Physical Science, Dr. Gladden
Solutions for HW#05

Solutions to Chapter 6 Exercises

4. The extra thickness extends the time during which momentum changes and reduces impact force.

5. This illustrates the same point as the previous exercise. The time during which momentum decreases is lengthened, thereby decreasing the jolting force of the rope. Note that in all of these examples, bringing a person to a stop more gently does *not* reduce the impulse. It only reduces the force.

10. Crumpling allows more time for reducing the momentum of the car, resulting in a smaller force of impact on the occupants.

15. The large momentum of the spurting water is met by a recoil that makes the hose difficult to hold, just as a shotgun is difficult to hold when it fires birdshot.

30. If the rocket and its exhaust gases are treated as a single system, the forces between rocket and exhaust gases are internal, and momentum in the rocket-gases system is conserved. So any momentum given to the gases is equal and opposite to momentum given to the rocket. A rocket attains momentum by giving momentum to the exhaust gases.

53. We assume the equal strengths of the astronauts means that each throws with the same speed. Since the masses are equal, when the first throws the second, both the first and second move away from each other at equal speeds. Say the thrown astronaut moves to the right with velocity V, and the first recoils with velocity $-V$. When the third makes the catch, both she and the second move to the right at velocity $V/2$ (twice the mass moving at half the speed, like the freight cars in Figure 6.14). When the third makes her throw, she recoils at velocity V (the same speed she imparts to the thrown astronaut) which is added to the $V/2$ she acquired in the catch. So her velocity is $V + V/2 = 3V/2$, to the right~~too~~ fast to stay in the game. Why? Because the velocity of the second astronaut is $V/2 - V = -V/2$, to the left~~too~~ slow to catch up with the first astronaut who is still moving at $-V$. The game is over. Both the first and the third got to throw the second astronaut only once!

Chapter 6 Problem Solutions

3. From $Ft = \Delta mv$, $F =$ = [(75 kg)(25 m/s)]/0.1 s = **18,750 N**.

7. The answer is 4 km/h. Let m be the mass of the freight car, and $4m$ the mass of the diesel engine, and v the speed after both have coupled together. Before collision, the total momentum is due only to the diesel engine, $4m$(5 km/h), because the momentum of the freight car is 0. After collision, the combined mass is $(4m + m)$, and combined momentum is $(4m + m)v$. By the conservation of momentum equation:

   $\text{Momentum}_{\text{before}} = \text{momentum}_{\text{after}}$
   $4m(5\ \text{km/h}) + 0 = (4m + m)v$
   $v =$ = **4 km/h**
   (Note that you dont have to know m to solve the problem.)

10. Momentum conservation can be applied in both cases.
(a) For head-on motion the total momentum is zero, so the wreckage after collision is **motionless**.
(b) As shown in Figure 6.18, the total momentum is directed to the northeast~~the~~ resultant of two perpendicular vectors, each of magnitude 20,000 kg m/s. It has magnitude 28,200 kg·m/s. The speed of the wreckage is this momentum divided by the total mass, v = (28,200 kg·m/s)/(2000 kg) = **14.1 m/s.**