PHY151H1F – Practice Problem Set 5

Ch. 4, Q. 25

25. A 1-kg standard cart collides with a 5.0-kg cart initially at rest on a low-friction track. After the collision, the standard cart is at rest and the 5.0-kg cart has a velocity of 0.20 m/s to the left. What was the initial velocity of the standard cart? ●●

Ch. 4, Q. 47

47. A cart moving on a low-friction track has a momentum of 6 kg · m/s to the right. At the end of the track is a wall. (*a*) What is the momentum of the system that consists of the cart and the wall? (*b*) After the cart collides with the wall, the cart's momentum is 6 kg · m/s to the left. What is the wall's momentum after impact? (*c*) Is the system defined in part *a* an isolated system? Why doesn't the wall move? ●●

Ch. 4, Q. 60

60. You are driving your 1000-kg car at a velocity of $(20\ \text{m/s})\hat{\imath}$ when a 9.0-g bug splatters on your windshield. Before the collision, the bug was traveling at a velocity of $(-2.0\ \text{m/s})\hat{\imath}$. Before the collision, what were (*a*) your car's momentum and (*b*) the bug's momentum? (*c*) What is the change in velocity of the car due to its encounter with the bug? ●●

Challenge Problem (If you have finished all of the above) From Mazur Practice Pages 60 & 61

Suppose a rocket that has a combined rocket + fuel inertia m_i starts from rest and then expels fuel at a rate dm/dt. The speed of the fuel as it exits the rocket at any instant t is the difference between the forward speed of the rocket at this instant and the constant nozzle speed of the ejected fuel v_{fuel} (that is, v_{fuel} is the speed with which the fuel is ejected when the rocket is at rest). Use conservation of momentum to show that, once enough fuel has been expelled to reduce the combined rocket + fuel inertia to m_f, the change in the rocket's speed $\Delta v_{rocket} = v_{rocket,f} - v_{rocket,i}$ is

$$v_{rocket,f} - v_{rocket,i} = v_{fuel} \ln \frac{m_i}{m_f}.$$

Ignore any gravity effects. (This classic rocketry formula was first worked out by Russian engineer K. Tsiolkovskii in 1897.)