling on a smooth road at 5.0 m/s collides with a truck that is stationary at a set of traffic lights. After the collision they are stuck together and move off with a speed of 2.0 m/s. How much momentum did the car transfer to the truck? What is the mass of the truck? If the collision took place over a period of 0.3 s, what was the average force exerted by the car on the truck?