In a particular crash test, a car of mass 1 500 kg collides with a wall, as shown in Figure 9.6. The initial and final velocities of the car are $v_i = -15.0\hat{i}$ m/s and $v_f = 2.60\hat{i}$ 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: Let us assume that the force exerted by the wall on the car is large compared with other forces on the car so that we can apply the impulse approximation. Furthermore, we note that the gravitational force and the normal force exerted by the road on the car are perpendicular to the motion and therefore do not affect the horizontal momentum The initial and final momenta of the car are

$p_i = mV_i = (1500\ kg)\ (-15.0\hat{i}\ m/s) = -2.25 \times 10^4\hat{i}\ \ kg*m/s$

$p_f = mV_f = (1\ 500\ kg)\ (2.60\hat{i}\ m/s) = 0.39 \times 10^4\hat{i}\ \ kg*m/s$

Hence, the impulse is equal to

$I = \Delta p = p_f - p_i = 0.39 \times 10^4\hat{i}\ \ kg*m/s - (-2.25 \times 10^4\hat{i}\ \ kg*m/s) = 2.64 \times 10^4\hat{i}\ \ kg*m/s$

The average force exerted by the wall on the car is

$$\overline{F} = \frac{\Delta p}{\Delta t} = \frac{2.64\ \text{X}\ 104\hat{i}\ \ \text{kg} * \text{m/s}}{0.150\ s} = 1.76 \cdot\ 10^5\hat{i}\ \ \text{N}$$

Note that in this problem the signs of the velocities indicate the reversal of directions.