Answer on Question #45037, Physics, Other

Task: In a particular crash test, a car of mass 1500 kg collides with a wall. The initial and final velocities of the car are v = -15.0 m/s and v = 2.60 m/s, respectively. If the collision lasts for 0.150 s, find the impulse caused by the collision and the average force exerted on the car.

Solution:

The collision time is short, so we can imagine the car being brought to rest very rapidly and the moving back in the opposite direction with a reduced speed. Let us assume the net force exerted on the car by the wall and friction from the ground is large compared with other forces on the car (such as air resistance). Furthermore, the gravitational force and the normal force exerted by the road on the car are perpcndiculat to the motion and therefore do not affect tin horizontal momentum. Therefore, we categorize the problem as one in which we can apply the impulse approximation in the horizontal direction. We also see that the car's momentum changes due to an impulse from the environment. Therefore, we can apply the nonisolated system (momentum) model.

Evaluate the initial and final momenta of the car:

$$\vec{p}_i = m\vec{v}_i = 1500(-15 m/s) = -2.25 \cdot 10^4 kg \cdot m/s$$
$$\vec{p}_j = m\vec{v}_j = 1500(-2.6 m/s) = 0.39 \cdot 10^4 kg \cdot m/s$$

The impulse on the car: $\vec{I} = \vec{p}_j - \vec{p}_i = m\vec{v}_j = 1500(-2.6 m/s) = 2.64 \cdot 10^4 kg \cdot m/s$

the average force exerted on the car: $\sum \vec{F} = \frac{\vec{I}}{t} = \frac{2.64 \cdot 10^4 kg \cdot m/s}{0.150 s} = 1.76 \cdot 10^5 N$