

Review: Elastic Collisions. Low Speed Crash. Solution

A 1000 kg car going 3 m/sec overtakes and collides with a truck of mass 2000 kg going 1 m/sec. The bumpers were designed to deform elastically and spring back, i.e., to undergo low speed collisions without damage. Assuming the collision is elastic, what is the final speed of the truck?

What impulse did the collision apply to the car?

Momentum is conserved. Also the speed of approach (2 m/s) is equal to the speed they recede from each other after the collision. Thus we write

P_{total} , originally equal to $1000 \cdot 3 + 2000 \cdot 1 = 5000 \text{ N}\cdot\text{s}$

and

$P_{\text{final}} = 5000 = 1000v_1 + 2000 v_2$

where v_1 and $v_2 > v_1$ are the final velocities of the two vehicles.

We also write

$v_2 - v_1 = 2$ being the speed with which they recede from each other.

Solving these two equations gives $v_2 = 2.33 \text{ m/s}$ and $v_1 = 0.333 \text{ m/s}$

The car changed its momentum from 3000 N-s to 333 N-s. Thus it received an impulse of -2666 N-s. The truck received an impulse of +2666 N-s.