Momentum Problem Set 1

1. The world's most massive train rain in South Africa in 1989. Over 7 km long, the train traveled 861.0 km in 22.67 hours. Imagine that the distance was traveled in a straight line north. If the train's average momentum was 7.32×10^8 kg·m/s to the north, what was its mass?

2. In 1993, a generator with a mass of 1.24×10^5 kg was flown from Germany to a power plant in India on a Ukranian-built plane. This constituted the heaviest single piece of cargo ever carried by a plane. Suppose the plane took off with a speed of 101 m/s toward the southeast and then accelerated to a final cruising speed of 197 m/s. During this acceleration, a force of 4.00×10^5 N in the southeast direction was exerted on the generator. For how much time did the force act on the generator?

3. The largest nuts (and, presumably, the largest bolts) are manufactured in England. The nuts have a mass of 4.74×10^3 kg each, which is greater than any passenger car currently in production. Suppose one of these nuts slides along a rough horizontal surface with an initial velocity of 2.40 m/s to the right. If the force of friction acting on the nut is 6.8×10^3 N to the left, (a) what is the change in the nut's momentum after 1.1 s? (b) How far does the nut travel during its change in momentum?

4. Kangaroos are good runners that can sustain a speed of 56 km/h. Suppose a kangaroo is sitting on a log that is floating in a lake. When the kangaroo gets scared, she jumps off the log with a velocity of 15 m/s toward the bank. The log moves with a velocity of 3.8 m/s away from the bank. If the mass of the log is 250 kg, what is the mass of the kangaroo?

5. The Chinese giant salamander is one of the largest of salamanders. Suppose a Chinese giant salamander chases a 5.00 kg carp with a velocity of 3.60 m/s to the right and the carp moves with a velocity of 2.20 m/s in the same direction (away from the salamander). If the speed of the salamander and carp immediately after the salamander catches the carp is 3.50 m/s to the right, what is the salamander's mass?

6. Alaskan moose can be as massive as 8.00×10^2 kg. Suppose two feuding moose, both of which have a mass of 8.00×10^2 kg, back away and then run toward each other. If one of them runs to the right with a speed of 8.0 m/s and the other runs to the left with a speed of 6.0 m/s, what amount of kinetic energy will be lost after their inelastic collision?

7. American juggler Bruce Sarafian juggled 11 identical balls at one time in 1992. Each ball had a mass of 0.20 kg. Suppose two balls have an elastic head-on collision during the act. The first ball moves away from the collision with a velocity of 3.0 m/s to the right, and the second ball moves away with a velocity of 4.0 m/s to the left. If the first ball's velocity before the collision is 4.0 m/s to the left, (a) what is the velocity of the second ball before the collision? (b) Confirm your answer by checking the kinetic energy is conserved before and after the collision.

(2D) 8. A 80 kg football player running 3 m/s north collides inelastically with a 60 kg player who is running 4 m/s west. Find the speed and direction of the players while they are stuck together.

(2D) 9. Three friends go ice skating together. At some point during their adventure, the huddle up next to each other and come to a complete stop. They push off each other simultaneously. Joe, 65 kg, moves north at 2 m/s. Jesse, 55 kg, moves east at 2.5 m/s. If the third friend, Nick, has a mass of 70 kg then with what speed and with what direction does he travel with after the 'explosion'?

(2D) 10. A cue ball of mass 0.8 kg elastically collides with the 8 ball (also a mass of 0.8 kg). The cue ball was originally rolling to the right at 1.5 m/s and strikes the 8 ball which was originally at rest. After the collision, the 8 ball moves directly downwards at 0.7 m/s. What is the speed and direction of the cue ball after the elastic collision?