W7.05

MOMENTUM

Impulse / Elastic Collisions-problems

1. A bullet with a mass of .008-kg (8.0-gram) is fired horizontally into a stationary 9.0-kg block of wood on a frictionless horizontal surface. The bullet sticks into the block of wood and after the impact, the block has a speed of 0.4 m/s.
   a. What was the initial velocity of the bullet?
   b. If the bullet came to rest inside the block in 3.0 milliseconds (3.0×10^{-3} sec), what force did the block of wood applied on the bullet?
   c. What is the change in mechanical energy (KE) of the bullet-block system?
   d. What is the change in momentum of the bullet-block system?
   e. If the bullet bounced off the block rather than embedding itself in the block, would the impulse be larger or smaller? Explain.

2. A 2.0-kilogram brick is moving at a speed of 6 meters per second. How large a force is needed to bring the brick to rest in 7.0×10^{-4} seconds?

3. A 40,000-kg freight car is coasting at a speed of 5.0 m/s along a straight track when it strikes a 30,000 kg stationary freight car and couples to it. What will be the speed after impact?

4. Two balls of equal mass, moving with a speed of 3.0 m/s, collide head on. Find the velocity of each after impact for each of the following situations.
   a. They have an inelastic (stick) collision.
   b. They have a perfectly elastic collision (KE conserved).

5. Four 50-kg girls are sitting in a boat at rest. They simultaneously dive horizontally in the same direction at 2.5 m/s from the same side of the boat. The empty boat has a speed of 0.1 m/s afterwards.
   a. What is the mass of the boat?
   b. What is the change in mechanical energy of the system?

6. A 4,000-kg truck is moving eastward through a frictionless intersection at 3.0 m/s. A second truck, with a mass of 8,000 kg, is moving northward through the same intersection at 2.0 m/s. They collide and stick together.
   a. What is their speed immediately after impact?
   b. What is the change in mechanical energy of the system?
   c. Name at least two places the energy went.

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1. a. 450.4 m/s
   b. 1.2×10^3 N
   c. -810.72 J
   d. 0 Ns
   e. Larger Δp for bullet when it bounces (+ to – v), so larger impulse

2. -17143 N (- means opposite direction of movement)

3. 2.86 m/s

4. a. 0 m/s
   b. 3 m/s (both reverse direction)

5. a. 5000 kg
   b. +650 J

6. a. 1.67 m/s
   b. -17333 J
   c. heat, sound, deformation