Answer on Question 74312, Physics, Other

Question:

A car's bumper is designed to withstand a $4\ km/h$ collision with an immovable object without damaging the body of the car. The bumper cushions the shock by absorbing the force over a distance. Calculate the magnitude of the average force in a bumper that collapses $0.205\ m$ while bringing a $875\ kg$ car to rest from an initial speed of $1.2\ m/s$, in Newtons.

Solution:

We can find the average force in a bumper from the work-energy theorem (the change in the kinetic energy of the car is equal to the work done by the force F over a distance s to stop the car):

$$W = KE_f - KE_i = Fs,$$

$$\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = Fs,$$

$$F = \frac{\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2}{s} = \frac{\frac{1}{2}\cdot 875\ kg\cdot\left(0\ \frac{m}{s}\right)^2 - \frac{1}{2}\cdot 875\ kg\cdot\left(1.2\ \frac{m}{s}\right)^2}{0.205\ m} = \\ = -3073\ N.$$

The sign minus indicates that the car slows down. The magnitude of the average force in a bumper is $3073\ N$.

Answer:

$F = 3073\ N.$