Chapter 7 Problem 51

Bumper designed to withstand a 1.1 m/s collision.

Find the averge force of the bumper during a collision.

$\Delta x = 0.200\,m$

$m = 900\,kg$

$v_0 = 1.1\,m/s$

By the Work energy theorem

$$W = \Delta K = \tfrac{1}{2} m v_f^2 - \tfrac{1}{2} m v_0^2$$

The work done by the bumper is

$$W = F_{avg} \cdot \Delta x$$

$$\therefore \quad F_{avg} \cdot \Delta x = \frac{1}{2} m v_f^2 - \tfrac{1}{2} m v_0^2$$

Final velocity is zero. Therefore

$$F_{avg} = \frac{0 - \tfrac{1}{2} m v_0^2}{\Delta x} = -\frac{m v_0^2}{2 \Delta x}$$

$$= -\frac{(900\,kg)(1.1\,m/s)^2}{2\,(0.200\,m)} = \boxed{-2700\,N}$$

The negative sign indicates the force of the bumper is opposite of the direction of motion. that is why the car comes to a stop (negative acceleration)