Momentum

FORMULAS

momentum:	$p = mv$	measured in kg·m/s
impulse:	$\Delta p = F\Delta t = m(\Delta v) = mv_f - mv_i$	measured in N·s
elastic collision (kinetic energy is conserved):	$m_a v_a + m_b v_b = m_a v_a' + m_b v_b'$	
inelastic collision (energy escapes):	$m_a v_a + m_b v_b = (m_a + m_b)v'$	

LAW OF CONSERVATION OF MOMENTUM

When no external force acts on a system, the total momentum of the system remains constant.

total momentum before collision = total momentum after collision

Example 1: What is the momentum of a 1500-kg car moving at 10 m/s?

Solution: $p = mv = (1500\ \text{kg})(10\ \text{m/s}) = 1.5 \times 10^4\ \text{kg·m/s}$

Example 2: A 3.50-g bullet is fired into a 3.75-kg block of wood suspended from a string. The bullet is embedded in the block of wood, and they move off together with a speed of 0.885 m/s. What was the velocity of the bullet before the collision?

Solution: This is an example of an inelastic collision, since some energy went into deforming the block (specifically, making a hole in it).

$$m_{bullet} \cdot v_{bullet} + m_{block} \cdot v_{block} = (m_{bullet} + m_{block})v'$$

$$(3.50 \times 10^{-3}\ \text{kg})(v_{bullet}) + (3.75\ \text{kg})(0) = (3.50 \times 10^{-3} + 3.75\ \text{kg})(0.885\ \text{m/s})$$

$$v_{bullet} = \frac{3.7535 \times 0.885}{3.50 \times 10^{-3}} = 949\ \text{m/s}$$

EXERCISES

A. What is the momentum of an electron with a mass of 9.11×10^{-31} kg, moving at a velocity of 3.25×10^{7} m/s?

B. The momentum of a 2.25-kg object is 55.5 kg·m/s. At what velocity is it moving?

C. A bullet travelling at 750 m/s has a momentum of 6.6 kg·m/s. What is its mass?

D. What impulse is exerted by a hockey stick exerting a force of 115 N on a puck during the 0.06 s they are in contact?

E. What velocity will a 40-kg child sitting on a 50-kg wagon acquire, if pushed from rest by a force of 85 N for 2.0 s?

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