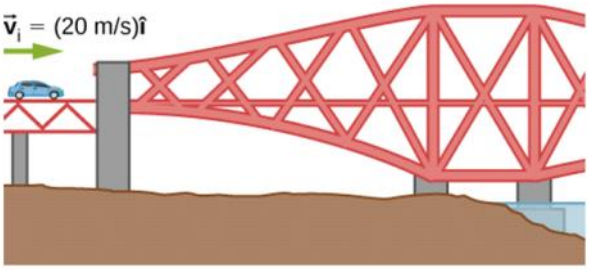
HW_8_Linear_Momentum_and_Collisions_Ch_9

Problems: 21, 25, 28, 33, 35, 39, 43, 47, 53, 57, 63, 69, 73, Total = 13

21. The mass of Earth is 5.97×10^{24} kg and its orbital radius is an average of 1.50×10^{11} m. Calculate the magnitude of its average linear momentum.

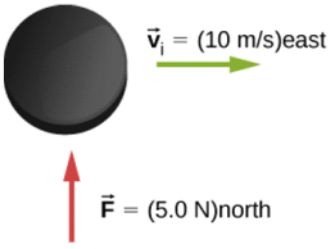
25. A 75.0-kg person is riding in a car moving at 20.0 m/s when the car runs into a bridge abutment (see the following figure).

a. Calculate the average force on the person if he is stopped by a padded dashboard that compresses an average of 1.00 cm.
b. Calculate the average force on the person if he is stopped by an air bag that compresses an average of 15.0 cm.



28. Calculate the final speed of a 110-kg rugby player who is initially running at 8.00 m/s but collides head-on with a padded goalpost and experiences a backward force of 1.76×10^4 N for 5.50×10^{-2} s.

33. A hockey puck of mass 150 g is sliding due east on a frictionless table with a speed of 10 m/s. Suddenly, a constant force of magnitude 5 N and direction due north is applied to the puck for 1.5 s. Find the north and east components of the momentum at the end of the 1.5-s interval.



35. Train cars are coupled together by being bumped into one another. Suppose two loaded train cars are moving toward one another, the first having a mass of 1.50×10^5 kg and a velocity of $(0.30\ \text{m/s})\,\hat{\mathbf{i}}$, and the second having a mass of 1.10×10^5 kg and a velocity of $-(0.12\ \text{m/s})\,\hat{\mathbf{i}}$. What is their final velocity?

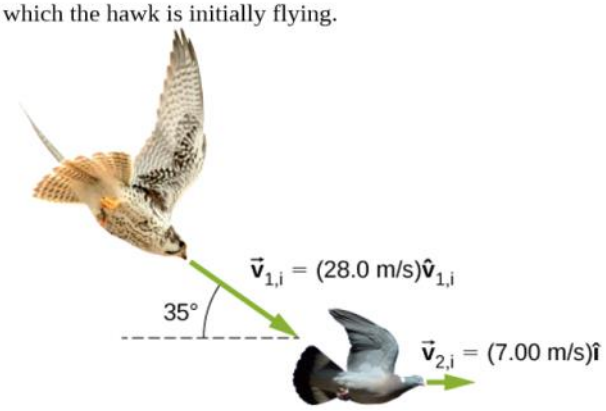
39. A 5000-kg paving truck coasts over a road at 2.5 m/s and quickly dumps 1000 kg of gravel on the road. What is the speed of the truck after dumping the gravel?

43. A 5.50-kg bowling ball moving at 9.00 m/s collides with a 0.850-kg bowling pin, which is scattered at an angle to the initial direction of the bowling ball and with a speed of 15.0 m/s.

a. Calculate the final velocity (magnitude and direction) of the bowling ball.
b. Is the collision elastic?

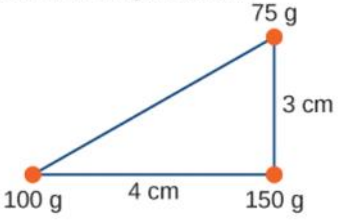
47. In an elastic collision, a 400-kg bumper car collides directly from behind with a second, identical bumper car that is traveling in the same direction. The initial speed of the leading bumper car is 5.60 m/s and that of the trailing car is 6.00 m/s. Assuming that the mass of the drivers is much, much less than that of the bumper cars, what are their final speeds?

53. A 1.80-kg falcon is diving at 28.0 m/s at a downward angle of $35°$. It catches a 0.650-kg dove from behind in midair. What is their combined velocity after impact if the dove's initial velocity was 7.00 m/s directed horizontally? Note that $\hat{\mathbf{v}}_{1,i}$ is a unit vector pointing in the direction in which the hawk is initially flying.



57. A 200-kg rocket in deep space moves with a velocity of $(121\ \text{m/s})\,\hat{\mathbf{i}} + (38.0\ \text{m/s})\,\hat{\mathbf{j}}$. Suddenly, it explodes into three pieces, with the first (78 kg) moving at $-(321\ \text{m/s})\,\hat{\mathbf{i}} + (228\ \text{m/s})\,\hat{\mathbf{j}}$ and the second (56 kg) moving at $(16.0\ \text{m/s})\,\hat{\mathbf{i}} - (88.0\ \text{m/s})\,\hat{\mathbf{j}}$. Find the velocity of the third piece.

63. Three point masses are placed at the corners of a triangle as shown in the figure below.



Find the center of mass of the three-mass system.

69. Find the center of mass of a rod of length L whose mass density changes from one end to the other quadratically. That is, if the rod is laid out along the x-axis with one end at the origin and the other end at $x = L$, the density is given by $\rho(x) = \rho_0 + (\rho_1 - \rho_0)\left(\frac{x}{L}\right)^2$, where ρ_0 and ρ_1 are constant values.

73. Find the center of mass of cone of uniform density that has a radius R at the base, height h, and mass M. Let the origin be at the center of the base of the cone and have +z going through the cone vertex.