PRACTICE D

Conservation of Momentum

1. A 63.0 kg astronaut is on a spacewalk when the tether line to the shuttle breaks. The astronaut is able to throw a spare 10.0 kg oxygen tank in a direction away from the shuttle with a speed of 12.0 m/s, propelling the astronaut back to the shuttle. Assuming that the astronaut starts from rest with respect to the shuttle, find the astronaut's final speed with respect to the shuttle after the tank is thrown.
2. An 85.0 kg fisherman jumps from a dock into a 135.0 kg rowboat at rest on the west side of the dock. If the velocity of the fisherman is 4.30 m/s to the west as he leaves the dock, what is the final velocity of the fisherman and the boat?
3. Each croquet ball in a set has a mass of 0.50 kg. The green ball, traveling at 12.0 m/s, strikes the blue ball, which is at rest. Assuming that the balls slide on a frictionless surface and all collisions are head-on, find the final speed of the blue ball in each of the following situations:
   a. The green ball stops moving after it strikes the blue ball.
   b. The green ball continues moving after the collision at 2.4 m/s in the same direction.
4. A boy on a 2.0 kg skateboard initially at rest tosses an 8.0 kg jug of water in the forward direction. If the jug has a speed of 3.0 m/s relative to the ground and the boy and skateboard move in the opposite direction at 0.60 m/s, find the boy's mass.

Newton's third law leads to conservation of momentum

Consider two isolated bumper cars, m_1 and m_2, before and after they collide. Before the collision, the velocities of the two bumper cars are $\mathbf{v_{1,i}}$ and $\mathbf{v_{2,i}}$, respectively. After the collision, their velocities are $\mathbf{v_{1,f}}$ and $\mathbf{v_{2,f}}$, respectively. The impulse-momentum theorem, $\mathbf{F}\Delta t = \Delta\mathbf{p}$, describes the change in momentum of one of the bumper cars. Applied to m_1, the impulse-momentum theorem gives the following:

$$\mathbf{F_1}\Delta t = m_1\mathbf{v_{1,f}} - m_1\mathbf{v_{1,i}}$$

Likewise, for m_2 it gives the following:

$$\mathbf{F_2}\Delta t = m_2\mathbf{v_{2,f}} - m_2\mathbf{v_{2,i}}$$